BOEM

Bureau of Ocean Energy Management

Comprehensive Synthesis of Impacts to Marine Mammals from Oil and Gas Activities on the Alaska Outer Continental Shelf

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ECO49 CONSULTING, LLC

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List of Acronyms

2D	two-dimensional
3D	three-dimensional
4MP	Marine Mammal Monitoring and Mitigation Plan
ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area
ADFG	Alaska Department of Fish and Game
AES	ASRC Energy Services
AEWC	Alaska Eskimo Whaling Commission
AGDC	Alaska Gasline Development Corporation
AIS	Automatic Identification System
ANIMIDA	Arctic Nearshore Monitoring in the Development Area
AKLNG	Alaska Liquified Natural Gas
ANWR	Arctic National Wildlife Refuge
AOGA	Alaska Oil and Gas Association
AOOS	Alaska Ocean Observing System
APA	Administrative Procedure Act
APD	Application Permits to Drill
ASAMM	Aerial Surveys of Arctic Marine Mammals
AMARs	Autonomous Multichannel Acoustic Recorders
AWL	Alaska Wilderness League
BA	Biological Assessment
BC	Black Carbon
BCB	Bering-Chukchi-Beaufort
BE	Biological Evaluation
BiOp	Biological Opinion
BLM	Bureau of Land Management
BMPs	Best Management Practices
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BOWFEST	Bowhead Whale Feeding and Ecology Study
BPXA	British Petroleum Exploration Alaska, Inc
bbls	barrels
bpd	barrels per day
BSEE	Bureau of Safety and Environmental Enforcement
CAA	Conflict Avoidance Agreement
cANIMIDA	Continuation of the Arctic Nearshore Monitoring in the Development Area
CAO	Central Arctic Ocean
CCG	Canadian Coast Guard
CCVA	Climate Change Vulnerability Analysis
CEO	Chief Executive officer
CFR	Code of Federal Regulations
CIPL	Cook Inlet Pipeline
CIRT	Cook Inlet Response Tool
CITES	Convention of International Trade in Endangered Species
Com-Center	Communication Center
CPAI	Conoco Phillips Alaska

CSAW	Chukchi Sea Acoustics Workshop
dB	decibel
DECC	Department of Energy and Climate Change
DoD	Department of Defense
DOSITS	Discovery of Sound in the Sea
DPS	Distinct Population Segment
DPP	Development and Production Plan
DSAR	Directional Autonomous Seafloor Acoustic Recorders
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EIS	Environmental Impact Statement
EP	Exploration Plan
ESA	Endangered Species Act
EVOS	*Exxon Valdez* Oil Spill
FLIR	Forward Looking Infrared
FM	Frequency Modulation
FONSI	Finding of no Significant Impacts
FR	Federal Register
GIS	Geographic Information System
GOA	Gulf of Alaska
GOOS	Global Ocean Observing System
GPS	Global Positioning System
GSC	Geological Survey of Canada
GXT	GX Technology
ha	hectare
HFC	High-frequency Cetacean
Hilcorp	Hilcorp Alaska, LLC
HSUS	Humane Society of the U.S.
HSWUA	Hanna Shoal Walrus Use Area
Hz	hertz
ICAS	Inupiat Community of the Arctic Slope
ISC	Ice Seal Committee
IHA	Incidental Harassment Authorization
ION	ION Geophyscial
IPCC	Intergovernmental Panel on Climate Change
ITL	Information to Lessees
ITR	Incidental Take Regulations
ITS	Incidental Take Statements
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
kHz	kilohertz
KRU	Kuparuk River Unit
kts	knots
L_{eq}	Average Continuous Sound Level
LBCHU	Ledyard Bay Critical Habitat Unit
LCF	Low Frequency Cetacean
LDPI	Liberty Development and Production Island
LME	Large Marine Ecosystem

LNG	Liquid Natural Gas
LOA	Letter of Authorization
LOC	Letter of Concurrence
m	meters
MarVib	marine vibroseis
MHHW	Mean Higher High Water
MFC	mid-frequency cetacean
MMC	Marine Mammal Commission
MMS	Minerals Management Service
MOC	Marathon Oil Company
MODU	Mobile Offshore Drilling Unit
MSFD	Marine Strategy Framework Directive
MPA	Marine Protected Areas
NAEC	Northern Alaska Environmental Center
NEPA	National Environmental Policy Act
NITS	Noise-Induced Threshold Shift
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NOAA	National Oceanic and Atmospheric Administration
NPRA	National Petroleum Reserve-Alaska
NRC	National Research Council
NRS	Noise Reference Stations
NSAR	National Strategy for the Arctic Region
NSB	North Slope Borough
OBC	Ocean Bottom Cable
OBN	Ocean Bottom Node
OBS	Ocean Bottom Sensor
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
ODS	Oooguruk Drill Site
OPP	Oliktok Production Point
OSA	Oil Search Alaska
OSPAR	Convention for the Protection of the Marine Environment of the Northeast Atlantic
OSR	Oil Spill Response
OSV	Offshore Supply Vessel
OTP	Oooguruk Tie-in Pad
OW	Otariid in Water
PacMARS	Pacific Marine Arctic Regional Synthesis
PAH	polycyclic aromatic hydrocarbon
PAM	Passive Acoustic Monitoring
PAME	Protection of the Arctic Marine Environment
PBSG	Polar Bear Specialist Group
PCE	Primary Constituent Elements
PCAD	Population Consequences of Acoustic Disturbance
PDV	Phocine Distemper Virus
PEA	Programmatic Environmental Assessment
Phillips	Phillips Alaska, Inc.
PK	Peak Sound Level

POA	Port of Anchorage
POC	Plan of Cooperation
POPs	Persistent Organic Pollutants
PRN	Pseudorandom Noise
PSO	Protected Species Observer
PTS	Permanent Threshold Shift
PW	phocid in pater
Quintillion	Quintillion Subsea Operations, LLC
REDOIL	Resisting Environmental Destruction on Indigenous Lands
RCP	Representative Concentration Pathways
ROD	Record of Decision
ROW	Right of Way
RSL	Received Sound Level
SEIS	Supplemental Environmental Impact Statement
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure level
SDC	Steel Drilling Caisson
SID	Spy Island Drillsite
SL	Source Level
SOAR	Synthesis of Arctic Research
SOI	Shell Offshore, Inc.
SPL	Sound Pressure Level
SPTS	Sound Pressure Time Series
SZ	Safety Zone
TL	Transmission Loss
TNAP	Temporary Noise Attenuation Pile
Statoil	Statoil USA E&P, Inc.
UCOC	Union Oil Company of California
USACE	U.S. Army Corps of Engineers
USCGC	U.S. Coast Guard Cutter
USGS	U.S. Geological Survey
USFWS	U.S. Fish and Wildlife Service
TAPS	TransAlaska Pipeline System
TK	Traditional Knowledge
TTS	Temporary Threshold Shift
Veritas	CGGVerita
UAS	Unmanned Aircraft System
UK	United Kingdom
VLOS	Very Large Oil Spill
VSP	Vertical Seismic Profile
ZOI	Zone of Influence
ZVSP	Zero-offset Vertical Seismic Profile

Introduction

The Bureau of Ocean Energy Management's (BOEM) Environmental Studies Program (ESP) develops, conducts, and oversees world-class scientific research specifically to inform policy decisions regarding offshore oil and gas development. As such, BOEM is a contributor to the growing body of scientific knowledge about the nation's marine environment including in the Arctic. BOEM's Alaska Region Office is responsible for managing the development of oil and gas, as well as other mineral and renewable resources, in an environmentally and economically responsible way according to the Outer Continental Shelf Lands Act (OCSLA). To that end, BOEM's decision-making capability is strongly tied to available science and its knowledge of potential effects on marine mammals as a result of development activities.

This annotated bibliography represents an examination of information sources relevant to understanding the potential impacts of oil and gas activities on marine mammals in Alaska's Arctic and Cook Inlet within the context of other anthropogenic activities for the period 2000 - 2020. Out of nearly 1,000 scientific, government and industry reports, journal articles and publications screened with regard to BOEM's objective, over 500 were identified as germane to the topic of oil and gas activities and marine mammals in the regions of interest (Cook Inlet, Beaufort Sea or Chukchi Sea). Annotations have been categorized into eight broad topic "bins" as described below and each bin lists citations chronologically. The broad scope of information sources includes: peer reviewed articles; scientific publications; technical reports produced by federal, state agencies, industry and other stake holders; applications for rulemaking along with proposed or final rules published in the *Federal Register*; and public comments. For this reason, the annotations may contain different types of information and read differently.

To help users cross-reference citation topics and allow for easy identification of specific issues of interest, checklists have been created for each bin and are included as Appendix A. In addition, Figures 1 – 8 provide a visual reference of the checklists to show the number of documents on specific topics in each bin. This qualitative representation is intended to provide a general perspective on the amount of information available to natural resource managers, industry, scientists and other stakeholders in order to evaluate other similar activities and inform decisions.

Bin 1. Endangered Species Act Section 7 Consultation, Biological Opinions and Letters of Concurrence
The Endangered Species Act (ESA) requires the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) evaluate the potential impacts of authorizing actions (such as oil and gas activities) on ESA-listed species. Bin 1 includes Biological Opinions (BiOps) and other ESA Section 7 Consultation documents such as Letters of Concurrence. This bin contains 67 annotated citations, covering 40 topics (Figure 1).

Bin 2. Marine Mammal Protection Act Rules, Letters of Authorization and Incidental Harassment Authorizations
The Marine Mammal Protection Act (MMPA) prohibits the "take" of marine mammals with certain exceptions. Sections 101(a)(5)(A) and (D) of the MMPA (16 U.S.C. 1361 et seq.) direct the Secretary of Commerce to allow, upon request, the incidental, but not intentional, taking of small numbers of marine mammals by U.S. citizens who engage in a specified activity (other than commercial fishing) within a specified geographical region if certain findings have been made and either regulations have been issued or, if the taking is limited to harassment, a notice of a proposed incidental take authorization may have been provided to the public for review. Authorization for incidental takings shall be granted if

NMFS or USFWS find that the taking will have a negligible impact on the species or stock(s) and will not have an unmitigable adverse impact on the availability of the species or stock(s) for taking for subsistence uses (where relevant). Bin 2 includes MMPA rules, Letters of Authorization (LOAs) and Incidental Harassment Authorizations (IHAs) and related documents. This bin has 98 citations covering 42 topics (Figure 2).

Bin 3. National Environmental Policy Act Environmental Impact Statements and Environmental Assessment

The National Environmental Policy Act (NEPA) requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. The broad range of actions covered by NEPA may include making decisions on permit applications, adopting federal land management actions, or constructing facilities. Agencies use the NEPA process to evaluate environmental, social and economic effects of proposed actions and provide opportunities for public review and comment on those evaluations. Evaluations are referred to as Environmental Impact Statements (EIS), Environmental Assessments (EA) or Categorical Exclusions. EAs are often accompanied by a Finding of No Significant Impact (FONSI). Bin 3 includes NEPA documents prepared to evaluate proposed oil and gas activities and includes 41 annotated citations covering 46 topics (Figure 3).

Bin 4. Mitigation and Monitoring

Mitigation and monitoring required under the MMPA or ESA for oil and gas activities are documented in the form of Marine Mammal Monitoring Plans and Reports, 90-day Monitoring Reports, and Annual Monitoring Reports. In addition, published literature may report results of mitigation and monitoring efforts associated with oil and gas activities. These types of information sources comprise Bin 4 and by nature, relate to the authorizations and evaluations that comprise Bins 1-3. Bin 4 has 104 annotated reports and covers 44 topics (Figure 4).

Bin 5. Subsistence and Traditional Knowledge

Bin 5 includes information sources on subsistence and traditional knowledge (TK) as it relates to impacts from oil and gas activities and marine mammals. Bin 5 also contains annotations for cooperative agreements such as Conflict Avoidance Agreements (CAA) or Plans of Cooperation (POC) that are developed between Alaska Native subsistence communities and industry to minimize the potential impacts of oil and gas on subsistence activities. In addition, a representative sample of public comments received from Alaska native communities and organizations on federal processes such as NEPA documents and MMPA authorizations are also summarized. There are 77 annotated documents in this bin that cover 33 topics (Figure 5).

Bin 6. Climate Change

Bin 6 includes information sources on climate change as relevant to the project objective on the potential impacts of oil and gas activities on marine mammals in the Beaufort and Chukchi seas and Cook Inlet. The impacts of climate change on marine mammals provides critical context for understanding the environmental baseline inhabited by marine mammals. Due to the sheer volume of articles on this subject a relatively small sample of applicable literature has been included. There are 24 articles or reports are annotated in this bin and they cover 21 topics (Figure 6).

Bin 7. Scientific Studies

Bin 7 includes peer-reviewed literature, journal articles, and other synthesis documents such as the Synthesis of Arctic Research (SOAR), among others, as they specifically relate to understanding the potential impacts of oil and gas activities on marine mammals in the Beaufort and Chukchi seas and

Cook Inlet. Again, due to the large volume of scientific literature on the topic of oil and gas impacts, we have included a large representative selection of literature on this and other relevant topics. Bin 7 includes 101 annotated citations covering 41 topics (Figure 7).

Bin 8. Oil Spill Incidents, Preparation and Response
Bin 8 contains eight documents regarding oil spill response guidelines, spill occurrence estimators, and preparedness. The documents cover 7 topics (Figure 8).

While this bibliography does not encompass every article or report written on the topics of interest for this time period, it is intended to represent information most relevant to activities and marine mammal species found in Cook Inlet, the Chukchi Sea and Beaufort Sea. In some cases, information sources may relate to each other, such as a proposed and final rule or a series of monitoring reports such as a 90-Day, Annual and Comprehensive Marine Mammal Monitoring Report required under the MMPA. In such cases, there may be one annotation to represent the series of documents referenced.

Each information source is contained in Endnote (Version X9), a searchable citation database designed primarily for managing bibliographies, citations and references. EndNote provides pre-defined fields for recording basic reference information including reference type (journal or report), year, author(s), title, institution, and document or identification number. Any of these fields can be searched using Endnote. Annotations in Endnote are listed in the "notes" data field. Actual PDF documents for each information source is also attached to the citation in the Endnote. This allows users to open the PDF of the complete document directly from Endnote, if needed. In some cases, there may be multiple PDF attachments to a single citation (i.e., a proposed rule and a final rule).

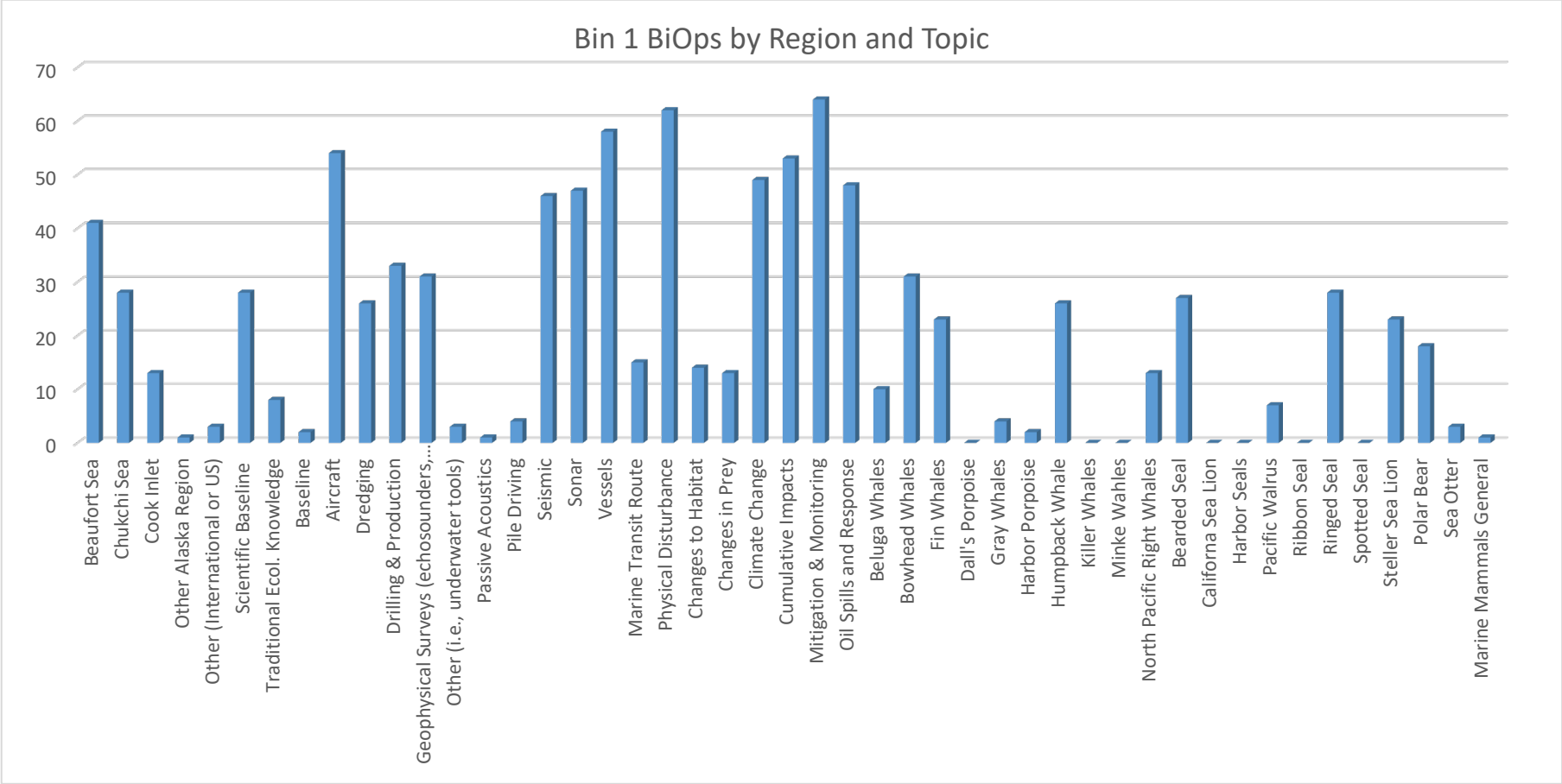

Figure 1. Bin 1 – BiOps by Region and Topic

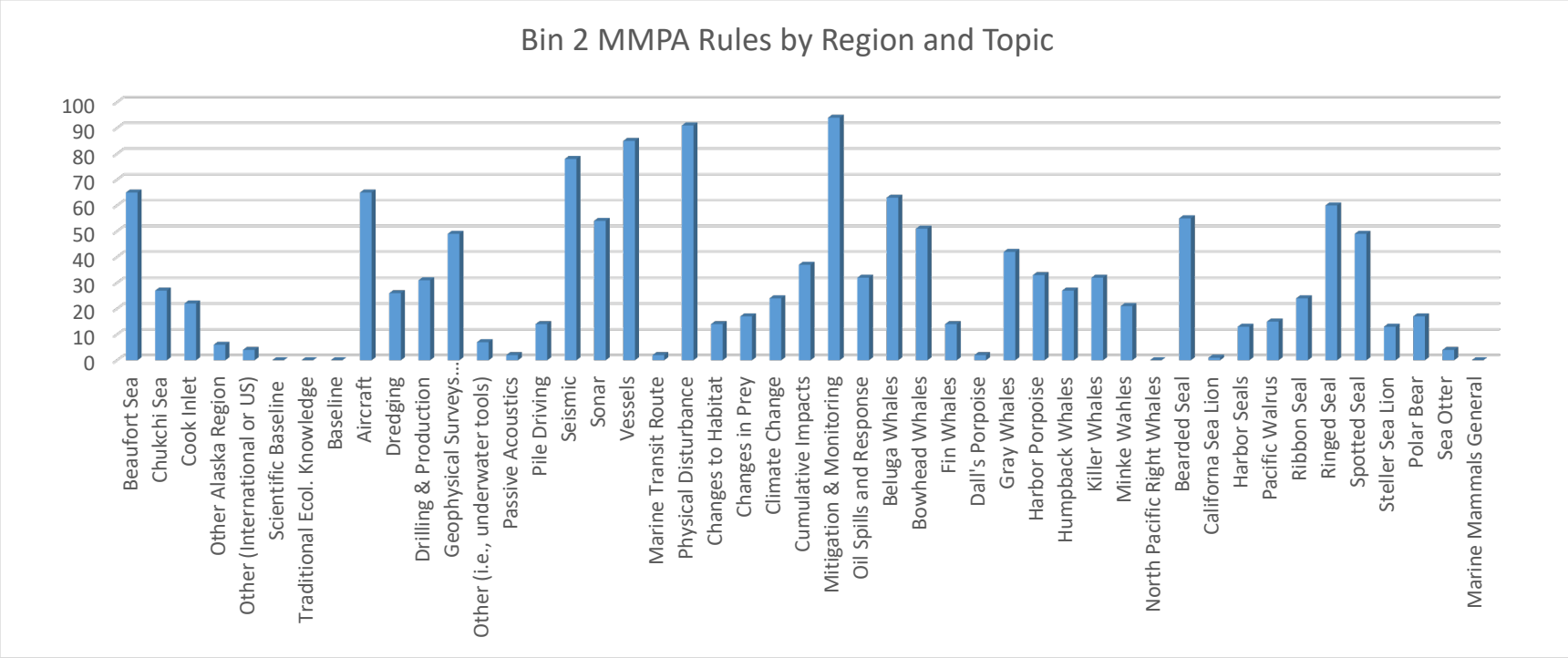

Figure 2. Bin 2 - MMPA Rules by Region and Topic

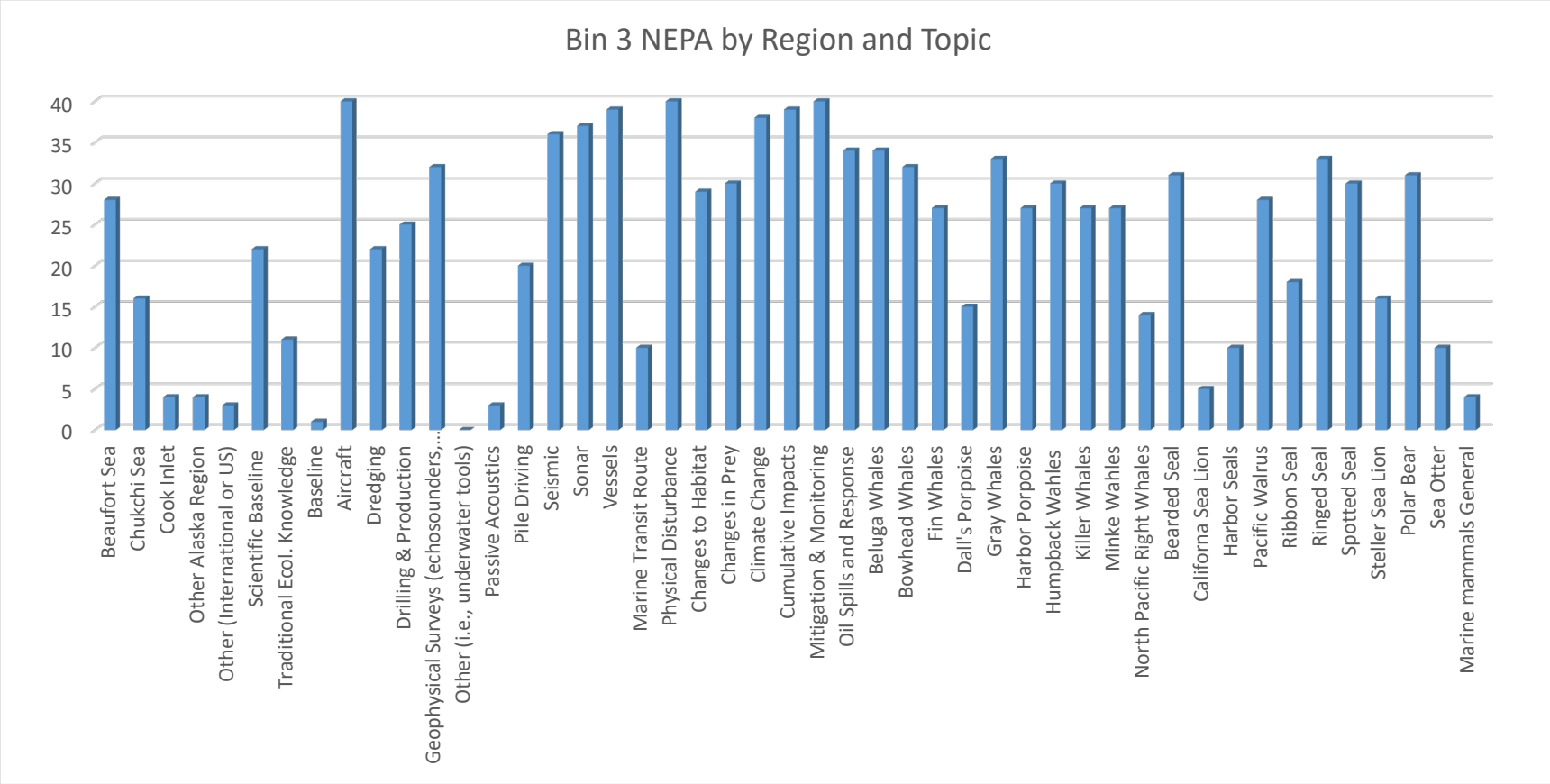

Figure 3. Bin 3 - NEPA Documents by Region and Topic

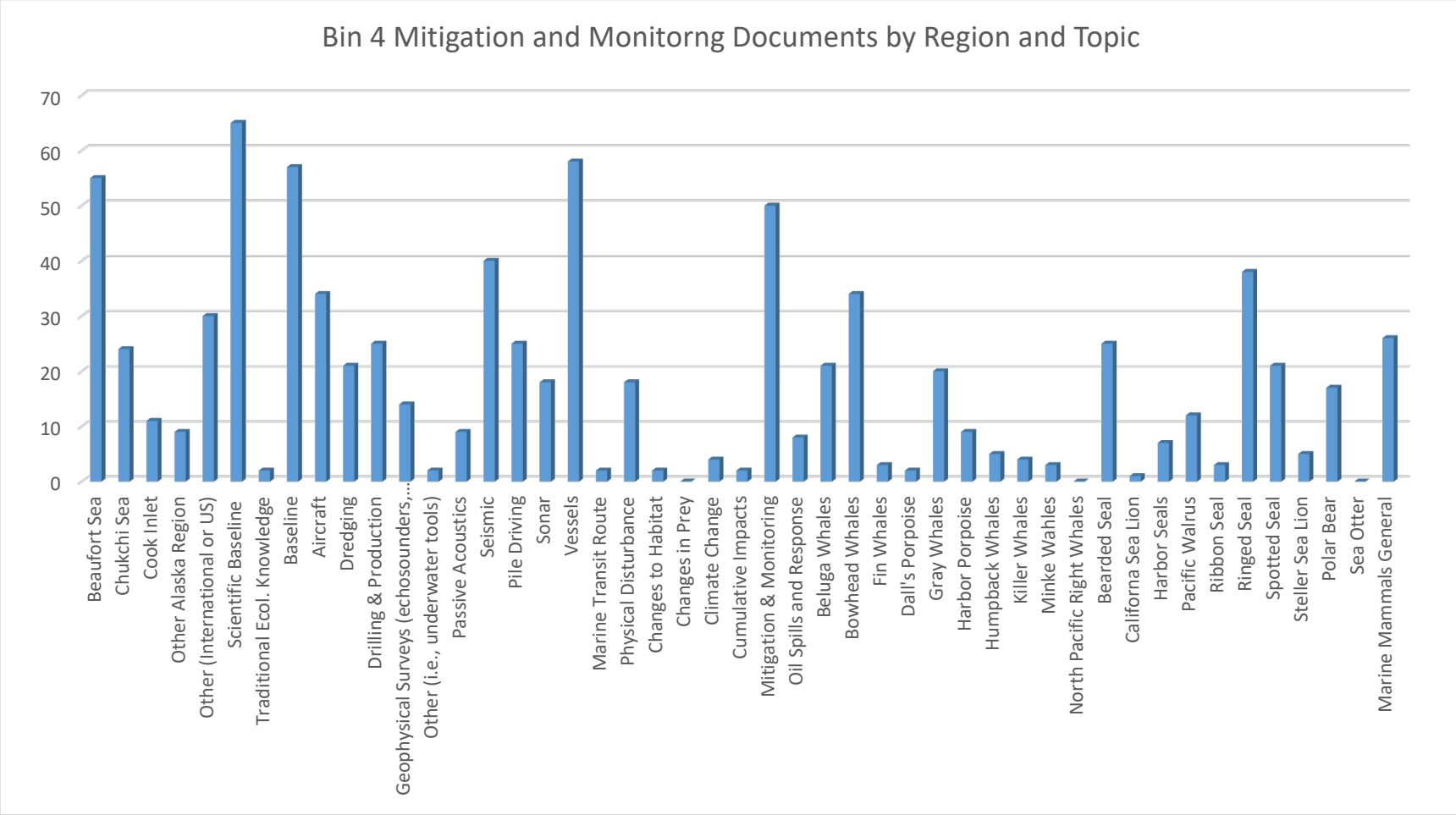

Figure 4. Bin 4 - Mitigation and Monitoring Documents by Region and Topic

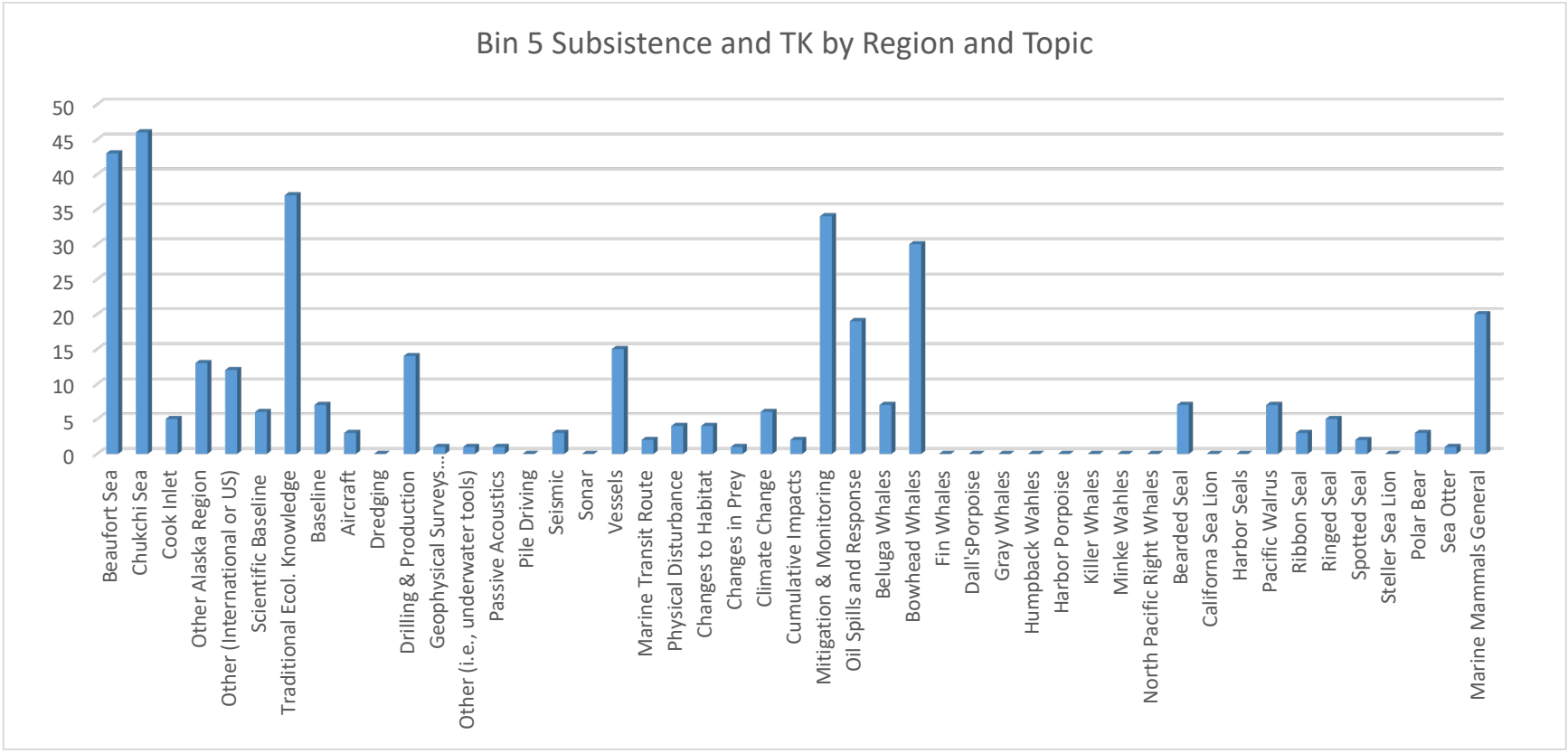

Figure 5. Bin 5 - Subsistence and TK Documents by Region and Topic

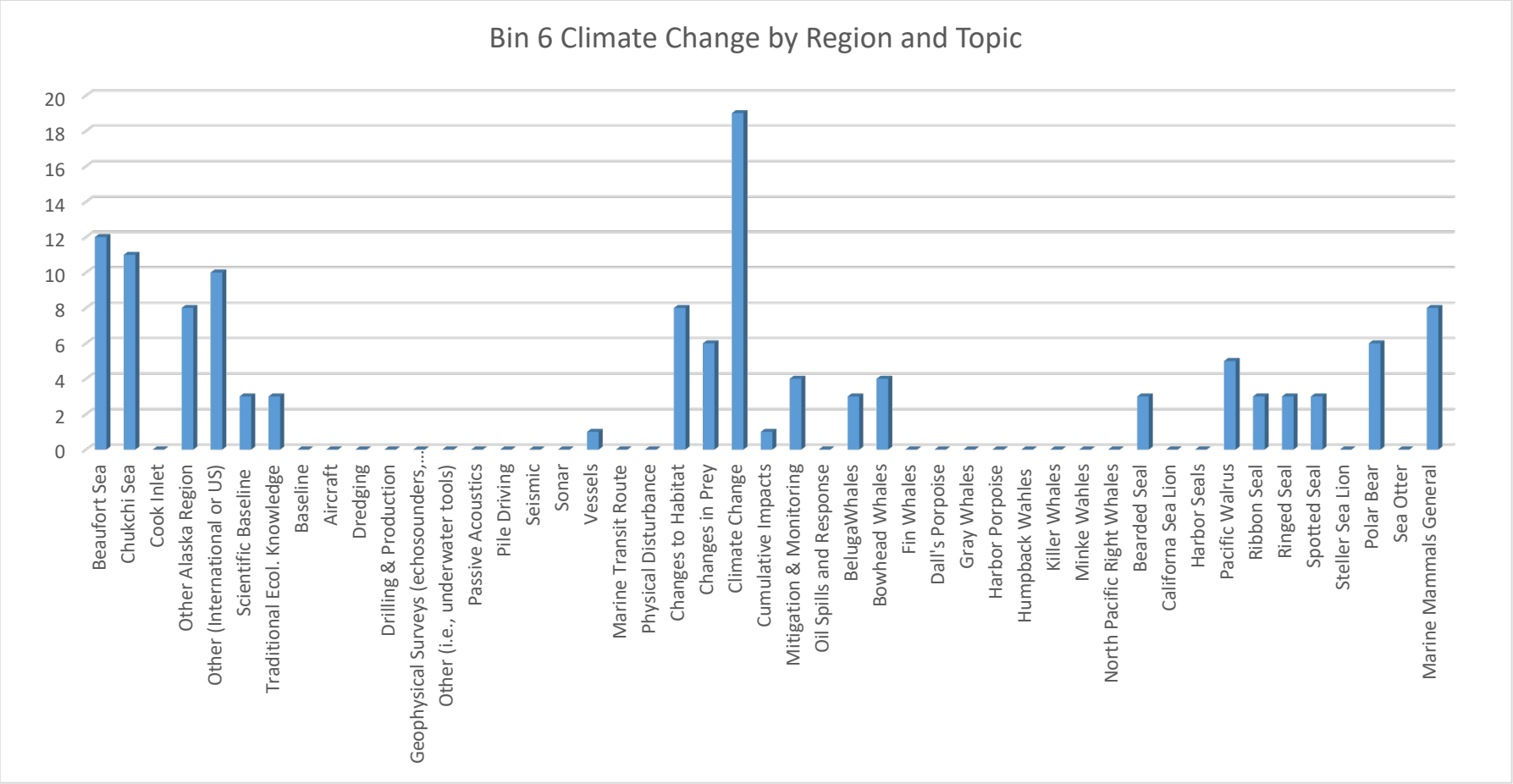

Figure 6. Bin 6 - Climate Change Documents by Region and Topic

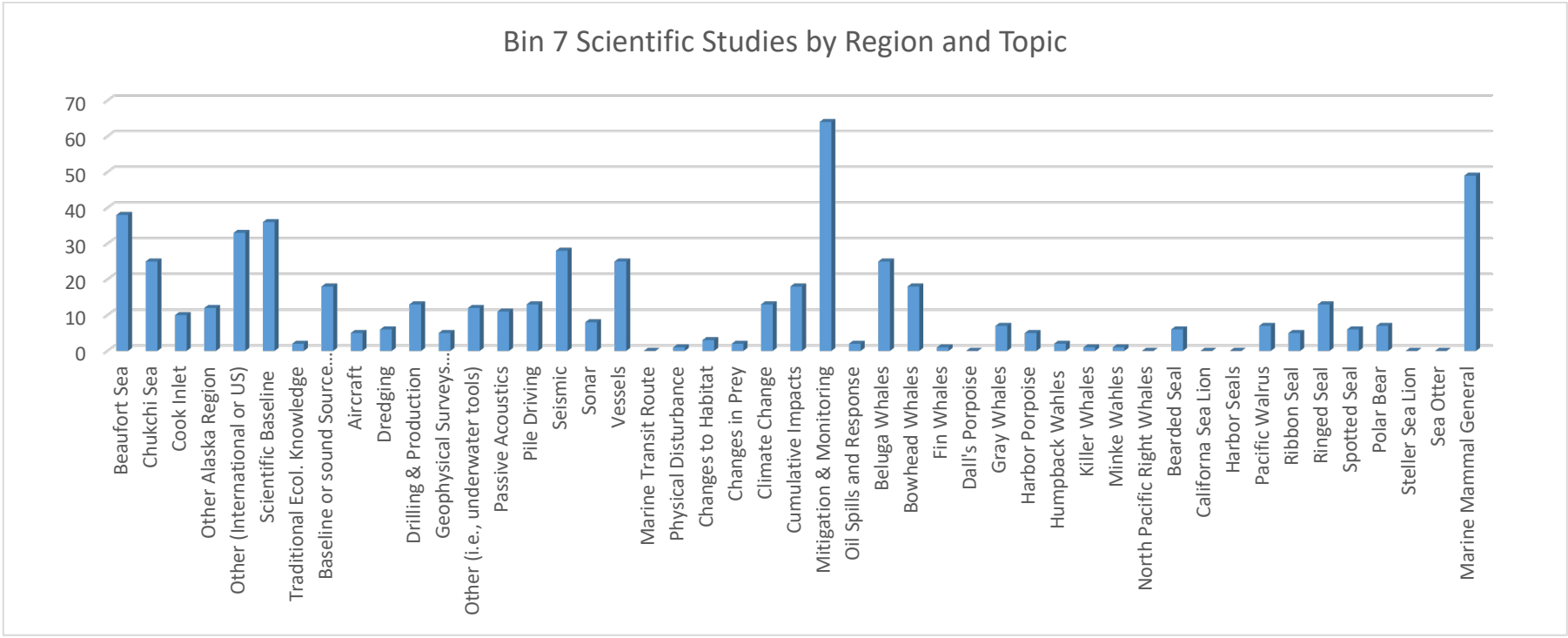

Figure 7. Bin 7 - Scientific Studies by Region and Topic

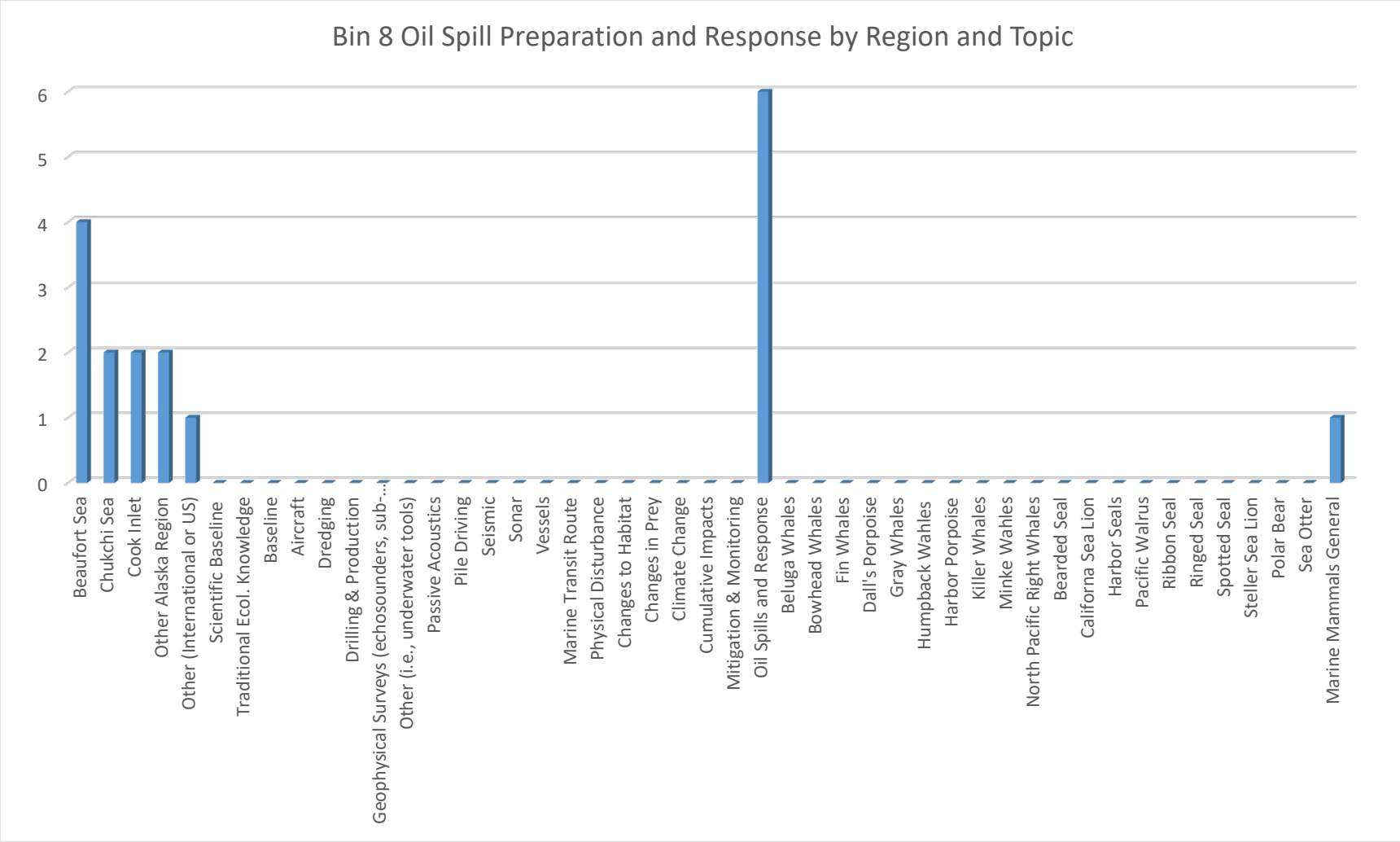

Figure 8. Bin 8 - Oil Spill Preparation and Response Documents by Region and Topic

Bin 1 - Endangered Species Act (ESA) Section 7 Consultation, Biological Opinions (BiOps) and Letters of Concurrence

NMFS (2002). Biological Opinion: BPXA Construction and Operation of the Liberty Oil Production Island, Beaufort Sea, Alaska. National Marine Fisheries Service, Alaska. Office of Protected Resources. Consultation Number F/AKR/2001/00889, January 31, 2002. 51 pp.

This Biological Opinion (BiOP) analyzed direct impacts on bowhead whales from seismic surveys, construction, drilling, aircraft, and support vessels. The analysis was based on previous studies and scientific literature. Inupiat hunters provided traditional knowledge (TK) on behavioral responses by whales to noise and disturbance but TK was not used in the effects analysis. The inclusion of TK represented recognition by the National Marine Fisheries Service (NMFS) that Endangered Species Act (ESA) assessments should consider and understand TK alongside "western science". Despite a lack of sufficient information on bowhead hearing a needed to adequately describe the potential for permanent threshold shift (PTS) or temporary threshold shift (TTS), the BiOp concluded that avoidance reactions of bowheads to approaching seismic vessels would likely prevent exposure to potentially injurious noise pulses. It was NMFS's opinion that noise and disturbance from the Liberty project was not likely to reduce the survival or recovery of bowhead whales by reducing their reproduction, numbers, or distribution. Critical habitat has not been designated for bowhead whales and therefore is not included in this BiOp. The BiOp also concluded that the Liberty project was not likely to adversely affect any other listed marine mammal in the Gulf of Alaska or North Pacific due to transport of oil originating from the North Slope.

NMFS (2003). Biological Opinion: MMS Lease Sales 191 and 199 Oil and Gas Exploration Activities, Cook Inlet, Alaska. National Marine Fisheries Service, Alaska. Office of Protected Resources. Juneau, AK. March 31, 2003. 56 pp.

This BiOp addressed the impacts of leasing and exploration in Cook Inlet on Steller sea lions, fin and humpback whales following an incremental step analysis in compliance with the Outer Continental Shelf Lands Act (OCSLA). This and other early BiOps focused on qualitatively analyzing impacts to marine mammals from exposure to increased noise during seismic surveys. At the time, Steller sea lions were considered one species or population, Cook Inlet beluga whales were not ESA-listed, and there was no critical habitat designated for these species. Similar to previous BiOps, NMFS estimated the number of marine mammal exposures to project ESA takes but the biological significance of behavioral responses to exposure remained in question. This approach is conservative for evaluating "jeopardy" under the ESA since an instance of exposure may not result in a take by harassment. The exposure estimates do reflect the best scientific and commercial data available. There was concern that increased noise levels would mask natural sounds, interfere with communication or alter normal behavior. NMFS recognized that extremely loud noise might cause TTS or PTS, but no evidence was presented that noise from routine human activities (aside from explosions) would cause injury. NMFS concluded that Steller sea lions and baleen whales exposed to noise-producing activities would experience temporary, nonlethal effects (harassment) and exhibit avoidance behavior. Oil and gas activities from MMS oil and gas lease sales 191 and 199 in Cook Inlet would not likely jeopardize the continued existence of any listed marine mammal species, or result in the adverse modification of critical habitat of the Steller sea lion. The BiOp also assessed probability of a large oil spill as a worst case. ESA takes from oil spills were not authorized but mitigation and monitoring measures are included to reduce spill impacts.

USFWS (2003). Biological Opinion: Steller's Eiders from Fairweather Geophysical/Veritas DGC 3D Seismic in Lower Cook Inlet, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Endangered Species Program. Consultation Number 2002-0188, February 4, 2003. 51 pp.

This U.S. Fish and Wildlife Service (USFWS) BiOp analyzed the effects on the Steller's eider from proposed issuance of a U.S. Army Corps of Engineers (USACE) Nationwide Permit 6 for Fairweather Geophysical/Veritas DGC to conduct on-shore and off-shore seismic surveys. This BiOp did not address

impacts to the Northern sea otter population in lower Cook Inlet, which was not ESA-listed until 2005. Therefore, marine mammal species were not part of the analysis of impacts in this BiOp.

NMFS (2006). Biological Opinion: MMS Oil and Gas Leasing and Exploration 2006 - 2013 in Beaufort and Chukchi Seas, Alaska. National Marine Fisheries Service. Alaska Region. June 16, 2006. 108 pp.
The environmental baseline and cumulative effects analysis in this BiOp was very similar to previous BiOps in terms of organization, analysis and conclusions, a pattern that is still evident in BiOps published through 2020. NMFS concluded that the leasing program was likely to adversely affect bowhead whales. Similar to previous BiOps, it was determined that bowheads exposed to industry noise would experience temporary, nonlethal effects. Neither ringed nor bearded seals were ESA-listed at this time. Fin and humpback whales were not expected in the planning areas and were not discussed in the effects section. This BiOp also addressed the authorization of incidental and unintentional taking of bowhead whales under the Marine Mammal Protection Act (MMPA), and placed a much greater emphasis on TK and whale avoidance/deflection from seismic noise. Statements by Inupiat subsistence whalers suggested that industrial noise, especially seismic noise, displaced the fall bowhead migration seaward and reduced accessibility of bowhead whales to subsistence hunters. The BiOp included a statement from the Arctic Open Water Noise Peer Review Workshop held June 5-6, 2001, and as supported by testimony from Inupiat whalers that "Monitoring studies of three-dimensional (3D) seismic exploration…in the nearshore Beaufort Sea during 1996-1998 [at Northstar] have demonstrated that nearly all bowhead whales will avoid an area within 20 km of an active airgun", [and may begin to deflect at distances up to 35 km].

MMS (2008). Supplement to the 2006 Biological Evaluation for MMS Oil and Gas Lease Sales in the Chukchi and Beaufort Seas on Bowhead, Fin and Humpback Whales. U.S. Dept. of the Interior, Minerals Management Service. Region, A.O. May 8, 2008. 63 pp.
On December 3, 2007, MMS sent a letter to NMFS discussing the need to re-initiate consultation on activities associated with oil and gas leasing and exploration in the Beaufort Sea and Chukchi seas. Responding on January 10, 2008, NMFS recommended that formal consultation was necessary to address new information on endangered humpback and fin whales. The Arctic Regional BiOp dated June 06, 2006, stated "because fin and humpback whales are not likely to occur within the action area they are not likely to be adversely affected by these actions and will not be addressed in this opinion." More recent information regarding humpback and fin whales in the Chukchi and Beaufort seas warranted examination to determine if previous conclusions remained valid. This supplement stated that new information regarding bowhead whales was not substantial, would not alter the findings of the 2006 BiOp, and concluded that bowheads are likely to be exposed to and adversely affected by noise and disturbance associated with seismic surveys. Fin and humpback whales were increasing in the Chukchi Sea but were not likely to be exposed to or adversely affected by noise, disturbance, discharges, or oil spills associated with seismic survey activities.

NMFS (2008). Biological Opinion: MMS Oil and Gas Leasing and Exploration 2006 - 2013 in Beaufort and Chukchi Seas, Alaska. National Marine Fisheries Service. Alaska Region. July 17, 2008. 141 pp.
The effects of oil and gas leasing and exploration as well as authorization of "small take" permits under the MMPA for bowhead, fin and humpback whales are evaluated in this BiOp. NMFS stated that subsequent phases of Outer Continental Shelf (OCS) development would require additional consultation to ensure the entire action would not jeopardize the continued existence of a listed species or result in adverse modification of critical habitat. The BiOp notes the uncertainty regarding impacts of sound on marine mammals, on the factors that determine response and effects, and on the long-term cumulative consequences of increasing noise from multiple sources. Summarizing the National Research Council (NRC) 2005 report *Characterizing Biologically Significant Marine Mammal Behavior*, this BiOp stated that

"it is unknown how, or in what cases, responses of marine mammals to anthropogenic sound rise to the level of biologically significant effects". The BiOp recognized that under the ESA, exposures to noise levels that would be considered a "take" under the MMPA may not be considered a "take" under the ESA if there are insignificant consequences to the species. NMFS concluded that the proposed actions would likely have a temporary adverse effect on bowhead, fin and humpback whales due to vessel operations, marine geophysical (seismic) exploration, aircraft traffic, and drilling noises. Available data did not indicate that noise or disturbance from oil and gas exploration and development activities since the mid-1970s have had a lasting population-level adverse effect on bowhead whales. As with previous BiOps, NMFS stated the probability of a large oil spill was "likely remote during the first incremental step of exploration, [but] the ability to prevent, contain, and remove spilled oil was a significant concern".

USFWS (2008). 73 FR 76249 Special Final Rule to Protect Polar Bears Under ESA Section 4(d). ***Federal Register*****, 73:76249-76267.**

The USFWS amended regulations at 50 Code of Federal Regulations (CFR) part 17 to create a final special rule under section 4(d) of the ESA that adopted the existing regulatory requirements under the MMPA for the polar bear. If an activity was prohibited (e.g., not authorized or exempted under the MMPA or the Convention of International Trade in Endangered Species (CITES), it would be prohibited under the ESA.

USFWS (2009). Amended Biological Opinion: BPXA Northstar and Liberty Projects. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. September 1, 2009. 60 pp.

These two BiOps, originally completed prior to the polar bear being listed as threatened under the ESA on May 15, 2008, were revised to include polar bears. The effects of the Northstar and Liberty projects on spectacled and Steller's eiders were evaluated in previous BiOps (USFWS 1999 and USFWS 2007). USFWS concluded that activities associated with the Northstar and Liberty projects may adversely affect polar bear behavior through disturbance, human-polar bear interactions, and through potential crude and refined oil spills. With the exception of oil spills, adverse effects would be limited and not anticipated to result in polar bear mortality. At the time critical habitat for polar bears was not designated and was not evaluated.

USFWS (2009). Biological Opinion: MMS Oil and Gas Lease Sales 186, 195, 202 and 193 in the Chukchi and Beaufort Seas. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. September 3, 2009. 174 pp.

Effects to listed spectacled eiders, Alaska-breeding Steller's eiders, polar bears, the Ledyard Bay Critical Habitat Unit, and the candidate species yellow-billed loons and Kittlitz's murrelets from the proposed lease sale program were evaluated in this BiOp. Since the 2006 BiOp on lease sales, polar bears were listed as a threatened (73 Federal Register [FR] 28212) and the yellow-billed loon was designated a candidate species under the ESA (74 FR 12932). Measures to protect subsistence activities and prevent unreasonable conflicts and interference between the oil and gas industry and subsistence activities are described. This BiOp recommended that vessel operations in the Beaufort and Chukchi seas, including seismic geophysical exploration, should be scheduled to avoid bowhead migratory periods in spring and fall to reduce potential harassment of whales or disruptions to the subsistence hunt. USFWS concluded that exploration may adversely affect spectacled and Steller's eiders, and polar bears. However, based on the limited number of listed individuals likely to be affected and mitigation measures required by MMS during seismic and exploratory drilling activities, seismic surveys and exploratory drilling were not likely to jeopardize listed species or result in the destruction or adverse modification of critical habitat.

NMFS (2010). Biological Opinion: IHAs 2010 Shell and Statoil Oil and Gas Exploration Activities in Beaufort and Chukchi Seas, Alaska. National Marine Fisheries Service. Alaska Region. July 13, 2010. 106 p.
As a follow up assessment to the 2008 BiOp, NMFS analyzed plans for 2010 seismic surveys in the Chukchi Sea between July and November 2010 by StatOil USA E&P Inc. In addition, site-specific activities by Shell Offshore Inc. including site clearance and shallow hazards surveys, ice gouging and strudel scour surveys in the Beaufort Sea between July and October 2010 were assessed. NMFS concluded that authorization of small takes of endangered marine mammals under the MMPA was not likely to jeopardize the continued existence of fin, humpback, or bowhead whales. No critical habitat had been designated for these species and were therefore not evaluated.

BOEMRE (2011). Biological Evaluation: Impacts of Oil and Gas Activities on the Beaufort and Chukchi Sea Planning Areas on Polar Bear and Polar Bear Critical Habitat, Steller's Eider, Spectacled Eider and Spectacled Eider Critical Habitat, Kittlitz's Murrelet, and Yellow-billed Loon. U.S. Dept. of Interior, Bureau of Ocean Energy Management Regulation and Enforcement. September 2011. 406 pp.
This is the Bureau of Ocean Energy Management's (BOEMs) assessment of the continued authorization of oil and gas exploration and development activities in the Arctic Region of the OCS, consistent with previous 5-year oil and gas leasing programs. This assessment updated BOEMs previous 2009 evaluation and considered substantial mitigation measures when evaluating potential impacts of the proposed action on listed species and designated critical habitats. The assessment included recent updates to the status of polar bears and designated critical habitat (75 FR 76086) but is otherwise similar to past consultations. The most likely impacts to polar bears from seismic surveys and other associated activities would be disturbance and possible impacts to bears' food resources (seals). Consistent with previous consultations, the USFWS determined that leasing, exploration, development and production activities that may result from lease sales, would not jeopardize the continued existence of the polar bear.

NMFS (2011). Biological Opinion: IHA ConocoPhillips and Statoil 2011 Shallow Hazards Survey in Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. July 22, 2011. 90 pp.
This BiOp consulted on the issuance of an Incidental Harassment Authorization (IHA) for "takes" of bowhead, fin and humpback whales associated with geotechnical and shallow hazard surveys. Supporting information in this BiOp was nearly identical to that presented in NMFS "Biological Opinion: Authorization of Small Takes Under the Marine Mammal Protection Act for certain Oil and Gas Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska for 2010." The status of species, environmental baseline and cumulative effects analyses in the 2010 BiOp were incorporated. NMFS concluded that authorization small takes of marine mammals under the MMPA for Statoil's proposed surveys in the U.S. Chukchi Sea in 2011 was not likely to jeopardize the continued existence of any ESA-listed whales. Effects on critical habitat were not included because no critical habitat had been designated for these species.

USFWS (2011). Programmatic Biological Opinion: Issuance of Incidental Take Regulations 2016-2020 on Behalf of AOGA for Polar Bears and Pacific Walrus in the Beaufort Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. 92 pp.
On April 22, 2009, the Alaska Oil and Gas Association (AOGA) submitted a petition to renew the MMPA incidental take regulations for the Beaufort Sea area to provide continued authorization for the nonlethal incidental take of small numbers of walruses and polar bears from oil and gas exploration, development and production activities from 2011–2016. MMPA incidental take of up to 150 polar bears and 10 Pacific walrus is anticipated annually (76 FR 13454). The BiOp stated the proposed action may adversely affect polar bears. The most significant potential effect to denning bears was disturbance. However, activities

would not occur within one mile of a known polar bear den. No lethal take was anticipated and would be minimized by mitigation requirements listed in the subsequent MMPA Letters of Authorization (LOAs). Given that bears would be hazed away from the area and considering the small size of the affected area, such effects would be limited to small numbers of polar bears. A large oil spill to marine waters could adversely affect tens of bears in the action area. USFWS reviewed polar bear status, environmental baseline, potential effects of the activities, documented impacts of industry activities on the species, past monitoring data from the Beaufort and Chukchi seas since 1993, and cumulative effects and concluded the proposed action was not likely to jeopardize the continued existence of the polar bear. Noise disturbance, seismic surveys, vessel and aircraft traffic may result in minor, temporary behavioral changes of a few walrus. Based on few walrus expected in the area, no lethal takes, and minor behavioral effects, activities were not likely to reduce survival or recovery. While a limited area for new developments or ice breaking activities may adversely affect a portion of polar bear critical habitat, these activities would not destroy or adversely modify polar bear critical habitat.

USFWS (2011). Biological Opinion & Conference Opinion: BOEMRE Permitting for Northstar Operations Polar Bear Critical Habitat and Pacific Walrus in Beaufort Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. September 7, 2011. 14 pp.

This USFWS memorandum responded to the request by the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) for "conference" for Pacific walrus and consultation on polar bear critical habitat. BOEMRE proposed to continue permitting operations at the Northstar offshore oil production facility. In March 1999, the USFWS first consulted on effects of this project on Steller's and spectacled eiders and then amended the initial BiOp on September 1, 2009 to include polar bears, and their designated critical habitat, yellow-billed loons, Kittlitz's murrelet, and Pacific walrus. This memo supplemented the 2009 BiOp with analysis of effects from industry noise, disturbance, and associated vessel traffic on these species. There was concern of more pronounced impacts on walrus. However, because very few walrus occur in the Action Area and required mitigation measures would reduce impacts, the USFWS concluded the proposed action would not likely to jeopardize the species continued existence. Impacts to polar bear critical habitat Primary Constituent Elements (PCEs) were also analyzed. The effects of some disturbance (e.g., winter ice travel) were determined to be temporary, while others were long-term (e.g., in critical habitat adjacent to Northstar). The BiOp stated that while Northstar activities may adversely affect localized areas of critical habitat, sufficient polar bear critical habitat would remain available. The proposed action was not likely to destroy or adversely modify critical habitat.

NMFS (2012). Biological Opinion: BPXA Northstar Development Marine Mammal Protection Act Authorization 2012-2016, Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. June 22, 2012. 127 pp.

In 1999 and 2004, British Petroleum Exploration Alaska, Inc. (BPXA) petitioned NMFS to issue regulations and LOAs under the MMPA for potential incidental taking of small numbers of whales and seals at the Northstar offshore oil production facility. This BiOp analyzed impacts on bowhead, gray and beluga whales, and bearded, spotted and ringed seals associated with renewing MMPA regulations for the period 2012-2016 for oil and gas operations at Northstar. No critical habitat had yet been designated or proposed for any ESA-listed species in the Beaufort Sea. This BiOp incorporated a decade of marine mammal monitoring results from Northstar. There was no indication that seals had been affected in a biologically meaningful way during Northstar production years 2003-2009 based on considerable research. Ringed seals regularly occur close to Northstar and for this reason, NMFS concluded the species was most likely to be affected by operations. This BiOp incorporated considerable information from

previous BiOps including TK from Inupiat hunters. At this time, mitigation and monitoring plans at Northstar were well developed, as was a Communications Plan and Conflict Avoidance Agreement (CAA) that had been negotiated with subsistence hunters over several years. This combined knowledge contributed to a more complete understanding of the likely effects from the proposed activities over the proposed period 2012 - 2016. NMFS concluded that re-authorization of oil and gas activities at Northstar was not likely to jeopardize the continued existence of the endangered bowhead whale, the Beringia Distinct Population Segment (DPS) of bearded seal, or the Arctic subspecies of ringed seal. At this time, critical habitat had not been designated for these species.

NMFS (2012). Biological Opinion: IHA Shell Offshore, Inc. 2012 Exploratory Drilling in Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. April 23, 2012. 119 pp.
Authorization under the MMPA (i.e., IHA) for incidental and unintentional taking of bowhead, fin, and humpback whales, and ringed and bearded seals due to exploratory oil drilling in the Chukchi Sea is evaluated in this BiOp. Shell planned to conduct an offshore exploration drilling program in the Chukchi Sea during the 2012 open water season. Activities with potential to take marine mammals included operation of the drillship, ice management/icebreaking, and vertical seismic profile (VSP) surveys. The BiOP incorporated much of the information presented in NMFS's Notice of Proposed IHA and Environmental Assessment (EA) published November 9, 2011 (76 FR 69958). Other data in the environmental baseline and cumulative effects sections of this BiOp have been described in previous BiOps for this area. Anticipated impacts from activities were expected to be similar for the Beaufort and Chukchi seas. This BiOP followed the Deepwater Horizon oil spill of 2010. For this reason, offshore drilling, especially in the ice-covered Arctic was scrutinized. As such, BOEM conditioned the approval of Shell's exploration plan on strict mitigation to reduce the possibility of an oil spill occurring late in the season when ice formation could reduce response efficiency. Mitigation measures included requiring Shell to leave sufficient time to implement cap and containment operations as well as significant clean up before the onset of sea ice in the event of a loss of well control. Shell was required to cease drilling 38 days before the anticipated first date of ice encroachment over the drill site, anticipated as November 1 (as based on a 5-year analysis of historic weather patterns). The 38-day period also provided a window for drilling a relief well, if needed. NMFS concluded that authorization of the IHA to Shell was not likely to jeopardize the continued existence of the endangered bowhead, humpback, and fin whale, the Arctic sub-species of ringed seal, or the Beringia DPS of bearded seal. At this time, no critical habitat had been designated for these species.

NMFS (2012). Biological Opinion: IHA and Geological and Geophysical Permit to ION for 2012 2D Seismic Surveys in Chukchi and Beaufort Seas, Alaska. National Marine Fisheries Service. Alaska Region. October 17, 2012. 159 pp.
This BiOp addressed authorization by NMFS of the incidental and unintentional taking of bowhead whales, and ringed seals and bearded seals (both seals were proposed for listing) due to seismic surveys by ION in the Beaufort and Chukchi seas. The unique ION program included an in-ice geophysical (seismic reflection/refraction) survey and related vessel operations October to December 2012. The primary survey area extended from the U.S.–Canadian border to Point Barrow. To avoid the bowhead whale hunting season, the survey was to be conducted from a seismic vessel escorted by a medium class icebreaker moving from east to west through the Beaufort Sea, following the bowhead whale migration, through ice if necessary. Historically, on average over 95 percent of bowheads have passed through the eastern U.S. Beaufort Sea by October 15th. In-ice surveys were to start in the eastern Beaufort Sea in late October or early November 2012, avoiding bowhead whales. NMFS anticipated potential minor changes in pinniped behavior on small spatial scales as the seismic and ice-breaking vessels moved through ice. These disturbances would not result in harm to individual seals or populations. NMFS concluded that the

proposed actions were not likely to jeopardize the continued existence of the bowhead whale, the Arctic subspecies of ringed seal or the Beringia DPS of bearded seal. At this time, no critical habitat had been designated for these species.

NMFS (2012). Biological Opinion: IHA BP Offshore, Inc. 2012 Seismic Surveys in Simpson Lagoon, Beaufort Sea, Alaska. National Marine Fisheries Service. Region, A. June 21, 2012. 136 pp.
This BiOp addressed authorization of the incidental taking of bowhead whales, ringed seals, and bearded seals due to ocean bottom cable seismic surveys by BPXA in Simpson Lagoon. Proposed activities with the greatest potential to disturb marine mammals included: pulsed sounds from vessel sonar, pingers, and airguns; helicopter traffic noise; and physical presence of vessels. NMFS determined that bowhead and humpback whales, and ringed and bearded seals may experience behavioral harassment due to noise but effects to humpback whales were discountable. NMFS also determined that Simpson Lagoon seismic surveys were not likely to adversely affect bowhead whales. Moderate numbers of ringed seals and low numbers of bearded seals were expected during the time of the activities. The activities would not likely result in the abandonment of foraging habitat within the action area, nor present concern for the seals or their ability to fulfill critical life history functions. No lethal takes were anticipated, nor were population-level consequences. NMFS concluded that the authorization of the proposed IHA to BPXA was not likely to jeopardize the continued existence of the bowhead whale, the Arctic subspecies of ringed seal, or the Beringia DPS of bearded seal. Critical habitat had not been designated for these species.

NMFS (2012). Biological Opinion: IHA Shell Offshore, Inc. 2012 Exploratory Drilling in Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. April 23, 2012. 108 pp.
Shell Offshore, Inc. proposed to conduct exploratory oil drilling in Camden Bay in 2012. This BiOp evaluates the issuance of an IHA for incidental harassment of bowhead whales and bearded and ringed seals. TK from Inupiat hunters is presented in this analysis and is similar to information in previous BiOps. While there is a clear analysis of impacts on marine mammals, it is not noticeably different previous BiOps for IHAs. NMFS determined that bowhead whales and ringed and bearded seals may occur in the action area and may be adversely affected by the proposed action due to harassment by noise causing brief behavioral reactions. However, as bowhead whales have been shown to avoid seismic noise sources within 20 km and may begin to deflect at distances up to 35 km, Shell committed to suspending all operations beginning on August 25 until completion of the Nuiqsut (Cross Island) and Kaktovik subsistence bowhead whale hunts. Consistent with earlier BiOps, NMFS concluded that potential effects would not likely to jeopardize the continued existence of the endangered bowhead whale, the Arctic subspecies of ringed seal, or the Beringia DPS of bearded seal. No critical habitat had been designated for these species.

NMFS (2012). Revised Biological Opinion: Apache 3D Seismic Surveys in Cook Inlet, Alaska. National Marine Fisheries Service. Alaska Region. May 21, 2012. 131 pp.
As a follow up to the original 2012 BiOp and at the request of USACE, NMFS conducted formal consultation for Apache's 3D Seismic Surveys for middle to lower Cook Inlet, specifically Trading Bay in the west and from East Foreland south to Anchor Point, between 2012 and 2015. While the BiOp reviewed the program in its entirety (as in the February 2012 BiOp), the precise location of the survey was evaluated. NMFS had previously determined that the proposed Cook Inlet 3D Seismic Program was unlikely to affect the Steller sea lion population or their critical habitat. This BiOp also focused on Cook Inlet beluga whales and their critical habitat. NMFS concluded that the second phase of the proposed action was not likely to jeopardize the continued existence of the Cook Inlet beluga whale nor destroy or adversely modify beluga critical habitat.

NMFS (2012). Biological Opinion: Apache 3D Seismic Surveys in Cook Inlet, Alaska. National Marine Fisheries Service. Alaska Region. February 17, 2012. 128 pp.
At the request of USACE, NMFS conducted formal consultation for Apache's 3D Seismic Surveys Cook Inlet between 2012 and 2015. NMFS evaluated potential effects of Apache's activities on Cook Inlet beluga whales and their critical habitat, as well as the western DPS of Steller sea lions. While critical habitat was designated for the Steller sea lions, none existed within the action area. The proposed 3D seismic program was unlikely to affect Steller sea lions. Thus, this BiOp focused on impacts to Cook Inlet beluga whales and their critical habitat. In late March 2011, Apache conducted a test program to evaluate using nodal (no cables) seismic recording equipment in Cook Inlet. Test results showed that nodal technology was feasible, therefore Apache proposed to conduct a phased 3D seismic survey program throughout Cook Inlet over three years. This BiOp reviewed the entire program, though subsequent take authorizations required separate consultations. During the first year, activities occurred from East and West Foreland north to the Beluga River on the western side of upper Cook Inlet, which included beluga critical habitat. NMFS concluded that effects from seismic surveys were likely to adversely affect Cook Inlet beluga whales. Mitigation measures included operating within 10 miles of the mean higher high water (MHHW) line of the Susitna Delta (Beluga River to the Little Susitna River) between mid-April and mid-October to avoid noise or physical effects to belugas in this critical feeding and potential breeding area. NMFS concluded that considering the specific mitigation and monitoring measures for Cook Inlet beluga whales and their critical habitat, activities were not likely to jeopardize

the continued existence of the beluga whale or Steller sea lions, nor destroy or adversely modify beluga critical habitat.

USFWS (2012). Biological Opinion & Conference Opinion: OCS Planning Areas Beaufort & Chukchi. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. May 8, 2012. 205 pp.

This BiOp was consistent with previous analyses of oil and gas leasing, exploration, development and other activities in the Chukchi and Beaufort Sea Planning Areas on polar bears, polar bear critical habitat, spectacled eiders and eider critical habitat, Steller's eiders, and candidate species Kittlitz's murrelets, and yellow-billed Loons. The analysis includes particular focus on impacts to polar bears and their critical habitat. Industry activities were more likely to encounter polar bears along the coast during the first phases of activities described. USFWS stated that activities within the two Planning Areas would affect polar bears differently as polar bears use the Beaufort and Chukchi seas and adjacent terrestrial habitat in different ways. Human-polar bear interactions would occur more frequently in the Beaufort Sea than the Chukchi Sea. Polar bears do not den along coastal areas of the Chukchi Sea and disturbance of denning bears in the Chukchi Sea was unlikely. However, because polar bears den along the coast of the Beaufort Sea, some activities could disturb denning bears. While adverse effects to polar bears may occur, even under the worst of circumstances of a very large spill, only tens of polar bears could be potentially oiled and killed. The USFWS concluded that such effects were not likely to cause population-level declines nor destroy or adversely modify polar bear critical habitat. Rather, critical habitat would retain the intended function for which it was designated.

USFWS (2012). Biological Opinion: ExxonMobil Point Thomson Development Beaufort Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. September 14, 2012. 85 pp.

ExxonMobil proposed to develop a hydrocarbon reservoir at Point Thomson leases, east of Prudhoe Bay over four winter seasons (2012-2016). The area directly affected by the proposed project included gravel pads and roads (including the airstrip), export pipeline and infield gathering lines, ice roads and pads, material source site, barge routes and facilities, and areas potentially affected by terrestrial or marine spills. This BiOp described the effects of the proposed action on Alaska-breeding Steller's eiders, spectacled eiders, polar bears, and polar bear critical habitat. The USFWS determined the proposed action may affect but was not likely to adversely affect Steller's eiders; and may adversely affect spectacled eiders, polar bears, and polar bear critical habitat. The proposed action was not likely to jeopardize the continued existence of yellow-billed loons or Pacific walruses. The action could adversely affect polar bears through disturbance, increased polar bear-human interactions and potential intentional take (due to intentional harassment of bears), and habitat loss. The adverse effects were expected to be non-lethal and without population-level impacts. Habitat loss was also expected to be minor. The USFWS concluded the proposed action was not likely to jeopardize the continued existence of any listed species or adversely impact critical habitat for any species.

USFWS (2012). Biological Opinion: LOAs Shell 2012 Exploration Activities in Chukchi Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. June 4, 2012. 14 pp.

Shell requested an LOA (referred to as LOA 12-CS-02) for the incidental, unintentional, non-lethal take of small numbers of polar bears and Pacific walrus for oil and gas activities in the Chukchi Sea. In addition, Shell requested an LOA (referred to as LOA-12-INT-12) to enable it to deter polar bears and walrus from endangering human safety or damaging private property or to protect the welfare of the animal. Minor, short term changes in behavior of up to 33 polar bears, and non-lethal deterrence through the use of

projectiles of two or less polar bears were evaluated. In previous BiOps, USFWS determined that the effects of all exploration and related activities in the Beaufort and Chukchi seas would not likely jeopardize the continued existence of polar bears but could cause temporary affects to small areas of polar bear critical habitat. All exploratory drilling and associated activities in the Beaufort and Chukchi seas, including supporting environmental studies proposed by Shell, would likely result in minor, temporary effects on polar bear critical habitat. Therefore, Shell's activities would not likely destroy or adversely modify polar bear critical habitat. While activities could affect Pacific walrus, effects would be non-lethal and would only small numbers of the species. Given the estimated size of the Pacific walrus population (approx. 129,000, with a 95% CI: 55,000 -507,000), the required mitigation measures, and the non-lethal nature of the take at issue, any impacts to walrus would not likely to jeopardize the continued existence of the species.

USFWS (2012). Revised Biological Opinion & Conference: OCS Planning Areas Beaufort & Chukchi U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. May 8, 2012. 6 pp.

A revised BiOp was prepared to supplement the May 2012 BiOp in order to address updated developed scenarios as well as updates to terms and conditions, and mitigation measures. This is a 6-page document which includes concise summaries of the terms and conditions and reporting requirements under which BOEM and BSEE agreed to operate for authorizing leases. The conclusions in this revised BiOp are not different from the original 2012 BiOp.

NMFS (2013). Biological Opinion: BOEM and BSEE Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number F/AKR/2011/0647, April 2, 2013. 527 pp.

This BiOp provides a useful chronology of activities and demonstrates how the series of BiOps completed since 2000 have built upon each other. Potential effects of BOEM's authorization of oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi seas 2013 through 2027 on bowhead, fin, humpback, and North Pacific right whales; the Western DPS of Steller sea lions; Arctic subspecies of ringed seals; and the Beringia DPS of bearded seals; as well as the designated critical habitats for North Pacific right whale and Steller sea lions were evaluated. Initially, a BiOp for Oil and Gas Leasing and Exploration Activities in the Beaufort Sea was issued May 25, 2001 and concluded that oil and gas leasing and exploration in the Beaufort Sea was not likely to jeopardize the continued existence of bowhead whales (the only listed species under NMFS' jurisdiction known to use the action area at that time). MMS (now BOEM) requested re-initiation of consultation in 2006, to cover planning areas in both the Beaufort and Chukchi seas and a revised opinion was issued in June 2006. Subsequent to the NMFS 2006 BiOp, monitoring by industry indicated the potential occurrence of humpback and fin whales in the Action Area. Responding to this new information, MMS requested re-initiation of consultation on May 14, 2008, and provided a Biological Evaluation (BE) of the consequences to these additional species. NMFS provided a revised BiOp in June 2008 and concluded that OCS oil and gas leasing and exploration was not likely to jeopardize the continued existence of bowhead, fin or humpback whales. NMFS then proposed to list bearded seals and ringed seals as threatened (75 FR 77496 and 75 FR 77476). BOEM again requested re-initiation of ESA consultation on October 14, 2011, and provided a BE that covered the potential impacts of continued oil and gas leasing and exploration activities on the proposed listed species of seals. NMFS initiated consultation on January 25, 2012 and completed its analyses with this BiOp, which had no significant new findings from previous BiOps. The potential exposure of marine mammals to seismic surveys associated with the exploration activities were not likely to jeopardize the continued existence of bowhead, fin, or humpback whales, or ringed and bearded seals. Activities were also not likely to adversely affect North Pacific right whales or western DPS Steller sea lions along the

marine transit route. NMFS concluded that the proposed action was not likely to result in destruction or adverse modification of critical habitats for the western DPS of Steller sea lions or the North Pacific right whale.

NMFS (2013). Biological Opinion: Re-initiation of Section 7 Consultation Apache 3D Seismic Surveys of Cook Inlet, Alaska. National Marine Fisheries Service. Alaska Region. February 14, 2013. 137 pp.
This BiOp is the third in a series of evaluations since 2012 and analyzes the effects of the final Cook Inlet 3D seismic survey by Apache in upper Cook Inlet. The action area evaluated in this BiOps included Knik Arm and specifically an area around the Susitna River including the intertidal and offshore areas. Potential effects on the Cook Inlet beluga whales and their critical habitat, as the western DPS of Steller sea lions were assessed. Information that became available after 2012 and the remaining activities planned for February 2013 through December 2014 were assessed in detail. While most of the information contained in this BiOp does not differ from the 2012 BiOps, year one activities were considered part of the environmental baseline. Noise from airguns was likely to have the greatest impact to ESA-listed species more so than any other aspects of the proposed action. Activities may affect and were likely to adversely affect beluga whales (and Steller sea lions if present) in the action area. During this phase of the seismic program, activities were much closer to critical beluga foraging areas in Upper Cook Inlet. Therefore, Apache was required to avoid the critically important areas around the Susitna Delta during high-use periods during spring and summer. Following conclusions of the previous BiOps, NMFS concluded that the continued surveys were not likely to jeopardize the existence of the Cook Inlet beluga whale or Steller sea lion populations, nor to destroy or adversely modify Cook Inlet beluga whale critical habitat.

NMFS (2013). Biological Opinion: IHA SAExploration, Inc. 2013 Marine 3D Ocean Bottom Cable Seismic Activities in Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number F/AKR/2013/9283, July 29, 2013. 246 pp.
Potential effects of using an IHA to take marine mammals by harassment incidental to open-water seismic surveys in the nearshore waters of the Colville River Delta, Beaufort Sea from July 15 to October 31 are evaluated in this BiOp. Potential effects were likely on bowhead, fin, humpback and North Pacific right whales; the western DPS of Steller sea lions; the Arctic subspecies of ringed seal; and the Beringia DPS of bearded seal; as well as the designated critical habitats for North Pacific right whale and western DPS of Steller sea lions. Specifically, the BiOp concluded that surveys could expose a few individual humpback whales to increased noise levels along the marine transit route. North Pacific right whales were not likely to be directly or indirectly exposed to the seismic activities or vessel traffic. Proposed surveys would not reduce either species' ability to survive or recover. Surveys were temporarily ceased during the fall bowhead whale hunt to avoid interference with the Cross Island, Kaktovik, and Barrow hunts. Other mitigation measures included beginning seismic surveys in the offshore areas first and completing surveys in the bowhead whale migration corridor prior to their arrival. NMFS also concluded that the 3D seismic surveys were likely to disturb seals, causing disruptions in the behavioral ecology and social dynamics of individual Arctic ringed or bearded seals, but not to the extent where natural behavioral patterns would be abandoned or considerably altered. In summary, the proposed action was not likely to jeopardize the continued existence of any ESA-listed species or destroy or adversely modify designated critical habitat.

NMFS (2013). Biological Opinion: IHA 2013 Shell Geophysical Surveys, and Equipment Recovery and Maintenance Activities in Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number F/AKR/2013/9281, June 19, 2013. 352 pp.

On March 11, 2013, NMFS initiated consultations for the proposed issuance of three IHAs to take marine mammals by harassment incidental to open-water seismic and marine surveys by Shell, TGS, and SAE from July 1 through October 31, 2013 in the Beaufort and Chukchi seas. Shell surveys were continuations of programs in the Beaufort since 2006 and the Chukchi since 2008. This BiOp determined that these actions could affect bowhead, fin, humpback and North Pacific right whales; the western DPS of Steller sea lions and their critical habitat; Arctic subspecies of ringed seal; and the Beringia DPS of bearded seal. NMFS concluded that critical habitat for the right whale would not be adversely affected by the authorized activities in the Chukchi Sea and that vessel traffic was not likely to exclude western SSLs from designated critical habitat near Dutch Harbor. Disturbance from vessels, if it occurred, would be temporary. Therefore, vessel traffic was not likely to destroy or adversely modify the designated critical habitat for western SSL. Shell proposed a new suite of mitigation measures for the Chukchi Sea including: using aerial surveys to time and position activities to avoid interference with the spring beluga hunt at Point Lay and the fall bowhead hunt; scheduling activities and identifying transit routes to avoid subsistence use areas; and communicating with coastal communities before operating in or passing through these areas. NMFS concluded that shallow hazard and site clearance surveys and equipment maintenance and recovery activities would not reduce the likelihood that whales would survive or recover. The proposed action was not likely to jeopardize the continued existence of any listed species or destroy or adversely modify designated critical habitat.

NMFS (2013). Biological Opinion: IHA TGS-NOPEC ASA (TGS) 2013 Marine 2D Seismic in Federal and International Waters, Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number F/AKR/2013/9282, July 11, 2013. 328 pp.

This BiOP examined issuance of an IHA to take marine mammals by harassment incidental to two-dimensional (2D) seismic surveys in the Chukchi Sea by TGS-NOPEC Geophysical Company ASA between July 15 and October 31, 2013. These surveys, including the marine transit route to the survey area, had the potential to affect the bowhead, fin, humpback and North Pacific right whales; the western DPS of Steller sea lions and their critical habitat; Arctic subspecies of ringed seal; and the Beringia DPS of bearded seal. By 2013, fin and humpback whales were considered more regular in the Chukchi Sea during the open water period. During the planned 2D seismic surveys, NMFS estimated 215 humpback whale exposures to sounds from seismic airguns at received levels between 120 dB and 159 dB which had not been considered in previous consultations. Earlier studies of marine mammals and responses to seismic transmissions and vessel noise had shown that individuals were likely to exhibit behavioral response upon hearing low-frequency seismic transmissions and vessel noise, but the biological significance of those behavioral responses was considered unknown. Because of their preference for ice, bearded seals were less likely to encounter seismic surveys during the open water season than ringed seals. Consistent with previous consultations, NMFS concluded that activities were not likely to jeopardize the continued existence of endangered or threatened marine mammals, or destroy or adversely modify Steller sea lion critical habitat.

USFWS (2013). Biological Opinion & Conference Opinion: Polar Bears & Walrus Chukchi Sea Rule and LOAs in Chukchi Seas, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. May 20, 2013. 67 pp.

This BiOp evaluates the effects of issuing MMPA LOAs for incidental takes of polar bears for oil and gas exploration activities in the Chukchi Sea. At this time, Pacific walrus was still a candidate species, therefore, USFWS provided conducted a conference opinion on the effects of the proposed action on

walrus. The status of polar bear critical habitat had changed prior to this BiOp. On October 29, 2009, the USFWS proposed critical habitat for polar bears (74 FR 56058) and a final rule designating critical habitat was issued on December 7, 2010 (75 FR 76086). On January 11, 2013, the final rule was vacated and remanded to the Service by the U.S. District for the District of Alaska in Alaska Oil and Gas Association et al. v. Salazar, et al. (D. Alaska)(3:11-cv-00025-RRB). The USFWS filed a motion for reconsideration of the District Court's decision. The motion was denied on May 15, 2013. Thus, at the time of this consultation, there was no critical habitat designated for polar bears. The BiOp concluded that the sum total of the proposed activities would not jeopardize the continued existence of the species. In part, this conclusion relied on the determination that activities that may be authorized under the MMPA regulations could only result in negligible impacts to small numbers of marine mammals under the MMPA.

USFWS (2013). Biological Opinion: Pioneer Oooguruk Development 2014-2015 Modifications. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. August 27, 2013. 23 pp.

This BiOp reviewed a proposal by Pioneer Natural Resources Alaska, Inc. to modify the Oooguruk Development Project in the Kuparuk River Unit (KRU) west of Deadhorse, including an expansion of the Oooguruk Tie-in Pad (OTP), installation of a seawater flowline with tie-in pad, and an expansion of the Oooguruk Drill Site (ODS). The USFWS determined that the proposed action may affect but was not likely to adversely affect Steller's eiders, and was not likely to jeopardize the continued existence of the yellow-billed loon or Pacific walrus. The proposed action may adversely affect spectacled eiders and polar bears. Industry monitoring programs from 1994 to 2004 recorded only 10 Pacific walrus (listed as candidate species) in the Beaufort Sea. The U.S. Geological Survey (USGS) had reported only a few tagged walrus in the extreme western Beaufort Sea near Barrow during studies of walrus movements in 2007–2011. Considering the proposed modifications for ODS expansion would occur during winter months when walrus were not present, the USFWS concluded that effects from the proposed action were discountable. In addition, while very small number of polar bears may also be adversely affected through polar bear-human interactions (including intentional take), lethal take or population-level impacts to the species were not anticipated. Habitat loss was expected to be minor and large oil spills were characterized as extremely unlikely.

USFWS (2013). 78 FR 11766 Special Final Rule to Protect Polar Bears Under ESA Section 4(d). *Federal Register*, 78:11766-11788.

Following publication of the USFWS special rule for polar bears in 2008 (73 FR 76249), the District of Columbia District Court found that although the final 4(d) special rule was consistent with the ESA, the USFWS violated the National Environmental Policy Act (NEPA) and the Administrative Procedure Act (APA) by failing to conduct a NEPA analysis when it promulgated the final rule. On November 18, 2011, the Court vacated the final 4(d) rule and ordered that the May 15, 2008, interim 4(d) rule take effect until superseded by a new final 4(d) special rule. This final special rule reinstated the regulations afforded the polar bear under the December 2008 rule. Specifically, the special rule adopts the existing conservation regulatory requirements under the MMPA and CITES as the appropriate regulatory provisions for this species. Therefore, if an activity is not authorized or exempted under the MMPA or CITES, it would be prohibited under the general prohibitions under the ESA

NMFS (2014). Biological Opinion: IHA BPXA Shallow Geohazard Survey in Foggy Island Bay, Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2014-9370, June 19, 2014. 139 pp.

NMFS proposed to issue an IHA to take marine mammals by harassment incidental to 2D, high-resolution, shallow geohazard seismic surveys in the Foggy Island Bay between July 1 and September 30, 2014. A

transit route from Prudhoe Bay to Foggy Island Bay was included in the proposed action. Effects of the 2D seismic geohazard surveys on bowhead whales, the Arctic subspecies of ringed seal, and the Beringia DPS of bearded seal were assessed. There was no critical habitat designated for these species at this time. Bowhead whales are uncommon to rare inside the barrier islands that form the seaward boundary of Foggy Island Bay. This project-specific Section 7 consultation was linked indirectly to the programmatic Arctic Regional Biological Opinion that was issued in April 2013 (NMFS 2013). This tiered process enabled NMFS to track the overall take occurring from multiple oil and gas projects occurring in the Arctic, and to issue ESA Incidental Take Statements (ITSs) that more accurately estimated the total level of takes anticipated. The risk analyses were similar to previous BiOps and stated that implementation of mitigation measures would reduce the instances of exposure and minimize the effects on listed species, and the proposed action would not appreciably reduce the ringed seals' likelihood of surviving or recovering. NMFS concluded the proposed action was not likely to jeopardize the continued existence of the endangered bowhead whale, threatened Arctic subspecies of ringed seal or the threatened Beringia DPS of bearded seal.

NMFS (2014). Biological Opinion: IHA SAExploration2014 Marine 3D Ocean Bottom Node Seismic in Colville River Delta, Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2014-9383, August 8, 2014. 149 pp.

This BiOp summarized the effects of issuing an IHA to take bowhead whales, Arctic subspecies of ringed seals, and Beringia DPS of bearded seals by harassment incidental to 3D seismic surveys in Prudhoe Bay from July 1 to September 30, 2014. Similar to previous BiOps, NMFS relied on the estimated marine mammal exposures to proposed activities described in the IHA application (i.e., takes by harassment under the MMPA) as a proxy for the ESA take estimates. While this approach reflected the current practice for assessing potential effects, the biological significance of marine mammal behavioral responses to such exposures remained in question under the ESA. NMFS used this conservative approach for evaluating jeopardy under the ESA in most consultations because the exposure estimates are likely overestimated, and an exposure in and of itself may not actually result in a take by harassment. There was no critical habitat designated for these species at this time. The proposed seismic surveys during the open water season were similar to programs conducted in the Beaufort Sea by Shell beginning in 2006, BPXA beginning in 2008, and ION Geophysical beginning in 2012. Density data used for the take estimates were updated for this BiOp from Aerial Surveys of Arctic Marine Mammals (ASAMM) conducted in 2012 and 2013. Otherwise, the environmental baseline, cumulative effects analysis and ESA determination analyses were similar to previous BiOps. NMFS concluded that the proposed action was not likely to jeopardize the continued existence of any ESA-listed species. The most significant conservation recommendation from this BiOp was that NMFS work with BOEM and other relevant stakeholders (the Marine Mammal Commission [MMC], International Whaling Commission [IWC], and the marine mammal research community) to develop a method for assessing the cumulative impacts of anthropogenic noise in the Arctic on marine mammals.

NMFS (2014). Biological Opinion: IHA BPXA 2014 Marine 3D Ocean Bottom Sensor Seismic in Prudhoe Bay, Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2014-9369, June 10, 2014. 144 pp.

NMFS proposed to issue an IHA to take marine mammals by harassment under the MMPA incidental to 3D ocean bottom sensor (OBS) seismic surveys in the Prudhoe Bay area between July 1 and September 30, 2014. These actions could affect bowhead whales, Arctic subspecies of ringed seal, and the Beringia DPS of bearded seal. There was no critical habitat designated for these species at this time. Similar to previous BiOps, NMFS used the estimated exposures of marine mammals to seismic activities as described in the IHA application as a proxy for the ESA takes. Based on very few humpback whales

observations in the Action Area, risks to humpback whales were discountable. At this time, bowheads were increasing at a rate of approximately 3.2% per year. The strongest evidence supporting the conclusion that seismic operations have minimal impact on bowhead whales was the estimated growth rate of the population in the Arctic. Of all of the stressors considered in this and previous BiOps, the responses of marine mammals to low-frequency seismic noise had received the greatest amount of attention and study. Nevertheless, despite decades of study, empirical evidence on the responses of free-ranging marine animals to seismic noise had not significantly increased since the late 1980s and 1990s, and remained limited at this time. Cumulative effects analyses in this and previous BiOps are also similar, using updated information wherever possible but relying on the same reference material and previous studies for conclusions. Mitigation measures were designed to avoid or minimize adverse impacts associated with seismic and other activities, so that NMFS (and USFWS in their consultations) could make a negligible impact determination for bowhead whales, and ringed and bearded seals. NMFS concluded the proposed action was not likely to jeopardize the continued existence of bowhead or humpback whales, the Arctic subspecies of ringed seal, or the Beringia DPS of bearded seal.

USFWS (2014). Biological Opinion: Polar Bear and Pacific Walrus Deterrence Program. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. January 13, 2014. 20 pp.

The USFWS issues LOAs under the MMPA that allow the use of deterrence (e.g., hazing) to prevent polar bears and Pacific walruses from damaging private property or endangering personal safety which are evaluated in this BiOp. The MMPA specifically identifies the circumstances when the deterrence of a polar bear may occur and by whom. Federal, State, or local governmental officials or employees may also deter polar bears (e.g., for the welfare of the animal) when enacting official duties. Deterrence activities are used predominantly to limit human-bear interactions to maintain human safety but are also used to minimize walrus-human interactions for the safety of walruses. Deterrence activities can be passive and preventative (75 FR 61631) or active, and both are necessary components of an effective human-polar bear interaction plan. Passive techniques do not require authorization, and their effects on polar bears have been analyzed previously (75 FR 61361). This BiOp analyzed effects of active deterrence by trained and qualified citizens (i.e., persons with documents verifying training) including hazing with vehicles or vessels, and shooting projectiles from a firearm. This BiOp assessed these methods of deterrence as issued under LOAs through February 2018, unless circumstances required re-initiation of consultation or negated the validity of this consultation. USFWS concluded that the proposed action was not likely to jeopardize the continued existence of polar bears or Pacific walruses by reducing survival or recovery of these species.

AKLNG (2015). Biological Assessment: 2015 Geophysical & Geotechnical Program in The Waters of Cook Inlet. Alaska LNG. USAI-EX-SRZZZ-00-000006-000, Anchorage, AK. 72 pp.

Geophysical and geotechnical surveys were conducted by Alaska Liquified Natural Gas (AKLNG) in Cook Inlet in 2015. This Biological Assessment (BA) supported the IHA process for this project and addressed the effects of the action on humpback whales, Cook Inlet beluga whales, and Steller sea lions. The BA determined that the proposed project may affect, but was not likely to adversely affect these listed species and would have no effect on Steller sea lion critical habitat. Proposed mitigation and monitoring to reduce impacts included the use of Protected Species Observers (PSOs), implementation of clearing and ramp-up measures, shut-down, power-down, or vessel speed/course alterations. The cumulative effects section covers interactions with fisheries, other oil and gas efforts, coastal development, pollution, tourism, and subsistence hunting. The BA provides useful historical context of IHAs in Cook Inlet, typical mitigation measures, and beluga whale densities used to conduct exposures. Cook Inlet beluga whale densities used in this assessment were based on Goetz et al. 2012, ranging from 0.000021

to 0.001512 belugas/km2 at the Nikiski terminal and 0.000275 to 0.156718 belugas/km2 along the proposed pipeline crossing right-of-way.

BOEM (2015). Biological Assessment: BOEM Oil and Gas Activities Associated with Lease Sale 193. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. January 2015. 190 pp.
This BA evaluates the effects of the Chukchi Sea lease sale on spectacled eiders, spectacled eider critical habitat, Alaska-breeding Steller's eider, and polar bears. At this time, critical habitat was designated for polar bears. The main stressor for the polar bear was loss of sea ice from climate change. Since polar bears do not den along the coastal areas of the Chukchi Sea, disturbance of denning bears in the lease area was unlikely, and the main focus of the analysis was on non-denning polar bears. Based on the polar bear's status, it was determined that the proposed action may affect, and was likely to adversely affect polar bears, but was not likely to threaten the continued existence of the species. Also, based on the successful management of human-polar bear interactions in existing industrial areas through mitigation measures described in LOAs issued under the MMPA, it was expected that there would be minimal effects to polar bears from such interactions. Generally, impacts to listed species ranged from negligible to significant depending on several factors. The impact from an oil spill was one example where impacts ranged negligible to a significant impact if large volumes of oil reached areas with large concentrations of listed species (primarily eider species).

NMFS (2015). Biological Opinion: BOEM and BSEE Lease Sale 193 Oil and Gas Exploration Activities in Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2015-9422, 460 pp.
BOEM and BSEE proposed to authorize the following activities associated with exploration: marine seismic surveys; geohazard and geotechnical surveys; and exploratory drilling on the current leases within the Lease Sale 193 planning area from June 2015 to June 2024. The information in this BiOp is not substantively different from previous BiOps for lease sales in the Arctic. This BiOp evaluates the effects on marine mammals associated with the marine transit route to the planning area, including specific mitigation measures such as including reduced vessel speeds and placing PSOs on vessels that cannot avoid transiting through North Pacific right whale designated critical habitat. Effects of transiting vessels are evaluated for bowhead, fin, humpback, sperm whales, North Pacific right whales, the Western North Pacific DPS of gray whales, the western DPS of Steller sea lions, the Arctic subspecies of ringed seal, and the Beringia DPS of bearded seal. Considering the mitigation measures proposed, NMFS determined that the North Pacific right whale, Western North Pacific DPS of gray whale, sperm whales, the Western DPS of Steller sea lions and the designated critical habitats for these species would not likely be impacted by the proposed action. NMFS also required specific mitigation measures for avoiding ringed seal lairs stating that all activities must be conducted at least 150 m from any observed ringed seal lair. NMFS again concluded that the proposed action was not likely to jeopardize any ESA-listed species, or destroy or adversely modify proposed critical habitat for ringed seals (proposed on December 3, 2014 (79 FR 71714) and pending at the time of this BiOp).

NMFS (2015). Biological Opinion: Proposed IHA Hilcorp Shallow Geohazard and Strudel Scour Surveys in Foggy Island Bay, Beaufort Sea, Alaska. National Marine Fisheries Service Alaska Region. Consultation Number AKR-2015-9454, June 26, 2015. 63 pp.
This BiOP evaluates issuance of an IHA to Hilcorp for harassment of marine mammals incidental to shallow geohazard and strudel scour surveys, passive acoustic monitoring, and the transiting to and from the passive acoustic monitoring equipment sites in Foggy Island Bay. NMFS evaluated the effects of these actions on ESA-listed bowhead whales, Arctic subspecies of ringed seals, and the Beringia DPS bearded seals. On July 25, 2014, the U.S. District Court for Alaska issued a memorandum decision in a lawsuit

challenging the listing of bearded seals under the ESA. The decision vacated NMFS's listing of bearded seals as threatened. NMFS appealed that decision and while the appeal was pending, this BiOp addressed effects to bearded seals even though the listing was not in effect. The BiOp also considered effects on critical habitat for ringed seals, proposed on December 14, 2014 but not finalized. NMFS determined that vessel noise, vessel discharge, and disturbance of sediment could have insignificant effects on ESA-listed whales and seals. The only stressor likely to adversely affect ESA-listed species was sound from the sub-bottom profiler. To mitigate impacts from the sub-bottom profiler, NMFS required PSOs, that profiler operations could not begin during darkness or poor visibility conditions, and that it may only continue if in operation before the onset of poor visibility conditions. NMFS concluded that the proposed action was not likely to jeopardize the continued existence of bowhead whales, Arctic ringed seals, or the Beringia DPS of bearded seals, or adversely modify proposed critical habitat for ringed seal.

NMFS (2015). Biological Opinion: IHA SAExploration, Inc. 2015 3D Seismic in Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2015-9451, 169 pp.
NMFS evaluated the potential effects of issuing an IHA to SAExploration, Inc. to take marine mammals by harassment incidental to 3D ocean bottom node (OBN) seismic surveys between Harrison Bay and the Sagavanirktok River delta in the Beaufort Sea. Proposed activities were to occur between July 1 and October 15, 2015. These actions had the potential to affect the bowhead whale, Arctic subspecies of ringed seal, and Beringia DPS of bearded seal. Although the Action Area overlapped with proposed ringed seal critical habitat, proposed ringed seal critical habitat was not included in this consultation because NMFS did not believe the designation would be finalized in 2015. This approach differs from previous BiOps to include proposed critical habitat. The project included laying and retrieving nodal recording sensors on the ocean floor, operating seismic source vessels towing active airgun arrays, and vessel activities associated with crew transfer, recording support, and PSO monitoring for marine mammals. No bowhead whales were anticipated to be exposed to sound levels that could result in TTS; exposures may cause behavioral responses (e.g. slight avoidance) but were not likely to reduce fitness because the whales actively forage in waters around the seismic operations or migrate through the seismic operations. NMFS anticipated zero instances where bowhead whales might be exposed to sounds produced by pingers and transponders at sufficiently high levels or close distances to result in behavioral harassment. NMFS expected ringed and bearded seals to be exposed to low-frequency active seismic noise at very low received levels but not to noise from pingers or transponders. The effects of the exposures were considered insignificant. No exposures to vessel noise or potential for vessel strikes were anticipated for either seal species. Probable responses by ringed or bearded seals included tolerance, avoidance, short-term masking, and short-term vigilance behavior. Seals were expected to make close approaches to seismic vessels but probable exposure of individual seals to seismic airgun pulses were not likely to cause population-level effects. NMFS concluded that the proposed action would not likely jeopardize the continued existence of bowhead whales, ringed seals, bearded seals.

NMFS (2015). Biological Opinion: IHA Shell 2015 Exploration Drilling Activities in Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2015-9449, 244 pp.
This BiOp considered the effects of issuing another IHA to Shell to continue their exploration drilling program in the Chukchi Sea between July 1 and October 31, 2015. The program began in 2012 and previous IHAs had been issued by NMFS for similar activities. The proposed action had the potential to affect seven ESA-listed marine mammals. Shell proposed to drill at up to four exploration drill sites. The program planned for the 2015 resulted in the completion of a partial well at Burger A. The proposed action required two ice management vessels and two anchor handler/icebreakers. Ice management would occur far out in the OCS, remote from the vicinity of any routine marine vessel traffic in the Chukchi Sea. Shell vessels were to communicate movements and activities through the 2015 North Slope

Communications Centers. The ice-management/anchor handling vessels were to deflect floes away from the drilling vessel or the anchor mooring buoys even if the drilling units were not anchored at a drill site. The environmental baseline in this BiOP reflected changes to the status of humpback whales. NMFS recognized three DPSs of humpback whales in the North Pacific Ocean; two of these, the Western Pacific DPS and the Central North Pacific DPS, were listed under the ESA and could occur in the Bering Sea with access to the Chukchi and Beaufort Seas. As in previous assessments, all humpback whales in the Action Area were considered listed under the ESA. Other than the changes to the humpback whale status, the environmental baseline, cumulative effects analysis, and NMFS determinations had not changed from previous BiOps. Level B harassment as a result of increased noise was evaluated in detail. NMFS concluded that the proposed action was not likely to jeopardize the continued existence of the bowhead, fin or humpback whales; the Arctic subspecies of ringed seal, or the Beringia DPS of bearded seal; nor was it likely to adversely affect North Pacific right whales; Western North Pacific DPS of gray whales; sperm whales; or Western DPS of Steller sea lion, or any designated or proposed critical habitat.

NMFS (2015). Biological Opinion: IHA Shell Aviation Operations Associated with Ice Condition Monitoring May 2015 - April 2016 Over the Beaufort and Chukchi Seas, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2015-9448, May 20, 2015. 25 pp.
This is the first of two BiOps that evaluated the issuance of an IHA to Shell for incidental to marine mammal harassment during the Ice Overflight Survey Program in the Chukchi and Beaufort Seas from May 2015 to April 2016. These activities tiered from the broader program considered in the NMFS 2013 BiOp on Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska). Except when encountering marine mammals, altitudes for all fixed wing flights were to be at or above 152 m and ranged from 30 to 610 m. Helicopter altitudes were at or above 61 m with a range of 15 to 152 m. NMFS determined that proposed overflight surveys would not add significant impacts to overall cumulative effects on marine mammals based on the limited noise footprint and temporal or spatial separation between occurrences of mammal disturbance. The mitigation and monitoring measures outlined in the Marine Mammal Mitigation and Monitoring Plan (4MP) were expected to reduce potential adverse effects. NMFS determined that the proposed action would not affect ESA-listed cetaceans because whales were unlikely to be present in the vicinity of ice-coring activities (or associated helicopter landings) and were unlikely to be disturbed by passing fixed-wing aircraft. Therefore, no take of such species was authorized in the IHA. Proposed surveys were expected to cause non-lethal take of small numbers of Arctic ringed seals and Beringia DPS bearded seals. Temporary behavioral changes or injury (e.g., TTS or disturbance-induced hypothermia among pups) were not expected. NMFS determined that the proposed action was not likely to jeopardize the continued existence of ringed or bearded seals, and it was not likely to destroy or adversely modify proposed ringed seal critical habitat.

NMFS (2015). Biological Opinion: IHA 2012 Shell Exploration Activities in Chukchi Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR2015-9449, June 5, 2015. 244 pp.
This is the second BiOp that evaluated issuance of an IHA to Shell to take marine mammals by harassment during the Ice Overflight Survey Program in the Chukchi and Beaufort seas but specifically for the period July through October 31, 2015 only. As different from the May 2015 BiOp for these activities, bowhead whales were evaluated for potential effects. Shell had revised the turnover rate and avoidance assumptions for bowhead whale exposures and provided updated exposure estimates on March 22, 2015. This update did not ultimately affect the total estimated bowhead exposures to acoustic noise, but did change the methodology used to calculate exposures. Bowhead whale density estimates were also revised in the IHA and therefore, this BiOp as well. NMFS concluded that potential adverse effects could occur for bowhead, fin and humpback whales as well as both ringed and bearded seals. NMFS concluded that activities were not likely to destroy or adversely modify proposed ringed seal critical habitat.

Other details including monitoring and mitigation) previously analyzed in the May 2015 BiOp were the same.

USFWS (2015). Biological Opinion: BOEM and BSEE Oil and Gas Activities Associated with Lease Sale 193. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. March 30, 2015. 189 pp.

This BiOp evaluates potential effects on ESA-listed species of future incremental steps that may result from BOEM and BSEE's authorization of oil and gas exploration of 460 leased blocks within LS 193 in the Chukchi Sea and associated onshore facilities between June 2015 and June 2024. ESA-listed species assessed in this BiOp include polar bears, spectacled eiders, the Ledyard Bay unit of designated spectacled eider critical habitat, and Alaska-breeding Steller's eiders. BOEM and BSEE requested an incremental section 7 consultation to assess marine seismic surveys, geohazard surveys, geotechnical surveys, exploratory drilling, and onshore facility construction. Information in this BiOP is similar to other incremental consultation BiOps by USFWS for lease sale activities. The environmental baseline, cumulative effects analysis and the incremental step analyses do not present substantially different findings from previous, similar BiOps for lease sales. Mitigation measures included several broad measures that were relatively standard at this time as well as the caveat that future consultations would likely require more specific mitigation once project details were defined. The USFWS concluded that the entire proposed action, including future incremental steps, was not reasonably likely to jeopardize the continued existence of listed species or to destroy or adversely modify designated critical habitat. Incidental take for marine mammals was not included until regulations, authorizations, or permits under the MMPA 101(a)(5) were in effect. Thus, the USFWS did not authorize incidental take for polar bears within this BO, but instead authorized take under the ESA through the process used to authorize incidental take for polar bears under the MMPA.

USFWS (2015). Biological Opinion: Alaska State Preparedness Plan for Response to Oil and Hazardous Substance Discharges (referred to as the Unified Plan). U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Anchorage Fish and Wildlife Field Office. Consultation 2011-0036, Anchorage, AK. February 27, 2015. 250 pp.

This programmatic consultation BiOp evaluates the effects of the Unified Plan for oils spill preparedness and response. USFWS assessed potential impacts of the program as a whole, considering activities conducted under the Unified Plan both individually and cumulatively to ensure they are not likely to jeopardize the continued existence of ESA-listed species or result in the destruction or adverse modification of designated critical habitat. Species evaluated included the southwest DPS of northern sea otters, short-tailed albatross, spectacled eiders, the Alaska breeding population of Steller's eider, Pacific walrus, (a candidate as of 2011), and polar bears. The proposed action included the oil and hazardous substance discharge responses authorized and conducted under the Unified Plan and the proposed Dispersant Use Plan for Alaska. As such, the Unified Plan established the decision-making processes that direct oil spill response in Alaska. Typical spill responses would likely be relatively small in scale. USFWS concluded that the proposed action would not jeopardize any ESA-listed species or result in adverse modification of designated critical habitat because the hypothetical worst-case scenario spill, when mitigated by proposed spill response activities would not impact a sufficient portion of the listed populations or their habitat to result in adverse effects.

USFWS (2015). Letter of Concurrence: Northern Sea Otters for Shell Offshore Support Vessels Dutch Harbor to Chukchi Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. May 11, 2015. 4 pp.

TThis USFWS memorandum responded to Shell's request for concurrence under the ESA that effects of the use of support vessels on the southwest Alaska DPS of northern sea otters were negligible. Shell anticipated three offshore supply vessels (OSV's) would make up to 30 round trips from Dutch Harbor to the Chukchi Sea to resupply the mobile offshore drilling units (MODUs) and support vessels in the Chukchi Sea each drilling season. Drilling materials, food, fuel and other supplies would be picked up in Dutch Harbor (with possible minor resupply from Kotzebue) and transported to the MODUs and support vessels. Because the proposed vessel transit would have at most a discountable impact on the southwest Alaska DPS of northern sea otters, the USFWS concurred that the proposed action was not likely to adversely affect this species. The intersect between the vessel activities and designated critical habitat was limited to the port of Dutch Harbor where the value of critical habitat is already reduced by the presence of infrastructure. Therefore, the USFWS concurred that the proposed action would have no effect on designated critical habitat. Further consultation under section 7 of the ESA was not necessary.

NMFS (2016). Biological Opinion: IHA 2016 Fairweather Anchor Retrieval Activities in Chukchi and Beaufort Seas, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2016-9526, June 17, 2016. 175 pp.

NMFS proposed to issue an IHA to Fairweather LLC to take marine mammals by harassment incidental to anchor retrieval operations in the Chukchi and Beaufort seas by between July 1, and October 31, 2016. These actions had the potential to affect bowhead, fin, humpback and North Pacific right whales, and the western DPS of Steller sea lions, Arctic subspecies of ringed seals, and the Beringia DPS of bearded seals; as well as the designated critical habitats for North Pacific right whale and Steller sea lion. Fairweather proposed to retrieve approximately 55 anchors from five locations in the Chukchi and Beaufort seas over 35 days using four specialized anchor handling towing vessels, and sonar survey vessels. The project included: transiting to anchor locations; anchor handling and dynamic positioning of vessels; retrieving mooring systems (chain, wire rope, synthetic fiber rope, connectors, and anchoring points); sidescan sonar; ice management; and vessel activity associated with crew and fuel transfer and resupply. Mitigation measures including PSOs as well as 500m safety and exclusion zones during anchor retrieval or ice management were expected to reduced exposures and minimize effects on listed whales and pinnipeds. A CAA ceased operations during the fall bowhead whale hunt. The analyses concluded that bowhead, fin, and humpback whales were not likely to be exposed to vessel noise or the potential for vessel strike because noise associated with the vessel operations is anticipated to drop to 120 dB within 176 m (or less). The limited number of vessels and small ensonified area reduced the probability of exposure to whales and effects were considered discountable. NMFS concluded that the proposed action was not likely to jeopardize the continued existence of any listed species or was not likely to adversely affect critical habitat.

USFWS (2016). Biological Opinion: 2016-2021 Polar Bear and Pacific Walrus Incidental Take Regulations Beaufort Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Fairbanks Fish and Wildlife Field Office. Fairbanks, AK. July 27, 2016. 76 pp.

This BiOp assesses Incidental Take Regulations (ITRs) for the period 2016-2021 for oil and gas exploration, development, and production in the Beaufort Sea and adjacent coastal areas of northern Alaska. The issuance Beaufort ITRs and potential effects on polar bears and walrus include disturbance, physical obstruction, increased human interactions, oil spills, and effects on prey species. While at this time, polar bear critical habitat was pending due to litigation, the USFWS included an evaluation of potential effects on habitat as proposed in the final rule described in 74 FR 56058. Due to the low density of polar bears

and walrus and the expansive size of the action area, encounters with polar bears were expected to be infrequent. However, up to 340 polar bears (68 annually) and 50 walrus (10 annually) would be subject to non-lethal incidental take. Broad mitigation measures such as food and waste containment and personnel training are evaluated however, the USFWS relies on future LOAs to specify project-specific measures to be followed by industry and therefore, includes language such as "Holders of LOAs must utilize policies and procedures to conduct activities in a manner that minimizes to the greatest extent practicable adverse impacts….". Even though only broadly defined in this BiOp, mitigation measures were expected to reduce these encounters which were anticipated to result in only minor, temporary changes in bear or walrus behavior, with no adverse effects (i.e., no injuries or deaths meeting the definition of incidental take under the ESA). Significant impacts to polar bears or walrus from large oil spills were unlikely due to the low likelihood of spills of that scale. The USFWS concluded that the proposed action was not likely to jeopardize the continued existence of polar bears or Pacific walrus, or adversely affect designated polar bear critical habitat.

Hilcorp (2017). Biological Assessment and Request for Emergency ESA Consultation: Hilcorp Middle Ground Shoals Platform A Gasline Repairs, Cook Inlet, Alaska. Anchorage, AK. August 25, 2017. 53 pp.
The ESA regulations recognize that an emergency (natural disaster or other incident) may require an expedited consultation process (at 50 CFR §402.05) especially where emergency actions are required that may affect listed species and/or critical habitats. In February 2017, Hilcorp requested an emergency consultation regarding emergency repair of a leaking subsea natural gas pipeline in Cook Inlet by May 1, 2017, beginning as soon as ice conditions allowed. The Action Area was defined as lower sections of upper Cook Inlet adjacent to the pipeline corridor to a distance where marine mammals would no longer be affected by underwater sounds that might result in Level B harassment. Activities such as use of the Caviblaster® to remove debris from the pipeline could result in noise levels affecting marine mammals for very short periods of time. The Caviblaster® was anticipated to be used for a maximum of 25 to 30 minutes per dive (50 to 60 minutes' total) over two consecutive days, (one dive per day). This BA provides a useful overview of pipeline maintenance and repair tools often used in Cook Inlet including their expected noise characteristics underwater. At the time of this BA, sound source verification for proposed equipment such as the Caviblaster ® was not available. Aerial marine mammal surveys, PSOs located at the site, and standard shutdown and monitoring procedures were proposed to minimize impacts on marine mammals that could be exposed to increased noise. Based on the overlap between the location of the emergency repair action and Cook Inlet beluga whale high density use areas, the BA concludes that noise from the emergency activities "may affect and were likely to adversely affect" beluga whales for discrete, short periods of time over a two-day repair period. No Level A takes (injury including PTS) were expected from noise generated from pipeline repair activities because of the relatively low level of noise expected from proposed repair equipment.

NMFS (2017). Biological Opinion: Furie's 2017-2021 Offshore Oil and Gas Exploration Drilling in the Kitchen Lights Unit of Cook Inlet, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2016-9600, May 31, 2017. 139 pp.
USACE proposed to authorize Furie to drill up to nine exploratory wells in the Kitchen Lights Unit of Cook Inlet, north of the East Foreland and south of the village of Tyonek, between 2017 and 2021. This BiOp considered potential effects of this action on fin whales, Pacific and Mexico DPSs of humpback whales, Cook Inlet beluga whales, the western DPS of Steller sea lion, and designated critical habitat for Cook Inlet beluga whales and Steller sea lions. The Kitchen Lights Unit occurs entirely within designated beluga whale critical habitat. However, none of the well sites are located in areas of known beluga whale concentrations. The action area was located well outside designated Steller sea lion critical habitat. The proposed activity included transport of a jack-up rig to each site using up to three tugs, geophysical

surveys, pile driving at each drilling location, drilling operations, vessel and air traffic associated with rig operations, fuel storage, and well completion activities. Cook Inlet beluga whales, humpback and fin whales, and western DPS Steller sea lions occur in the action area and were anticipated to overlap with and respond to noise from impact pile driving activities and the transport vessel. Standard mitigation focused on reducing impacts to beluga whales including: PSOs located on-site throughout drill rig transport, pile driving, vessel delivery activity, aircraft landings and take-offs, and throughout all associated aerial or marine-based protected species surveys; and measures such as exclusion zones and shutdown procedures to reduce disturbance to belugas. However, drilling could not be interrupted, nor could tug operations stop during rig transport. NMFS' BiOp concluded that the effects of this action were discountable, and that exposures to Mexico DPS humpbacks, Western North Pacific humpbacks, and fin whales were extremely unlikely to occur. Due to the location and timing of the project and implementation of mitigation measures, exposures to any listed species to noise levels that could cause disturbance were expected to be extremely minimal. Effects of this project would have been greater had the project been located further to the north during summer. The other whale species also occur in low densities in mid and upper Cook Inlet during summer. After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it was NMFS's biological opinion that the proposed action was not likely to jeopardize the continued existence of any listed species. Nor was the proposed action likely to adversely affect designated critical habitat for Steller sea lion or Cook Inlet beluga whales.

NMFS (2017). Letter of Concurrence: Emergency Consultation Hilcorp Middle Ground Shoals Platform A Gasline Repairs in Cook Inlet, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2017-9650, March 30, 2017. 17 pp.

On February 7, 2017, a natural gas pipeline leak was reported by Hilcorp Alaska, LLC (Hilcorp) to the National Response Center (NRC Report No. 1170504) indicating an unknown quantity release of natural gas from a subsea pipeline. The natural gas leak was located in upper Cook Inlet. On March 22, 2017, the USACE and Hilcorp convened a telephone call with NMFS Alaska Regional Office (AKRO), to describe the emergency status of the natural gas leak, the proposed methods to repair the pipeline, and the need for an emergency consultation under the ESA. NMFS AKRO agreed that pipeline repair work should proceed during this emergency consultation process, as soon as site conditions allow. After the proposed repair was completed, NMFS may require additional information, which may include documentation of mitigation measures used, the results of mitigation to minimizing takes, and an evaluation of the impacts of the action on ESA-listed species. In accordance with the requirements of the ESA, NMFS concurred on the determinations in the March 2017 BA, and forwarded a concurrence letter to USACE and a record of the consultation on October 3, 2017.

NMFS (2017). Biological Opinion: BOEM and BSEE 2017-2022 Oil and Gas Lease Sale 244 in Cook Inlet, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2016-9580, 307 pp.

NMFS consulted with BOEM and BSEE on the proposed leasing of areas for oil and gas exploration, and authorization of subsequent oil and gas exploration activities for Lease Sale 244 in Cook Inlet from August 2017 to August 2022. BOEM and BSEE requested an incremental section 7 consultation covering the first step of the proposed action – activities consisting of: (1) marine seismic surveys; (2) geohazard surveys; (3) geotechnical surveys; (4) exploratory drilling; and (5) onshore facility construction. This consultation also considered potential impacts through the endpoint of the action. marine mammals may be adversely affected by exposure to seismic exploration noise, drilling noise, pile driving noise, anchor handling, use of dynamic positioning or thrusters, and tug transport of drill rigs. Exposure to vessel noise (excluding tugs and drill ships), aircraft noise, noise from non-seismic geohazard surveys, seafloor

disturbance, and small oil spills may occur, but the expected effects would be minimal and would not likely result in take. NMFS expected that takes would result from vessel noise associated with tug movement of jack-up rigs and with use of drill ships. Small oil spill discharges could occur, but the effects were undetectable and would not rise to the level of take. The risk associated with larger oil spills was anticipated to increase during future incremental steps. The best available data suggested that beluga whales were almost entirely absent from the LS 244 area during summer months but present at low densities at the northern and western fringes area in fall and winter. Mitigation measures reduced exposure of all listed species to loud noise through project timing, and stipulating measures that facilitate early detection of approaching marine mammals and reduce acoustic output if marine mammals enter disturbance zones. It was NMFS's biological opinion that Based on the results of the Exposure Analysis for the first incremental step, NMFS determined that the proposed action may affect and was likely to adversely affect Cook Inlet beluga whales, fin whales, the Western North Pacific DPS and the Mexico DPS of humpback whales, and the western DPS of Steller sea lions, but was not likely to destroy or adversely modify designated critical habitat for either Cook Inlet beluga whales or Steller sea lions. The proposed action was not likely to jeopardize the continued existence of any listed species, or designated critical habitat for Steller sea lion or Cook Inlet beluga whales. NMFS determined that the quantity or availability of the essential features of critical habitat were not likely to decline as a result of being exposed to oil and gas exploration activities during the first incremental step.

USFWS (2017). Biological Opinion: Proposed Oil and Gas Lease Sale 244 in Cook Inlet, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Anchorage Fish and Wildlife Field Office. Consultation Number 016-F-0226, Anchorage, AK. May 26, 2017. 168 pp.

The Proposed Action included oil and gas exploration, development, production, and decommissioning in connection with the leases issued through LS 244. Oil and gas activities from the lease sale may affect Alaska breeding Steller's eider, the Alaska DPS of northern sea otter, and designated critical habitat for the southwest Alaska DPS of northern sea otter. The consultation was divided into incremental steps, the first step included marine seismic, geohazard, and geotechnical surveys, and drill exploration and delineation wells. Future incremental steps would include all subsequent development, production, and decommissioning activities. Based on the limited number of individuals of listed species likely to be affected, and the minor impacts to designated critical habitat, combined with the mitigation measures required and/or enforced by BOEM and BSEE during the first Incremental step of the Proposed Action, the USFWS concluded that activities were not likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat. The USFWS analyses' of the entire Proposed Action, including future incremental steps, resulted in a determination that the proposed action was not reasonably likely to jeopardize the continued existence of, or destroy or adversely modify designated critical habitat, of any listed species.

NMFS (2018). Biological Opinion: Issuance of U.S. Army Corps of Engineers Permit and IIHA for Harvest Cook Inlet Pipeline Cross-Inlet Extension Project. National Marine Fisheries Service. Alaska Region. Consultation Number AKR 2018-9719, February 27, 2018. 106 pp.

This BiOp considered the effects to ESA-listed species from the proposed issuance of an IHA and an USACE Letter of Permission (Standard Permit) to Harvest, Alaska LLC, authorizing the Cook Inlet Pipeline (CIPL) Cross-Inlet Extension Project and the Cook Inlet Gas Gathering System (CIGGS) in Cook Inlet. The CIPL Project included the installation of subsea pipelines between the west side of Cook Inlet and the offshore Tyonek Platform. In addition, existing subsea pipelines that cross Cook Inlet at the Forelands were to be converted from natural gas service to oil service. The ESA-listed species considered were Cook Inlet beluga whales, the Mexico and Western North Pacific DPSs of humpback whales, and the western DPS Steller sea lions. The ESA-listed Cook Inlet beluga whale was most likely to be adversely affected by

this project, primarily from noise. This BiOp distinguished between harassment pursuant to the MMPA (Level B take) from a "take," as defined by the ESA. Therefore, this BiOp assessed the risk of take under the ESA based on estimated exposure of marine mammals to certain sound levels, then characterized the responses of the exposed listed marine mammals as a 'take' or not, based on severity and type of marine mammal response under the ESA. NMFS concluded that only acoustic disturbance from the CIPL Project is expected to result in a possible take of the listed species and that this level of take by harassment, in addition to other effects of the proposed action, was not likely to jeopardize the continued existence of Cook Inlet beluga whales, Mexico DPS humpback whales, or western DPS Steller sea lions., All other project-related effects were not expected to be consequential to these species or to Cook Inlet beluga whale critical habitat and were therefore not considered a take.

NMFS (2018). Biological Opinion: Proposed IHA Office of Naval Research (ONR) Arctic Research Activities 2018-2021 in Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2018-9725, September 7, 2018. 115 pp.
This BiOp considered the effects of the Navy's military readiness exercises in the Arctic which have the potential to affect the Arctic subspecies of ringed seals and the Beringia DPS of bearded seals. As this consultation was on military readiness exercises, a detailed annotation is not included.

NMFS (2018). Letter of Concurrence: Hilcorp 2018-2028 Simpson Lagoon Dredging and Screeding in Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2018-9775, June 21, 2018. 20 pp.
NMFS completed an informal ESA consultation (i.e., provided a Letter of Concurrence [LOC]) for proposed dredging, screeding and beach nourishment activities in Simpson Lagoon along the Beaufort Sea coast. Based on a detailed project description which is summarized in the LOC, NMFS concluded the project should have no effect on the ESA-listed cetacean species that may occur in deeper, offshore waters of the Beaufort Sea. At the time of this LOC, the best available information regarding potential noise from dredging and screeding was based on studies conducted at Northstar which are referenced in the LOC. The use of PSOs and a 1,000 m shutdown zone supported NMFS concurrence with Hilcorp that any potential adverse impacts to bearded or ringed seals were discountable. Similarly the effects on proposed Arctic ringed seal critical habitat would be too small to detect or measure, and therefore insignificant. NMFS concurred that the proposed action may affect, but was not likely to adversely affect bearded or ringed seals.

NMFS (2018). Letter of Concurrence: Ringed Seals for Eni Oliktok Production Pad and Spy Island Drillsite Ice Road Activities, Beaufort Sea, Alaska. National Marine Fisheries Service. Office of Protected Resources. October 11, 2018. 9 pp.
At the time this LOC was in process, through informal consultation, Eni, Hilcorp and NMFS developed a suite of Best Management Practices (BMPs) for the construction, operation and maintenance of ice roads, trails and pads used along the Beaufort Sea coast by industry. NMFS concurred with Eni that by implementing BMPs during construction, operation and maintenance of the ice road and trails at Oliktok Production Point and Spy Island, the likelihood of taking Arctic ringed seals by behavioral harassment during the 2018-2019 ice road season was extremely low. NMFS concurred that the activities may affect but were not likely adversely affect listed ringed seals in the area. Notably, NMFS further stated that if BMPs were followed, applying for an incidental harassment authorization such as an IHA was not necessary for the proposed action. This LOC pre-dates the MMPA final rule and LOAs for ice roads, trails and pads published by NMFS on December 22, 2020 (85 FR 83451).

Oil Search Alaska, L. (2018). Biological Assessment: Terrestrial ESA-Listed Species: Oil Search Alaska (OSA) Nanushuk Project in North Slope, Alaska. National Marine Fisheries Service. August 28, 2018. 136 pp.

Oil Search Alaska (OSA) proposed the development of oil and gas leases targeting oil deposits in the Alpine C and Nanushuk reservoirs. OSA would drill wells and construct and operate infrastructure and facilities to produce and transport oil to TAPS. Informal consultation with NMFS for bowhead whales and bearded seals was initially requested by USACE in a letter dated March 6, 2018. This request was updated on March 14, 2018 to include ringed seals due to their reinstatement as a threatened species on February 12, 2018. The majority of project construction and operation activities occurred on land and would not affect the marine environment or marine mammals. The proposed project activities that could affect NMFS listed species were the underwater screeding process that included scraping and/or dragging sediments at the Oliktok Dock, and sealift module barge docking and offloading at the same location. Such activities could result in habitat alteration and disturbance. Any disturbance or displacement by the visual presence of or noise emitted from the barge and/or vessels associated with screeding activity was anticipated to be temporary and localized. For bowhead whales, the recommended effect determination for the Nanushuk Project was may affect, but not likely to adversely affect. Bearded and Arctic ringed seals occur in the waters where barging and screeding activities were to take place. Individuals could be disturbed by underwater noise or the physical presence of screeding vessels or barges. The use of marine mammal observers and the implementation of a 500-foot radius shutdown zone reduced impacts to bearded seals. Any disturbance was anticipated to be temporary and localized. Therefore, the recommended effect determination for the Nanushuk Project for pinnipeds was may affect, but not likely to adversely affect. The project action area for screeding activities was also located within the proposed critical habitat for Arctic ringed seals. Because screeding and associated vessel traffic would be temporary and short in duration, with minimal long-term impact to the underwater benthic environment or prey resources, the recommend effect determination for the Nanushuk Project on critical habitat for Arctic ringed seals was may affect, but not likely to adversely affect.

United States Court of Appeals (2018). Ringed Seal ESA Listing Opinion. 5 pp.

IThis legal opinion the U.S. Court of Appeals for the 9th Circuit upheld ESA protection for the Arctic subspecies of ringed seals to list them as a threatened species. On March 17, 2016, the ringed seal listing was vacated by the U.S. District Court for the District of Alaska (Alaska Oil and Gas Ass'n v. Nat'l Marine Fisheries Serv., 2016 WL 1125744 (D. Alaska 2016)). This 2018 ruling reversed that decision by the lower court and found that listing ringed seals as threatened was based on the best available science that the widespread loss of the sea ice habitat concerning for the species' survival. The decision relied heavily on its 2016 decision upholding similar ESA protection for bearded seals, another Arctic ice dependent species threatened by climate change. The court found that, as with bearded seals, climate change models from the Intergovernmental Panel on Climate Change (IPCC) show that ringed seal habitat is diminishing as sea ice recedes and reasonably supported the determination that a species reliant on sea ice likely would become endangered in the foreseeable future." Therefore, based on this decision, the Arctic ringed seal was again an ESA-listed species and prompted NMFS into action to evaluate designating critical habitat within a year of the listing. ESA-listing of the seals did not affect subsistence harvest of the species by Alaska natives.

NMFS (2019). Letter of Concurrence: Oil Search Alaska (OSA) Nanushuk Oliktok Dock Screeding and Module Offloading, Oliktok Point, Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKR-2019-9847, February 20, 2019. 43 pp.

The USACE requested an LOC from NMFS that the proposed screeding and offloading activities at Oliktok Dock may affect, but would not likely adversely affect, bowhead whales, Beringia DPS of bearded seals,

or Arctic subspecies of ringed seals in the project area. This request follows previous assessment of such activities as presented in the 2018 BA prepared for the Nanushuk Project. Through this informal consultation under Section 7 of the ESA, NMFS considered effects from vessel activity along the marine transit route to Prudhoe Bay on blue whales, fin whales, Western North Pacific gray whales, Western North Pacific DPS and Mexico DPS of humpback whales, North Pacific right whales, sperm whales, and Western DPS Steller sea lions as well as designated Steller sea lion and North Pacific right whale critical habitat. NMFS concurred that screeding and offloading modules may affect but were not likely to adversely affect bowhead whales, bearded seals, or ringed seals. NMFS concurred that vessel activity along the marine transit route may affect, but was not likely to adversely affect, listed species or critical habitat for species evaluated. Mitigation measures during screeding included: using a PSO to monitor an 800 m shut down, stopping work if an animal entered the safety zone; scanning the waters for 30 minutes prior to work starting, and not starting work if animals were present in the zone. In addition, if visibility degraded to less than 1,000 m work would cease. Mitigation for the marine transit route included: not approaching any whales within 100 m or within 800m of right whales; reducing vessel speeds and steering around whales; staying 300 m from calf cow pairs; and checking around the propellers to make sure no whales would be injured. In right whale critical habitat, vessel speed would be reduced to 5 knots (kts) in the absence of a PSO.

NMFS (2019). Biological Opinion: BOEM, BSEE, EPA, and USACE Authorizations for Hilcorp Liberty Oil and Gas Development and Production Activities in Beaufort Sea, Alaska. Consultation Number AKRO-2019-00004, August 30, 2019. 236 pp.

This BiOp analyzes potential effects on marine mammals associated with proposed construction of the Liberty Development and Production Island (LDPI) artificial island by Hilcorp Alaska, LLC (Hilcorp) in 5.8 m of water in Foggy Island Bay. The project would entail constructing a manmade island offshore (i.e., LDPI), oil and gas development, production, and decommissioning activities on LDPI over a 25-year period beginning in December 2020 through November 2045. Under a final rule and LOA, NMFS authorized Hilcorp to incidentally take bowhead, blue, fin, North Pacific right whales and sperm whales as well as the Mexico DPS and Western North Pacific DPS of humpback whales. Takes were also authorized for the Western DPS Steller sea lion, Arctic subspecies of ringed seals, and the Beringia DPS bearded seals, as well as designated critical habitats for North Pacific right whales and Steller sea lions. Estimated takes for all species were considered negligible. This BiOp includes a detailed construction schedule, helpful for understanding the project sequence and the potential for takes of marine mammals. NMFS determined there would be no effect on the Western North Pacific DPS endangered gray whales. The majority of authorized takes were associated with behavioral harassment from acoustic noise during construction of LDPI. The BiOp includes a detailed project description, complete with estimated distances to both Level A and Level B harassment during use of construction equipment as well as after construction while production drilling would occur. NMFS anticipated the proposed Liberty Project was likely to result in the incidental take of ESA-listed species by Level A harassment (from increased noise) and mortality (during sea ice road activities) for a small number of ringed seals, as well as Level B harassment (noise and physical presence). The limited level of anticipated take, coupled with mitigation and monitoring measures prescribed, was not likely to result in jeopardy of any ESA species or destruction or adverse modification of critical habitat. LDPI would be located well inside the barrier islands and inside of bowhead migratory routes, so possible takes from noise inside Foggy Island Bay (while possible) were largely inconsequential. Serious injury or mortality of a small number of ringed seals would be a very small fraction of the overall population. Therefore, the BiOp concluded that the sum total of the proposed activities would not jeopardize the continued existence of the ESA-listed species evaluated.

NMFS (2019). Biological Opinion: Final Rule, Hilcorp Alaska and Harvest Alaska Oil and Gas Activities, Cook Inlet Alaska. Consultation Number AKRO-2018-00381, 261 pp.

NMFS issued 5-year (2019-2024) ITRs under the MMPA (84 FR 12330) to Hilcorp and Harvest Alaska for harassment of marine mammals incidental to oil and gas exploration and development in Cook Inlet. BOEM also issued a 1-year (August 1, 2019 to August 1, 2020) geological and geophysical permit for seismic surveys in Cook Inlet. On April 1, 2019, NMFS published the proposed rule. This BiOP considered the potential to affect Cook Inlet beluga whales, fin whales, the Mexico and Western North Pacific DPSs of humpback whales, blue whales, and the Western DPS of Steller sea lions, and designated critical habitat for Cook Inlet beluga whales and Steller sea lions. Take would occur by Level A and Level B harassment incidental to a variety of sources including: 2D and 3D seismic surveys, geohazard surveys, vibratory sheet pile driving, and drilling of exploratory wells. This opinion focuses on Hilcorp's activities for the next five years (2019-2024); however, a portion of these activities (e.g., maintenance, production, etc.) may continue after 2024. Therefore, the analysis considered these activities 30 years into the future. Coastal development may detrimentally affect Cook Inlet beluga and Steller sea lion critical habitat through loss or degradation of habitat or alterations to prey availability. A full suite of detailed mitigation measures are described, including shutting down activities when beluga whales are seen at any distance from project sites. Exposures to noise at received levels that could cause harassment to any listed whales were expected to be minimal. According to the stipulations of Lease Sale 244, seismic surveys would not occur anywhere in the LS 244 area between November 1 and April 1, nor would both exploration and delineation drilling, and geohazard and geotechnical surveys occur within lease blocks within Cook Inlet beluga whale critical habitat between November 1 and April 1. This specific mitigation measure provides protection during the fall and winter months when this part of critical habitat is more heavily used by Cook Inlet beluga whales. Seismic surveys would not occur on LS 244 OCS blocks within 10 miles of nearshore feeding areas associated with anadromous streams between July 1 and September 30, when beluga whales may be present and foraging. NMFS concluded that the proposed action was not likely to jeopardize the continued existence of Cook Inlet beluga whales, fin whales, Western North Pacific DPS humpback whales, Mexico DPS humpback whales, or Western DPS Steller sea lions or to destroy or adversely modify designated Cook Inlet beluga whale or Steller sea lion critical habitat

NMFS (2019). Biological Opinion: BLM Oil and Gas Lead Sale Arctic National Wildlife Refuge Coastal Plain Beaufort Sea Coast, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKRO-2019-00141, October 18, 2019. 141 pp.

The Bureau of Land Management (BLM) proposed to implement an oil and gas leasing program in the Arctic National Wildlife Refuge (ANWR) Coastal Plain over an 85-year period beginning within one year of the Record of Decision for the Coastal Plain Oil and Gas Leasing Program EIS. This BiOp represents a framework programmatic consultation per 50 CFR §402.02. Associated seismic exploration to determine lease viability, and the subsequent phases of exploration, development, production, and abandonment and reclamation of leased blocks may affect listed species and designated critical habitat and are expected to require subsequent and future consultations. In the BiOp, the effects of the first phase of establishing and administering an oil and gas program for the leasing, development, production, and transportation of oil and gas in and from the Coastal Plain area of the ANWR are analyzed. The activities associated with these phases have the potential to incidentally take under the MMPA: bowhead, blue, fin, North Pacific right, and sperm whales, and the Mexico DPS and Western North Pacific DPS of humpback whales, as well as the Western DPS Steller sea lion, Arctic subspecies of ringed seals, and Beringia DPS of bearded seals. Designated critical habitats for North Pacific right whales and Steller sea lions were also evaluated. Bowhead whales may be impacted by activities occurring in the Coastal Plain portion of the action area. However, there is a low degree of human activity with the associated risk factors, which include ship strikes, oil and gas development, subsistence hunting, climate change, noise

pollution from aircraft and vessels, and potential oil spills. As discussed in the Approach to the Assessment section of this BiOp, an action that is not likely to reduce the fitness of individual whales would not be likely to reduce the viability of the populations or the extinction probability of the species. NMFS concluded that the proposed action was not likely to jeopardize the continued existence of any listed species or destroy or adversely modify designated critical habitat for North Pacific right whales and Steller sea lions.

NMFS (2019). Revised Biological Opinion: Proposed IHA Office of Naval Research (ONR) Arctic Research Activities 2018-2021 in Beaufort Sea, Alaska. National Marine Fisheries Service. Consultation Number AKRO 2019-00688, August 27, 2019. 116 pp.

This BiOp considers the effects of the Navy's Ice Exercise (ICEX20) in the winter and spring of 2020 which could affect the Arctic subspecies of ringed seals or Beringia DPS of bearded seals. As this BiOp was for military readiness exercises a detailed annotation is not provided.

NMFS (2020). Biological Opinion: Proposed Rule and LOAs to Hilcorp Alaska, LLC and Eni U.S. Operating Co. Inc. for 2020 to 2025 Ice Road and Trail Activities on the North Slope, Beaufort Sea, Alaska. National Marine Fisheries Service. Alaska Region. Consultation Number AKRO-2019-00194, March 26, 2020. 99 pp.

NMFS promulgated regulations and issued subsequent LOAs in December 2020 following the final rule to take marine mammals by harassment incidental to ice road, trail, and pad construction, use, and maintenance, in the waters of the Beaufort Sea by Hilcorp and Eni December 2020 to December 2025. This BiOp evaluated the proposed rule which did not differ substantively from the MMPA final rule. Ice road, trail and pad activities could affect the Arctic subspecies of ringed seals. The Beringia DPS of bearded seals are not expected to occur near ice road activity. This BiOp considered the effects of the construction, maintenance, and use of sea ice roads, trails, and pads to support drilling at three sites including Northstar, Spy Island Drillsite (SID) and Oliktok Production Point (OPP). The best available information used in this BiOp and the associated MMPA rule is primarily data and monitoring reports from Northstar studies. Work would begin during the ice season starting in 2020 and continue in subsequent winters for five years. Mitigation measures required during ice road and trail use focus on avoiding pupping season such that no new areas are to be disturbed for ice roads after March 1st when pupping is imminent. These and other measures are described in detail and have become the standard for ice road construction in the Arctic. NMFS concluded that the proposed action would not likely jeopardize the continued existence of Arctic ringed seals. No critical habitat has been designated for this species at this time, therefore, none will be affected.

Bin 2 - Marine Mammal Protection Act (MMPA) Rules, Letters of Authorization (LOAs) and Incidental Harassment Authorizations (IHAs)

NMFS (2000). 65 FR 34014 Taking Marine Mammals Incidental to Construction and Operation of Offshore Oil and Gas Facilities in the Beaufort Sea; Final Rule. *Federal Register*, 65:34014-34032.
This final rule is one of the foundational documents regulating marine mammal incidental take for an offshore, manmade oil production island in the Beaufort Sea, Alaska. Since 1998, there have been multiple subsequent rules, ESA Section 7 consultations and associated NEPA assessments related to Northstar. On November 30, 1998, BPXA requested that NMFS promulgate regulations to authorize the taking of small numbers of several marine mammal species incidental to the construction and operations at the Northstar and Liberty sites (64 FR 9965). Delays in construction required that BPXA update its application on October 1, 1999 (64 FR 57010) which, among other things, removed the request for marine mammal takes for construction and operation at the Liberty site. as the revised application and this final rule include a detailed description of BPXA's planned construction, operation and maintenance activities as well as proposed mitigation measures (i.e., winter construction to avoid bowhead whale exposure to pile driving sounds, ringed seal lair surveys using trained dogs, temporarily ceasing drilling during bowhead whale migration during the first year). NMFS provided discussion of potential impacts on subsistence harvest of bowheads and ringed seals. Notably, a summary of public comments from the North Slope Borough (NSB), MMC, Greenpeace and others on the proposed rule and NMFS' responses provides additional insights into the rationale behind NMFS' conclusions. Final regulations were codified on May 25, 2000 and remained in effect through May 25, 2005.

USFWS (2000). 65 FR 5275 Take of Polar Bears and Pacific Walrus during Oil and Gas Industry Operations in the Beaufort Sea. *Federal Register*, 65:5275-5278.
This final rule reinstated the existing regulations initially promulgated on January 28, 1999 (64 FR 4328) by the USFWS to authorize the incidental, unintentional take of small numbers of polar bears and Pacific walrus during oil and gas industry operations in the Beaufort Sea February 3 through March 31, 2000. This rulemaking was an interim measure intended to avoid a lapse in regulations while the USFWS considered public comments on the proposed rule published December 9, 1999 (64 FR 68973). The USFWS evaluated the impacts of the oil and gas activities to polar bears and Pacific walrus, and their effects on the availability of these species for subsistence use. Exploration activities included geological and geophysical surveys, which include geotechnical site investigation, reflective seismic exploration, vibrator seismic data collection, air gun and water gun seismic data collection, explosive seismic data collection, geological surveys, and drilling operations. Development and production activities were also included. Mitigation measures included avoiding known or observed bear dens by 1 mile through cooperative operating procedures. This rule also acknowledged that while a number of potentially dangerous encounters occurred in previous years, bear-human encounters had not resulted in injury to polar bears or humans. Based on the best available scientific information and the results of six years of monitoring data, the USFWS concluded that the effects of oil and gas related exploration, development, and production in the Beaufort Sea would have a negligible impact on polar bears and Pacific walrus and their habitat. The USFWS also found that the activities as described would have no unmitigable adverse impacts on the availability of these species for subsistence use by Alaska Natives.

NMFS (2001). 66 FR 9291 IHA Phillips Oil and Gas Exploration Drilling Activities in the Beaufort Sea, Alaska. *Federal Register*, 66:9291-9298.
Phillips Alaska, Inc.(Phillips), sought authorization to take small numbers of marine mammals incidental to oil and gas exploratory drilling activities and ice road construction at McCovey Prospect located approximately 22.5 kilometers (km) north of East Dock at Prudhoe Bay, 11.3 km northwest of Cross Island, and 19.3 km east of Northstar. One drilling well was planned from an ice island to be constructed in December 2000. NMFS determined that the short-term impact of exploratory drilling and related activities would likely result in no more than a temporary modification of the behavior of ringed seals and

a small number of bearded seals, provided that mitigation and monitoring efforts to locate and avoid seals during construction activities are effective. Of significance was the requirement by NMFS (and supported by MMC) to use trained dogs to detect seal lairs in the vicinity of the planned activities, namely ice road and ice island pad construction. Phillips was required to survey all ice roads to a distance of 150 m on each side of the disturbed ice. While MMC concurred with NMFS' preliminary determination that efforts to locate and avoid seals during construction activities were effective, MMC expressed an ongoing concern that cumulative impacts may not be negligible. MMC suggested that NMFS [and USFWS] consider ways to determine whether oil and gas related activities were having broader-scale effects on marine mammals that may not be detected by site-specific monitoring programs. NMFS concluded that the proposed activity would result in no more than an unmitigable adverse impact on subsistence hunting, and no more than a negligible impact on any species of marine mammal.

NMFS (2001). 66 FR 40996 IHA BPXA Exxon and Phillips Shallow-water Hazard Activities in the Beaufort Sea, Alaska. *Federal Register*, 66:40996-41005.

BPXA ExxonMobil Production Co, and Phillips (BPXA/EM/PAI) applied for an IHA for the harassment of small numbers of marine mammals incidental to conducting shallow hazards surveys along a proposed natural gas pipeline route in the central and eastern Alaskan Beaufort Sea during the 2001 open-water season. The primary purpose of the survey was to acquire detailed data on sea bottom and sub-bottom characteristics to support pipeline route selection, pipeline design, and safe pipeline operation along a route where water depths ranged from 20 – 60 feet. Estimated sound source levels for the proposed equipment are described. Comments from the Northern Alaska Environmental Center (NAEC), on behalf of several environmental organizations) believed BPXA/EM/PAI failed to consider the cumulative impacts from all seismic projects that would be taking place in the Beaufort Sea during 2001. NAEC was concerned these combined activities would have a considerable negative effect on ringed, spotted and bearded seals, and beluga and bowhead whales and could negatively impact subsistence hunting by the Inupiat. NMFS responded that short-term impacts of conducting shallow hazards surveys in the Alaskan Beaufort Sea would resulting a temporary modification in behavior by certain species of cetaceans and pinnipeds. Appropriate mitigation measures to avoid an unmitigable adverse impact on the availability of bowhead whales for subsistence needs were discussed in the CAA for the 2001 season. NMFS determined that BPXA/EM/PAI's shallow hazards survey would not have an unmitigable adverse impact on the availability of ringed, bearded and spotted seals needed for subsistence and would have only a negligible impact on small numbers of marine mammal species. NMFS published the Final IHA on August 6, 2001.

NMFS (2002). 67 FR 77750 LOA BPXA Northstar Oil and Gas Production Beaufort Sea, Alaska. *Federal Register*, 67:77750-77752.

On September 25, 2002, BPXA requested a renewal of an LOA issued September 28, 2000 (65 FR 58265) and re-issued on December 14, 2001 (66 FR 65923), for the taking of marine mammals incidental to oil production operations at Northstar. This request contained the necessary compliance information, and updated information since the original application in 2000. Impacts were possible through noise from barge, helicopter traffic, drilling, and other noise sources on the platform. Harassment due to noise of approximately 215 bowheads, 5 gray whales and 15 beluga whales was possible. Year-round operations could have also resulted in harassment of up to approximately 95 ringed seals and 1 bearded seal and the incidental mortality of up to 5 ringed seal pups. An important mitigation measure included the commitment by BPXA not to drill into oil-bearing strata during periods of open water or broken ice (i.e., between June 13 and ending with the presence of 18 inches of continuous ice cover for one-half mile in all directions). In the notice of the final 5–year rule published May 25, 2000 (63 FR 32207), and in the notice for the LOA published December 21, 2001 (66 FR 65923) for oil production at Northstar, NMFS

determined that the taking of small numbers of bowhead whales, beluga whales, ringed seals, and possibly California gray whales, bearded seals and spotted seals have only a negligible impact on these marine mammal stocks, would not have an unmitigable adverse impact on the availability of these species or stocks for taking for subsistence uses.

NMFS (2003). 68 FR 14401 IHA ConocoPhilips On-ice Seismic Activities, Beaufort Sea, Alaska. *Federal Register*, 68:14401- 14408.

NMFS published a notice on December 30, 2002, proposing to issue an IHA to Conoco Phillips Alaska (CPAI) to authorize taking small numbers of ringed and bearded seals incidental to conducting on-ice seismic operations in a 2,190 km2 area extending from approximately Cape Halkett on the west to Oliktok Point on the east and to approximately 7.4 – 37 km offshore of the Beaufort Sea coast December 2002 through May 2003. NMFS responses to public comments, including by the AEWC and MMC, provide supporting rationale to their determination that the short-term impact of the proposed activities would result in a temporary modification in the behavior of ringed seals and possibly a few bearded seals, provided that certain mitigation measures be implemented before commencing on-ice seismic surveys after mid-March to avoid ringed seal dens. Similar to prior MMPA authorizations, NMFS required ringed seal lair surveys using trained dogs for any offshore on-ice seismic surveys after March 20th in waters of 3 m or deeper. Surveys were to be conducted 150 m to each side of transit routes. If trained dogs were unavailable, NMFS required that take be determined using observed densities of seal on ice reported by Moulton et al. (2001) for the Northstar project. MMC commented that the use of trained dogs was the only reliable method for locating ringed seal lairs and other structures and that humans should not conduct monitoring. NMFS disagreed stating because of limited availability, trained dogs should first be made available to activities that have the greatest potential for injury or mortality to ringed seals and/or their young, such as construction of ice roads. Concerning potential cumulative impacts, NMFS stated that under section 101(a)(5)(D) there is no requirement that any applicant conduct monitoring to determine whether all activities in the subject area (i.e., the Beaufort Sea) might someday have a significant cumulative impact on marine mammals. CPAIs proposed monitoring plan was peer-reviewed and accepted by the participants at a workshop on the impacts of on-ice activities on marine mammals. Based on workshop conclusions, NMFS determined that monitoring programs for both open-water and wintertime activities would be adequate to identify impacts on marine mammals, both singly from the project and cumulatively throughout the industry. The IHA was effective March 19, 2003, through July 1, 2003.

NMFS (2003). 68 FR 47547 IHA EnCana Oil and Gas Movement of Steel Drilling Caisson through the Beaufort Sea from Cross Island, McCovey Prospect to Herschel Island, Yukon Territory. *Federal Register*, 68:47547-47549.

On May 14, 2003 (68 FR 36542), NMFS received a request from EnCana for an authorization to take small numbers of bowhead and beluga whales, and ringed, bearded, and spotted seals by harassment incidental to movement of a steel drilling caisson (SDC) from Cross Island to Herschel Island in the Yukon Territory August 2003 through January 2004. Harassment of bowhead whales, beluga whales, and ringed, bearded and spotted seals was possible from noise generated by the towing vessels during SDC mobilization or equipment removal from the SDC. The physical presence of the SDC tow vessels and helicopter could also lead to disturbance of marine mammals. Potential collisions between vessels and whales was mitigated by the slow tow speed and PSO monitoring throughout transit. EnCana proposed to reduce the production of noise during the fall bowhead whale migration worked with the AEWC, NSB, and other whaling communities to amend an existing CAA to include the 2003 to reduce impacts. NMFS determined that the proposed activity could result in the harassment of small numbers of bowhead and beluga whales, and ringed, bearded, and spotted seals, but would have no more than a negligible impact

on these marine mammal stocks, and would not have an unmitigable adverse impact on the availability of marine mammal stocks for subsistence uses. This IHA was effective from August 1, 2003 to July 31, 2004.

NMFS (2003). 68 FR 68874 LOA BPXA Northstar Construction and Operation of Offshore Oil and Gas Facilities in the Beaufort Sea. *Federal Register*, 68:68874-68875.
NMFS received a request from BPXA for a renewal of an LOA issued on September 18, 2000 (65 FR 58265) and reissued on December 14, 2001 (66 FR 65923), and December 9, 2002 (67 FR 77750) for the taking of marine mammals incidental to oil production operations at Northstar. . Activities could produce noise resulting in Level B harassment of approximately 765 bowheads (i.e., the LOA authorizes up to 765 bowheads annually, with a maximum of 1,533 in 2 out of 5 seasons, and a total of 3,585 in 5 years), 5 gray whales and 91 beluga whales. Year-round operations could result in the harassment of up to approximately 191 ringed seals, 10 bearded seals, and 5 spotted seals and the incidental mortality of up to 5 ringed seal pups. No take was authorized for an oil spill. NMFS concluded that based on the results from the monitoring program carried out since 1999, there were no indications that determinations made in 2000 and 2001 were in error, nor that estimated levels of incidental harassment have been exceeded, and because the activity previously reviewed in 2001 (oil production activities) had not changed, these determinations remained valid.

NMFS (2004). 69 FR 10209 IHA ConocoPhillips On-Ice Seismic Cape Halkett to Oliktok Point. *Federal Register*, 69:10209-10212.
On January 26, 2004, NMFS published a notice seeking comment on a request from CPAI for authorization to take small numbers of ringed and bearded seals by harassment incidental to on-ice seismic surveys from Cape Halkett to Oliktok Point to approximately 20 nautical miles offshore in the Beaufort Sea, through 31 May 2004 (69 FR 3564). This notice describes proposed activities, including equipment and survey schedule, which were similar to those for which incidental taking was authorized by NMFS for the 2003 season. Mitigation measures for activities in waters deeper than 3 meters after March 20th again required surveys using trained dogs to identify active seal holes/birthing lairs or hole/ lair habitats so they could be avoided to the greatest extent practicable. If trained dogs were not available, potential habitat would be identified by trained marine mammal biologists based on the characteristics of the ice (i.e., deformation and cracks). This notice provides useful citations for ringed seal studies used to support NMFS conclusion that impacts were expected to be negligible for the ringed and bearded seal populations. In a preliminary conclusions section, NMFS states Although seals may abandon structures near seismic activity, studies have not demonstrated a cause and effect relationship between abandonment and seismic activity or biologically significant impact on ringed seals. Potential effects of on-ice seismic were also not expected to have an unmitigable adverse impact on subsistence uses of ringed or bearded seals.

USFWS (2004). 69 FR 12174 LOAs Industry Oil and Gas Operations Beaufort Sea, Alaska. *Federal Register*, 69:12174.
This notice issued 12 LOAs under the existing regulations (in effect at this time) to take polar bears incidental to oil and gas industry exploration activities in the Beaufort Sea and adjacent northern coast of Alaska effective for one year beginning December 2003 and January 2004. Companies for which LOAs were authorized included CPAI, Fairweather Geophysical, TotalFinaElf Exploration and Production USA, Inc., BPXA and Anadarko Petroleum Corporation.

NMFS (2005). 70 FR 17066 IHA ConocoPhillips On-ice Seismic Operations in the Beaufort Sea, Alaska. *Federal Register*, 70:10766-10768.

On November 26, 2004, CPAI applied for the taking by harassment of ringed and bearded seals incidental to conducting an on-ice vibroseis seismic survey program planned from Milne Point to the eastern channel of the Colville River to a distance offshore of 4.3 km, an area encompassing approximately 132.1 km2. Water depths in most of the planned survey area were less than 3 m limiting seal access to the project site. NMFS required CPAI to avoid observed ringed or bearded seal lairs, training for the seismic crews to recognize potential areas of ringed seal lairs, conducting surveys using trained dogs or biologists to detect possible ringed seal lairs for any surveys after mid-March along on-ice routes in areas with water depths over 3 m. This IHA stated that "all activities would be conducted as far as practicable from any observed ringed or bearded seal lair" which is slightly more general than other MMPA authorizations around this time which were more specifically requiring avoidance of seals lairs at a distance of 100 m (see 71 FR 11314 for on-ice seismic). As with previous IHAs, CPAI was required to coordinate with the Native communities of Barrow (Utqiaġvik) and Nuiqsut to develop a Plan of Cooperation to minimize impacts on subsistence. The expected impact of winter seismic activities on the species or stock of ringed and bearded seals was negligible. Consequently, NMFS determined that no significant effects on individual ringed or bearded seals or their populations were expected, and that effects of on-ice seismic surveys would be limited to short-term and localized behavioral changes for a small number of seals. Also, the potential effects of the on-ice seismic operations during 2005 were unlikely to have an unmitigable adverse impact on subsistence uses of these two species. No public comments were received on the proposed IHA. NMFS issued an IHA to CPAI effective March 29, 2005 through March 28, 2006.

NMFS (2005). 70 FR 6626 Notice of Receipt of IHA Application ConocoPhillips On-ice Seismic Operations in the Beaufort Sea, Alaska. *Federal Register*, 70:6626-6630.
This is the Notice of Receipt for the CPAI application submitted November 24, 2004 for incidental harassment of marine mammals associated with an on-ice seismic survey from Milne Point to the eastern channel of the Colville River. NMFS issued an IHA to CPAI effective March 29, 2005 through March 28, 2006 (70 FR 10766).

NMFS (2005). 70 FR 47809 IHA FEX Movement of Barges Through the Beaufort Sea Between West Dock and Cape Simpson, Alaska. *Federal Register*, 70:47809-47813.
On March 29, 2005, FEX applied for the taking of several species of marine mammals incidental to the movement of two tugs towing barges West Dock in Prudhoe Bay to Cape Simpson. NMFS authorized FEX to incidentally take by harassment small numbers of bowhead and beluga whales, and ringed, bearded, and spotted seals or approximately 20 days during the 2005 open water season. FEX agreed to make every effort to avoid periods of whale migration and subsistence activities by completing barging by August 15th, but no later than September 1st. Level B harassment of marine mammals was possible due to noise generated by towing vessels during barge movement and the physical presence of the tugs and barges. Notably, NMFS states that noise disturbance from vessels might qualify as harassment to seals, but previous surveys have indicated little behavioral reaction from these animals to slow-moving vessels. No collisions between vessels and whales were likely due to the slow tow speed and visual monitoring by PSOs. Marine mammal species with the highest likelihood of being harassed during the tug and barge movements included beluga whales, ringed seals, and bearded seals. Spotted seals normally reside closer to the shore. Bowhead whales were not expected to be encountered in more than very small numbers during the planned period of time for the tug/barge movement. Any behavioral change would have a negligible impact on the survival and recruitment of marine mammals during the period of activity and the number of potential harassment takings was estimated to be small. No take by injury or death was anticipated. Principal mitigation measures included a CAA between FEX, the AEWC and the Whaling Captains Association; a POC; and an operation schedule that avoided barging operations during the traditional bowhead whaling season.

NMFS (2006). 71 FR 11314 Final Rule and LOA BPXA Northstar Operation of Offshore Oil and Gas Facilities in the Beaufort Sea, Alaska. *US Federal Register*, 71:11314-11324.

On September 23, 2004, NMFS published a request from BPXA seeking authorization to take small numbers of bowhead, gray and beluga whales; and ringed, spotted and bearded seals incidental to oil production operations at Northstar (69 FR 56995). Impacts on marine mammals could occur through noise from barges, helicopter traffic, drilling, and other activities on the island. However, impacts to marine mammal food resources or habitat were not expected from any of the continued drilling or operational activities. Underwater sounds associated with drilling and production operations have lower source levels than do the seismic pulses and drillship sounds that have been the main concern of the Inupiat hunters. As mitigation, BPXA was to: 1) establish a 190 dB safety zone for seals and 180 dB safety zone for whales and shut down if animals entered these zones; 2) avoid seal lairs by 100 m for any new activities on sea ice after March 20th; conduct monitoring using PSOs 30 minutes prior to activities; 3) avoid non-essential boat traffic during bowhead migration; and 4) establish a flight corridor for aircraft and maintain minimum altitude of 1,000 m except during takeoff/landing or when limited by weather. Comments on the proposed rule were extensive and addressed the following concerns: number of authorized takes, impacts to subsistence species and hunts, and mitigation and monitoring of impacts. Several commenters stated that available studies suggested the effects of the construction and operation of the Northstar were "subtle and small in the context of natural variation of the marine ecosystem." The MMC continued to recommend a monitoring program sufficient to detect any non-negligible effects to ensure that the activities were not individually or cumulatively having population-level effects on marine mammals. The rule also addressed impacts from oil spills although takes from spills were not authorized in this [or future] rulemakings by NMFS. Of significance to mitigation was the continued discussion of the use of trained dogs to find seal lairs in winter. BPXA used trained dog surveys during primary ice road construction to avoid, to the greatest extent possible, harassing ringed seals. Regulations were issued on March 7, 2006.

NMFS (2006). 71 FR 43112 IHA ConocoPhillips Open-water Seismic Operations in the Chukchi Sea, Alaska. *Federal Register*, 71:43112-43132.

NMFS issued an IHA to CPAI to take small numbers of marine mammals by harassment incidental to open-water seismic surveys in the Chukchi Sea from July 7 through December 31, 2006. Five cetaceans (bowhead, beluga, killer, gray, minke whales) and four pinniped (ringed, bearded, spotted, and ribbon seals) were known to occur in the project or vessel transit areas. NMFS anticipated that the effects of CPAI's seismic surveys on marine mammals would be behavioral disturbance, and possibly masking and TTS. Disturbance by seismic noise was the principal means of taking. Support vessels and aircraft were a potential secondary source of noise. The physical presence of vessels and aircraft could also lead to non-acoustic effects on marine mammals involving visual or other cues. NMFS did not expect any take from other sound sources (echosounder and acoustic positioning system). NMFS concluded it would be unlikely that pinnipeds would be harassed or injured by low frequency sounds from a seismic source unless they were close to the seismic array. While seals may be able to hear seismic arrays, they appear to tolerate intense pulsatile sounds. Comments by Native Alaskans expressed concerns about impacts on subsistence such as changes in behavior or migratory patterns of bowhead whales or other species due to noise such that that they are not present in traditional hunting grounds or at historical numbers. TK shared by Alaska Natives stated that bowheads may become increasingly ''skittish'' in the presence of seismic noise and exhibit behaviors such as tail-slapping, which translates to danger for nearby subsistence harvesters. Alaska Natives and the IWC expressed concerns that cumulative effects of increased or concurrent seismic surveys in the Chukchi and Beaufort seas may have population-level effects on subsistence stocks that would permanently affect subsistence harvests. CPAI had a signed a

CAA with the AEWC as well as a POC. NMFS public meetings in Anchorage in April 2006 resulted in expanding CPAI (and other) monitoring programs. Shell, CPAI and GXT committed to a joint aerial surveys for marine mammal approximately 20 miles offshore between Point Hope and Point Barrow, particularly for beluga whales near traditional hunting areas in the eastern Chukchi Sea. NMFS concluded that seismic surveys in the northeastern Chukchi Sea in 2006 would have no unmitigable adverse impacts to subsistence communities. While marine mammal behavioral and avoidance reactions may occur due to noise, these effects were expected to have a negligible impact on species and stocks.

NMFS (2006). 71 FR 43715 IHA FEX Movement of Barges through the Beaufort Sea between West Dock and Cape Simpson or Point Lonely, Alaska. *Federal Register*, 71:43715-43718.
On April 5, 2006, ASRC Energy Services (AES), on behalf of FEX applied for the taking of several species of marine mammals incidental to the movement of two tugs towing barges in the U.S. Beaufort Sea. Marine barges would transport drilling rig(s), consumables, fuel, essential construction equipment and supplies from West Dock to Cape Simpson or Point Lonely. NMFS published the request on June 13, 2006 (71 FR 34064) and proposed to authorize FEX to incidentally take by harassment small numbers of bowhead and beluga whales, and ringed, bearded, and spotted seals between approximately July 1 and November 30, 2006. Bowhead whales were not expected to be encountered. Level B harassment was possible due to noise from vessels during barge movement and disturbance due to physical presence of the tugs and barges. No collisions between vessels and whales were likely due to the slow tow speed and visual monitoring by PSOs. NMFS determined that the activity could result in a temporary behavioral changes by marine mammals. These behavioral changes would have a negligible impacts on marine mammal survival or recruitment during the period of activity and the number of potential harassment takings would be small. No take by injury or death was anticipated. The barging operation would have no more than a negligible impact on marine mammal stocks. No adverse impacts on subsistence activities were likely, in part, due to implementation of a CAA between FEX and the AEWC and Whaling Captains Association, a POC, and a schedule that avoided barging operations during the traditional bowhead whaling season. The IHA was published August 2, 2006.

NMFS (2006). 71 FR 49418 IHA GXT Seismic Surveys in the Chukchi Sea off Alaska. *Federal Register*, 71:49418-49433.
On March 28, 2006, GXT applied for an IHA to take several species of marine mammals incidental to conducting a marine seismic survey of approximately 5,302 km in the Chukchi and Beaufort seas, with mobilization from Dutch Harbor. Marine mammal species potentially affected included bowhead, fin, gray, minke, and killer whales and harbor porpoise as well as bearded, ringed, spotted and harbor seals. On March 31, 2006, GXT notified NMFS that it would only conduct surveys in the Canadian Beaufort Sea EEZ (not U.S.). Disturbance by seismic noise was the principal means of taking with potential for vessel and marine mammal survey aircraft noise as secondary sources. Table 1 of the IHA shows estimated distances to noise thresholds during surveys. Assuming mitigation and monitoring measures were followed, NMFS concluded GXT's seismic surveys would have no more than a negligible impact on the affected species or stocks of marine mammals, would potentially take only small numbers of marine mammals. In addition, provided the POC and CAA were followed, activities would not have an unmitigable adverse impacts on availability for subsistence uses. Several commenters disagreed with NMFS' small numbers and negligible impact determination and with the ability of PSOs to effectively monitor the areas of increased noise exposure. Generally, seismic surveys in the Chukchi were less well received than similar surveys in the Beaufort Sea. The Center for Biological Diversity (CBD) commented that hundreds or thousands of takes cannot be considered ''small" and stated that NMFS must look at the immediate effects of GXT's seismic surveys together with the cumulative effects over multiple years of other oil and gas activities and anthropogenic risk factors such as climate change, both onshore and

offshore Alaska. After consideration, NMFS determined that the impact of conducting relatively short-term seismic surveys in the U.S. Chukchi Sea may result in temporary behavior modifications by some marine mammals which were expected to have a negligible impact on the affected species and stocks. No take by death or serious injury was anticipated, and the potential for temporary or permanent hearing impairment would be avoided through mitigation measures. A final IHA was issued on August 23rd effective through December 31, 2006.

NMFS (2006). 71 FR 26336 ASRC Harrison Bay Seismic IHA. *Federal Register*, 71:26336-26340.
On October 24, 2005, AES Lynx applied for an IHA on behalf of Kuukpik for the taking by harassment of two species of marine mammals incidental to conducting an on-ice seismic survey program in Harrison Bay through May 20, 2006. The operation involved laying seismic cables with geophones on the frozen sea ice, using vibroseis, and recording the seismic signals in an area where water depths were generally less than 3 m. The proposed request was published February 27, 2006 (71 FR 9782). The anticipated impacts on species or stocks of ringed and bearded seals were expected to be negligible. MMC commented that effects of proposed activities by themselves were likely to be negligible, but they continued to be concerned about cumulative impacts and predicted climate change in the Beaufort Sea. MMC recommended that marine mammal monitoring programs be expanded to collect general information on density, abundance, prey, foraging, distribution and contaminant levels. MMC again commented that trained dogs were the only reliable method for locating ringed seal lairs. NMFS responded that experienced subsistence hunters should be an alternative if no dogs were available. Kuukpik committed to work with Barrow, Nuiqsut, and the Inupiat Community of the Arctic Slope (ICAS) to assess additional measures to minimize seismic activity impacts. A POC was developed between Kuukpik and Nuiqsut. NMFS concluded that effects of on-ice seismic were expected to cause short-term, localized behavioral changes of a relatively small numbers of seals. There would be no more than a negligible impact on the affected species or stocks of ringed and bearded seals and activities would not have an unmitigable adverse impact on subsistence uses of these two species. NMFS issued an IHA effective from April 30, 2006 through April 29, 2007.

USFWS (2006). 71 FR 26770 Notice of Receipt of IHA Applications Shell ConocoPhilips and GXT Houston Open-water Seismic Chukchi Sea, Alaska. *Federal Register*, 71:26770-26781.
On January 13, 2006, the USFWS received applications from Shell, CPAI, and GXT for the taking by harassment of Pacific walrus and polar bears incidental to conducting a seismic survey to support future oil and gas exploration in the Chukchi Sea Lease Sale 193 area. Leasing was scheduled for 2007. The notice includes individual descriptions for surveys to be conducted by each company including proposed equipment, locations and schedule. All surveys were to occur between June 1 and November 30, 2006 (including transit time). Although the applicants' seismic survey programs had minor differences, such as 2D versus 3D, the USFWS consolidated the analysis of these separate requests because they were substantially the same in nature and area of operation. Seismic ships and icebreakers may cause physical obstructions to polar bear movements but impacts would be short-term and localized. Noise from and the physical presence of seismic activities may disrupt natural behavior of bears and walrus. Pacific walrus hunting is important in the communities of Point Hope, Point Lay, Wainwright, and Barrow. Point Hope hunters typically begin their hunt in late May and June as walrus migrate north into the Lease Sale 193 Area. Standard operational conditions to minimize effects on bears and walrus are described in detail including the use of an 800 m exclusion zone, minimum 300 m aircraft altitude for polar bears or hauled out walrus and that no seismic activities would occur within a 40-mile radius of affected communities. The USFWS concluded that while incidental harassment of polar bears and walrus was reasonably expected to occur, the overall impact would be negligible on species' populations and limited to Level B harassment of a relatively small number of animals.

USFWS (2006). 71 FR 43926 Marine Mammals; Incidental Take During Specified Activities AOGA, dated August 2, 2006. *Federal Register*, 71:43926-43953.

This final rule was subsequent to several previous rules published to authorize the nonlethal, incidental, unintentional take of small numbers of polar bears and Pacific walrus during year-round oil and gas industry (Industry) exploration, development, and production operations in the Beaufort Sea and adjacent northern coast of Alaska. Industry operations for the covered period were similar to all previous regulations (November 16, 1993 [58 FR 60402]; August 17, 1995 [60 FR 42805]; January 28, 1999 [64 FR 4328]; February 3, 2000 [65 FR 5275]; March 30, 2000 [65 FR 16828]; and November 28, 2003 [68 FR 66744]). From 1993 to 2004, under this series of regulations, 262 LOAs were issued for oil and as seismic surveys and drilling; development activities, such as construction and remediation; and production activities for operational fields. A total of 726 polar
bear sightings were recorded by Industry with approximately 41 percent of these sightings during production activities. This rule described each lease sale area and the activities planned in each. Potential effects are described including noise disturbance, physical obstructions, human encounters and effects on prey. A detailed evaluation (including methodology) of the risk of a large oil spill and potential impacts is provided. The USFWS concludes that while the impacts of a large spill would be significant, it was unlikely to occur. Public comments and the USFWS' responses are summarized. The MMC recommended that USFWS conduct a more comprehensive analysis of Industry operations by the cumulative effect of all these activities over time along with climate change. The MMC also recommended USFWS include a more specific description of mitigation measures in the final regulations. The USFWS determined that the anticipated number of polar bears and walrus that were likely to modify their behavior as a result of oil and gas industry activity was small. In most cases, takes may result in a temporary behavioral change with no effect on rates of recruitment or survival. Other takes would be associated with deterrence or hazing events. Activities would not have an unmitigable adverse impact on the availability of these species for subsistence use by Alaska Natives. Final regulations were published and became effective August 2, 2006 through August 2, 2011.

NMFS (2007). 72 FR 31550 Notice of Receipt of IHA Application FEX Movement of Barges through the Beaufort Sea between West Dock and Cape Simpson or Point Lonely, Alaska. *Federal Register*, 72:31550-31593.

On April 26, 2007, NMFS received an application from FEX to take small numbers of bowhead, gray, and beluga whales, and ringed, bearded and spotted seals incidental to the movement of two tugs towing barges in the U.S. Beaufort Sea between approximately July 1 and November 30, 2007. Marine barges would be used to either resupply or demobilize ongoing drilling activities on the Northwest National Petroleum Reserve-Alaska (NPRA) Oil and Gas Leases. Consumables, fuel, and essential pad construction equipment would be marine lifted from West Dock to the Cape Simpson staging area, where they would be stored for the 2007 - 2008 winter exploration season. As with previous MMPA authorizations for barge activities, Level B harassment was possible due to vessel noise (within a 1 km radius from the source) and presence. There was zero change of vessel-mammal collision due to low vessel speeds and PSO monitoring. Early detection of whales was expected to direct vessels away from whales. Also, given the relatively short distances from sound sources (i.e., vessels), NMFS expected only a small number of bowhead whales, beluga whales and gray whales could be exposed to sound levels greater than 120 dB. Barging, as scheduled, would be completed before the westward migration of bowhead whales in the fall and the associated subsistence activities by the local whalers. The barge route west of Cross Island and east of Barrow, did not pass by any whaling base camps. NMFS determined that activities would result in the taking of no more than small numbers of marine mammals and that total takes would have a

negligible impact on marine mammal stocks, and would not have an unmitigable adverse impact on the availability of these species or stocks for subsistence.

NMFS (2007). 72 FR 45740 IHA FEX Movement of Barges Through the Beaufort Sea Between West Dock and Cape Simpson or Point Lonely, Alaska. *Federal Register*, 72:45740-45744.
This is the IHA for which NMFS received a request from FEX on April 26, 2007 (72 FR 31550), to take small numbers of bowhead whales, gray whales, beluga whales, ringed seals, bearded seals, and spotted seals by harassment incidental to conducting a barging operation within the U.S. Beaufort Sea between approximately July 1 and November 30, 2007. Details of the IHA do not differ from those summarized in the annotation for the Notice of Receipt for this activity (72 FR 31550).This IHA issued by NMFS on August 15, 2007 summarized previous years of monitoring data (i.e., 2005 and 2006) including seal sightings and total takes recorded. Based on the 2005 and 2006 barging activities, NMFS estimates that approximately 530 ringed seals, 10 spotted seals, 2 bearded seals, and 9 unidentified phocids could be taken by Level B harassment as a result of the 2007 barging activity.

NMFS (2007). 72 FR 17842 IHA Shell On-Ice Marine Seismic Research & Development Beaufort Sea, Alaska. *Federal Register*, 72:17842-17849.
On January 17, 2007, Shell applied for the taking by harassment of ringed, spotted and bearded seals incidental to conducting an on-ice marine geophysical research program. None of these species were listed under the ESA at this time. The on-ice work was an effort to develop mitigative alternatives to open water seismic acquisition. Several technologies were evaluated both for their efficacy in acquiring subsurface data and for reducing environmental impacts. By evaluating multiple technologies during an on-ice experiment, the hope was to identify a mitigative alternative to open water seismic surveys. Shell proposed a 3-dog protocol to detect seal breathing holes and lairs to mitigate potential impacts. Any work location would be at least 500 m from the nearest seal structure identified. The NSB supported the efforts to collect geological data from the ice instead of during the open water period when bowhead whales and other marine mammals might be present, and while significant subsistence activity takes place. Other detailed comments and NMFS responses provide supporting rationale for NMFS' determination that any potential impacts to ringed, bearded, and spotted seals to the proposed on-ice geophysical seismic program would be negligible and would be limited to distant and transient exposure. NMFS assumed that if there were seals in lairs within the safety zone, most acoustic energies from the airgun would be emitted under the water and may not even be audible by seals in lairs. In addition, if noises were audible and annoying, ringed seals would have a number of lairs and breathing holes available in their area. NMFS issued an IHA on April 10, 2007 for a period between March and May 2007.

NMFS (2007). 72 FR 38065 LOA BPXA Northstar Construction and Operation of Offshore Oil and Gas Facilities in the Beaufort Sea, Alaska. *Federal Register*, 72:38065-38067.
Following the final rule published in March 2006 (71 FR 11314), NMFS issued a LOA to BPXA to take small numbers of bowhead, gray, and beluga whales, and ringed, spotted, and bearded seals incidental to the production of offshore oil and gas at the Northstar development in the Beaufort Sea off Alaska effective July 7, 2007, through July 6, 2008. This LOA references information collected by BPXA during their long-term monitoring program at Northstar. For example, no responses of seals to Northstar activities were noted during monitoring surveys in 2005 other than a seal raising its head, possibly in response to Northstar activities. There was no evidence to suspect that any seals were killed or injured by Northstar-related activities during 2006. Further, no activities were conducted that could have exposed pinnipeds or whales to underwater received levels greater than 190 dB re 1 microPa (rms) or 180 dB re 1 microPa (rms), respectively. Mitigation measures outlined in the final rule issued in 2006 (71 FR 11314) were specified again in this LOA. This notice references supporting by information contained in the 2006 final

rule as well as BPXA's 2006 annual report that the activities would have no more than a negligible impact on small numbers of marine mammal stocks and would not have an unmitigable adverse impact on the availability of these species or stocks for taking for subsistence uses.

NMFS (2007). 72 FR 17864 Notice of Receipt of IHA Application Shell Seismic Surveys in the Beaufort and Chukchi Seas off Alaska. *Federal Register*, 72:17864-17873.

NMFS received an application from Shell Offshore, Inc. (SOI) on January 17, 2007, for an IHA to take small numbers of bowhead, gray, and beluga whales, and ringed, spotted, and bearded seals by harassment incidental to open-water offshore exploratory drilling in the Beaufort Sea between mid-July and November 2007. SOI planned to use two drilling units off of Pt. Thomson and Flaxman Island. Disturbance by drilling sounds was the principal means of taking as well as non-acoustic effects due to physical presence of vessels and aircraft. NMFS determined that any impacts on whale and seal populations of the Beaufort Sea were likely to be temporary and result in only short-term displacement of seals and whales from within ensonified zones. SOI noted that there could be an adverse impact on the Inupiat bowhead subsistence hunt if the whales were deflected seaward from traditional hunting areas north of Pt. Thomson. Mitigation measures included: (1) timing and locating some drilling support activities to avoid interference with the Kaktovik, Nuiqsut and Barrow (Utqiaġvik) bowhead whale hunts; (2) establishing appropriate 180 dB and 190 dB safety zones and the 160 and 120 dB behavior radii through pre-season modeling; and (3) vessel-based and aerial monitoring to implement mitigation and assess potential effects on marine mammals. SOI also committed to an aerial survey program in the Beaufort Sea during summer and fall of 2007, and implemented mitigation procedures described in the CAA between SOI, AEWC, and the Whaling Captains Associations of Kaktovik, Nuiqsut and Barrow. SOI also planned to conduct a study similar to one conducted for seismic in 2006 in the Chukchi Sea to determine the effect of drilling noise and noise from support vessels and seismic activities on migrating bowhead whales. NMFS concluded that an exploratory drilling program in the U.S. Beaufort Sea in 2007 would have no more than a negligible impact on marine mammals and would not result in an unmitigable impact to subsistence hunters.

NMFS (2007). 72 FR 17118 IHAs ConocoPhilips and Union Oil Co. of California Open Water Seismic Operations in Cook Inlet, Alaska. *Federal Register*, 72:17118-17133.

Several IHA applications for Cook Inlet in 2007 were highly controversial due to the continued declining status of Cook Inlet beluga whales and possible cumulative effects of multiple surveys in a short period of time. On October 6 and October 12, 2006, CPAI and Union Oil Company of California (UOCC), respectively, requested IHAs for harassment of small numbers of Cook Inlet beluga whales, Steller sea lions, Pacific harbor seals, harbor porpoises, and killer whales incidental to open water seismic operations using an ocean-bottom cable (OBC) system. CPAI was to operate in northwestern Cook Inlet just offshore from Beluga River south approximately 6km from mid-March through mid-May while UOCC planned to operate from Granite Point extending into the Inlet about 1.6 km from early May through mid-June 2007. A description of these activities was published on January 5, 2007 in the Notice of Receipt (72 FR 536). NMFS concluded the projects would result in no more than a negligible impact on marine mammals, and would not have an unmitigable adverse impact on the availability for subsistence uses, provided that all monitoring and mitigation measures were carried out. NMFS required aerial monitoring for Cook Inlet belugas within CPAI's project area off Beluga River in upper Cook Inlet to ensure the whales were not displaced from their normal habitat during surveys. The Humane Society of the U.S. (HSUS) was concerned that surveys would result in daily displacement of animals for months, and result in long-term significant effects on foraging success and fitness of individuals. CBD commented that the requirement of ''least practicable impact'' on the species was not met by NMFS. The MMC recommended not to issue the IHAs and that seismic surveying should not be allowed because recent status reviews and extinction

assessments revealed that the Cook Inlet beluga whale population had not shown appreciable recovery since 1999. The MMC also stated that increased vessel traffic, contaminants, military operations, waste management, and urban runoff were potential cumulative stressors. The Whale and Dolphin Conservation Society stated that any added pressure to this population might push it beyond recovery. NMFS concurred with the MMC concerns regarding the potential cumulative impact of the proposed activities on the Cook Inlet beluga whale stock. NMFS also concurred that extra caution was needed authorizing IHAs for Cook Inlet beluga whales due to the precarious situation of this stock. NMFS analyzed potential cumulative effects associated with short-term seismic surveys which were described in detail in the associated EA. NMFS determined that small numbers of beluga whales, Steller sea lion, Pacific harbor seals, killer whales, and harbor porpoises could be taken incidental to seismic surveys by Level B harassment and such taking would result in no more than a negligible impact on such species or stocks. IHAs were issued to CPAI and UOCC on March 30th for a period mid-March through mid-June 2007.

NMFS (2007). 72 FR 19695 IHA ConcoPhillips On-ice Geotechnical Operations in the Beaufort Sea. *Federal Register*, 72:19695-19699.

On November 29, 2006, NMFS CPAI applied for an IHA for the taking by harassment of a small number of ringed seals incidental to geotechnical portions of a site clearance survey just north of Cross Island in the spring of 2007. The site clearance location was on OCS and State of Alaska leases in the U.S. Beaufort Sea. The proposed operation was to be active 24 hours per day and use a conventional geotechnical drilling rig. The project would result in Level B behavioral harassment of a small number of ringed seals and no seals would be killed or injured. All activities were to be conducted as far as practicable from any observed ringed seal lairs. CPAI was to establish a route along the proposed travel corridor and work areas to discourage ringed seals from building lairs. NMFS required that for all activities after March 15th, trained dogs were to be used to detect and locate ringed seal lairs and other seal structures in the travel corridor and work areas where water depth exceeded 3 m. For activities conducted before March 15th, an experienced Inupiat hunter was hired as a marine mammal observer to locate potential lairs and breathing holes along the travel corridor. The NSB and MMC commented that NMFS require CPAI to use trained dogs to survey for ringed seals, with NSB stating that a single native hunter would not be sufficient to identify potential seal lairs. NMFS responded that CPAI requested use of an Inupiat hunter since it was successfully used at McCovey for a rolligon operation. NMFS concluded that on-ice geotechnical operations would result in the Level B harassment of small numbers of ringed seals, and that such taking would have a negligible impact on this species, and would not have an unmitigable adverse impact on the availability of this species for taking for subsistence uses. NMFS issued an IHA to CPAI on April 19, 2017.

NMFS (2007). 72 FR 56053 IHAs Union Oil Co. of California and Marathon Oil Co. Open Water Seismic Operations in Cook Inlet, Alaska. *Federal Register*, 72:56053-56058.

NMFS issued an IHA to UOCC on March 30, 2007 (72 FR 17118) for OBC seismic operations in upper Cook Inlet extending from Granite Point for the period early May through mid-June 2007. However, UOCC was unable to begin planned operations due to ice conditions and requested a change in the survey time to early September through mid-November 2007. In addition, on May 15, 2007, Marathon Oil Company (MOC) requested an IHA associated with open water seismic operations in lower Cook Inlet along the eastern shore from October 1 to November 30, 2007. NMFS estimated approximately 11 beluga whales and 3 harbor porpoises could be taken by behavioral harassment during UOCC surveys, and approximately 26 belugas and 6 porpoises during MOC seismic surveys (i.e., a total of 37 out of a population of 302 Cook Inlet beluga whales). Seismic guns were only to be active 1 – 2 hours per day during slack tide moving at a speed of 4-5 kts. A 454 m safety zone was required for all cetaceans and a

140 m safety zone for all pinnipeds. Other mitigation measures including shutdown are specified in the IHA. The MMC commented that the survey area proposed by MOC appeared to be well south of the area used by Cook Inlet beluga whales during the survey period and therefore, would not result in significant disturbance to beluga whales or other marine mammals. NMFS concluded that small numbers of beluga whales and harbor porpoises may be taken by Level B harassment incidental to seismic surveys. In addition, NMFS concluded that small numbers of Pacific harbor seals and killer whales, if present, could be taken incidentally by Level B harassment which would have no more than a negligible impact. Given the infrequent sightings of Steller sea lions, harbor seals, or killer whales in the specific project area, NMFS believed that any take of these species would be significantly lower than those of beluga whales and harbor porpoises. NMFS also believed take of Steller sea lions would be unlikely. No take by Level A harassment (serious injury or mortality) was anticipated or authorized, and harassment takes were expected to be at the lowest level practicable due to mitigation. While behavioral modifications, including temporarily vacating the area, could occur, NMFS concluded that this action would result in no more than a negligible impact on these marine mammal species or stocks. The proposed action would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence uses. NMFS issued two IHAs on October 2 , 2007.

NMFS (2008). 73 FR 49421 IHA ConocoPhillips Shallow Hazard and Site Clearance Surveys in the Chukchi Sea in 2008. *Federal Register*, 73:49421-49443.

On April 30, 2008, NMFS received an application from CPAI for the taking, by Level B harassment, of marine mammals incidental shallow hazard and site clearance surveys using acoustic equipment and small airguns in the Chukchi Sea for 30–45 days from August 10 through October 31, 2008. Detailed information was published in the proposed IHA on May 23, 2008 (73 FR 30064). There were two survey areas located generally west of Wainwright about 111 km off the coast, each approximately 2,000 km2. The IHA includes a discussion on potential effects ranging from tolerance to disturbance to hearing impairment. Details for sound sources are provided including the airguns, sub-bottom profiler, side-scan sonar and echosounder each of which was modeled to determine potential areas ensonified. NMFS expected approximately 10 bowhead, 37 gray whales, 42 harbor porpoises, and 376 bearded seals would be taken by Level B behavioral harassment. Mitigation measures included safety zones of 120 m for cetaceans and 24 m for pinnipeds, PSO monitoring, shutdown procedures, speed and course alteration conditions, and ramp-up procedures. Of particular concern in public comments were potential impacts on the beluga harvest at Point Lay and bowhead harvests at Point Hope, Wainwright and Barrow. Very little subsistence harvest occurs as far from shore as surveys were proposed. In addition, ,seismic surveys were planned during the late summer and fall (after many of the Chukchi Sea communities have harvested sizeable portions of their marine mammal quota). Many of the monitoring and mitigation requirements were consistent with the 2008 CAA between CPAI, other industry participants and Alaska Native communities. NMFS concluded that temporary modifications in behavior of small numbers of marine mammals was possible but would not reduce the availability of the affected species for subsistence. The IHA was published on August 21, 2008 and effective August 15 through October 31, 2008.

NMFS (2008). 73 FR 36044 Notice of Receipt of IHA Application Shell and WesternGeco Seismic Surveys in the Beaufort and Chukchi Seas, Alaska. *Federal Register*, 73:36044-36062.

SOI and contractor WesternGeco applied for an IHA to take small numbers of marine mammals by harassment incidental to conducting several programs in the Chukchi and Beaufort Seas during open water between August 2008 and July 2009 including: Chukchi Sea deep 3–D seismic survey; Beaufort Sea deep 3–D seismic survey; and Beaufort Sea marine surveys, which included site clearance and shallow hazards surveys, an ice-gouge survey, and a strudel scour survey. Detailed descriptions of these activities

are provided including sound source information and estimated distances to NMFS acoustic thresholds. Noise-related impacts to mammals were possible due to vessel movements and seismic operations which could have caused masking or behavioral disturbance which may cause temporary displacement of seals or whales. No injury or mortality was expected. Table 1 provides a detailed list of estimated Level B harassment takes for each species (i.e., up to 1,582 bowhead whales and 36,047 ringed seals for both survey areas in the Chukchi and Beaufort seas). Notably, at the time of this publication, SOI did not have a signed CAA with local communities but were in the process of negotiating the agreement which is described in this notice. Of particular concern was the potential impact on the beluga harvest at Point Lay and on future bowhead harvests at Point Hope, Wainwright and Barrow. NMFS determined that the seismic surveys in the northern Chukchi Sea and eastern and central Beaufort Sea in 2008/2009 would have no more than a negligible impact on marine mammals and that there would not be any unmitigable adverse impacts to subsistence communities, provided the mitigation measures described in the notice and future IHA were followed.

NMFS (2008). 73 FR 9535 IHAs CGGVeritas and Shell On-ice Geophysical and Seismic Beaufort Sea, Alaska. *Federal Register*, 73:9535-9544.
On August 8 and 14, 2007 CGGVeritas (Veritas) applied for the taking by Level B harassment of ringed, bearded, and spotted seals incidental to conducting on-ice 3D seismic surveys using vibroseis in Smith Bay and in the Pt. Thomson area from February to May 2008. On September 10, 2007, NMFS also received an application from SOI for the taking by harassment of these seal species incidental to conducting an on-ice seismic survey using vibroseis offshore north-northwest of Oliktok Point. No under-ice acoustic sources were to be deployed. NMFS estimated up to 984 ringed seals could be taken due to Veritas' Smith Bay survey, up to 477 ringed seals by Veritas' Pt. Thomson surveys, and up to 1,187 ringed seals by SOI's program. Due to the unavailability of reliable bearded and spotted seals densities within the proposed project area, NMFS was unable to estimate take for these two species. However, because on-ice seismic surveys are not conducted in broken pack ice (prime habitat for these species), very few spotted or bearded seals were expected to be taken. NMFS required the use of trained dogs to identify seal lairs in areas of water 3 m or greater. Seals and any seal structures were to be avoided by 150 m and vehicles on ice were to avoid pressure ridges or ice deformations where seal structures could occur. The CBD asserted that NMFS cannot lawfully issue these IHAs because the proposed activities ''have the potential to result in serious injury or mortality to seals". NMFS disagreed and determined the risk of injury or mortality to be minimal given mitigation and monitoring measures to avoid ringed seals and lairs. NMFS concluded that ringed seal take was small relative to the overall population. Based on harvest patterns and other factors, on-ice seismic operations were not expected to have an unmitigable adverse impact on subsistence uses of ringed and bearded seals because operations would end before the spring ice breakup and the subsistence harvest. Notably, subsistence advisors were to be used as PSOs. NMFS issued two IHAs to Veritas and one IHA to SOI on-ice marine geophysical and seismic surveys effective February 14, 2008 for a period of one year.

NMFS (2008). 73 FR 77623 Notice of Proposed IHA CGGVeritas On-ice Marine Geophysical and Seismic Operations in State/OCS Waters of the U.S. Beaufort Sea off Alaska. *Federal Register*, 73:77623-77630.
NMFS received an application from Veritas for an IHA to take small numbers of marine mammals, by Level B harassment incidental to an on-ice marine geophysical research and seismic survey using vibroseis over a 366 km2 area north and northwest of Thetis Island in OCS waters of the U.S. Beaufort Sea from February 15 to May 31, 2009. The ringed seal was the only species of marine mammal managed by NMFS that may be present in the project area during the on-ice seismic program. Ringed seals were not listed under the ESA at this time. No ringed seals would be injured or killed during the on-ice surveys assuming mitigation and monitoring measures were implemented. Seals were expected to avoid the

immediate area of on-ice seismic operations. Takes could cause temporary changes in behavior. Since seismic operations tend to avoid rough, deformed and broken ice, cracks, and areas near the edge of the landfast ice, they also avoid the preferred habitat of ringed seals. At the time of this publication, Veritas was working with the village of Nuiqsut and the Kuukpik Subsistence Oversight Panel to develop a POC. As with previous IHAs and LOAs, ringed seals and seal structures were to be avoided by 150 m and NMFS required Veritas to use trained dogs or marine mammal biologists (if dogs were unavailable) to identify seal lairs. The notice also states "On-ice operations have been conducted in the Beaufort Sea region for over 25 years and, during this time, there have been no noticeable adverse impacts on the ringed seal population or the availability of the species for subsistence uses." On February 9, 2009, NMFS received notice from Veritas to withdraw the application.

NMFS (2008). 73 FR 40512 IHA BPXA 3D OBC Seismic Survey in the Liberty Prospect, Beaufort Sea, Alaska. *Federal Register*, 73:40512-40538.

On November 21, 2007, BPXA applied for an IHA for the taking by Level B harassment of a small numbers of marine mammals incidental to conducting a 3D, OBC seismic survey in the Liberty Prospect area in Foggy Island Bay in 2008. BPXA updated the vessel inventory and submitted an addendum on April 21, 2008. The survey was to occur over 40–60 days in July and August 2008, with operations ceasing on August 25 prior to the Nuiqsut whaling season. The notice of the proposed IHA (73 FR 24236, May 2, 2008) included detailed discussion of the methodology used by BPXA to estimate incidental take. This IHA includes much discussion regarding the uncertainty with seal density estimates and the associated uncertainties for estimating ringed seal exposures and takes (see Tables 2 and 3). There is also much discussion about the tolerance of cetaceans and pinnipeds to these types of disturbances. CBD commented that the number of takes in the application were underestimated. Notably, NMFS stated that takes were conservative and that animals ''exposed'' to sounds does not necessarily indicate that all animals would have a significant behavioral reaction to the exposure. Oceana and the Ocean Conservancy commented on the lack of a comprehensive evaluation of the cumulative effects of seismic activities in the Arctic and requested that in light climate change, NMFS must not approve future seismic activities without a comprehensive evaluation. NMFS disagreed and noted that the MMS 2006 PEA, NMFS 2007 SEA, 2007 MMS/NMFS DPEIS, and NMFS 2008 SEA for the proposed issuance of IHAs for five seismic survey and shallow hazard and site clearance survey activities for 2008 all provide a comprehensive cumulative effects evaluation. MMC again recommended that NMFS develop a broad-based population monitoring and impact assessment program to ensure that these activities, in combination with other risk factors, are not having cumulative adverse population-level effects on marine mammals. NMFS concluded that BPXA's proposed surveys would have a negligible impact on small numbers of affected species or stocks of marine mammals and there would not be an unmitigable adverse impact on their availability for taking for subsistence uses. NMFS issued an IHA effective July 8 through August 25, 2008.

NMFS (2008). 73 FR 45969 IHA PGS Onshore Seismic Survey in the Beaufort Sea, Alaska, Summer and Early Fall 2008. *Federal Register*, 73:45969-45994.

On May 9, 2008, PGS (a contractor for Eni Petroleum) applied for an IHA for the taking, by Level B harassment only, of small numbers of bowhead, gray and beluga whales and ringed, bearded and spotted seals incidental to an exploratory 3D marine seismic survey in the Beaufort Sea, using an OBC technique from July to mid-September 2008. The project area was located in states waters of the Nikaitchuq Lease Block, north of Oliktok Point and covering Thetis, Spy, and Leavitt Islands, and would extend to the 5–km state/Federal water boundary. Water depth ranges from 0–15 m with most of the area shallower than 3 m. Therefore, presence of beluga, bowhead, and gray whales within the barrier islands was considered possible but very limited. The discussion of the potential effects of noise and seismic activity on marine

mammals was similar to previous IHAs and LOAs, describing sound sources, safety radii, etc. Most mitigation and monitoring measures (such as PSOs, shutdowns or power downs, etc.) followed other recent authorizations. NMFS estimated that up to 28 bowhead whales, 25 beluga whales, 3,551 ringed seals, 178 spotted seals, and 94 bearded seals would be affected by Level B behavioral harassment. Notably, PGS planned to continue surveying after August 25 when bowhead subsistence hunting typically begins. NMFS required PGS to show their sound source would attenuate to less than 120 dB before reaching the normal bowhead whale migration lanes. The radius to the 120 dB isopleth was estimated to be about 10–15 km due to the downward sound directionality of the airgun configuration. In addition, PGS planned to move operations inside the barrier islands by August 25 and remain there throughout the subsistence hunt and whale migration. In addition, to address AEWC comments, PGS planned to survey over two separate periods with the deepest surveys occurring before the bowhead whale hunt. Comments from MMC, CBD, AEWC, Resisting Environmental Destruction on Indigenous Lands (REDOIL), NSB and others are summarized along with NMFS' responses. Potential cumulative effects of oil and gas on marine mammals and their subsistence uses was again a key topic. NMFS determined that only minor, temporary effects from the seismic survey project were anticipated. Adverse impacts on the subsistence harvest of bowhead whales as a result of the proposed survey were not anticipated. NMFS issued the IHA July 30, 2008.

NMFS (2008). 73 FR 38990 LOA Northstar Construction and Operations Beaufort Sea. *Federal Register*, 73:38990-38991.

On May 27, 2008, BPXA requested a renewal of an LOA issued on July 6, 2007 for the taking of small numbers of bowhead, gray, and beluga whales, and ringed, spotted, and bearded seals incidental to oil production operations at Northstar under regulations issued March 7, 2006 through April 6, 2011 (71 FR 11314). This request contained information in compliance with 50 CFR 216.209, which updates information provided in BPXA's original application for takings incidental to construction and operations at Northstar. There is a helpful summary of activities completed in 2007 – 2008 as well as the monitoring activities that occurred including placement of seven Directional Autonomous Seafloor Acoustic Recorders (DASARs) August – October 2007. Five DASARs were deployed at locations 11.4–21.4 km north, northeast of Northstar Island and recorded low frequency sounds continuously for approximately 36 days. Near-island recordings were obtained from two DASARs placed 410–480 m from Northstar and recorded a total of 11,780 bowhead whale calls. Nuiqsut subsistence hunters at Cross Island did not report any negative effects from Northstar activities on their ability to conduct the hunt. NMFS determined that BPXA complied with the requirements of the 2007 LOA, and that the marine mammal take resulting from activities was within that analyzed in the 2006 regulations. NMFS issued a 1–year LOA effective from July 7, 2008 through July 6, 2009.

AOGA (2009). Request for LOA AOGA Oil and Gas Activities in the Beaufort Sea and Adjacent North Slope of Alaska 2011-2016. Alaska Oil and Gas Association. Anchorage, AK. April 2009. 105 pp.

On April 22, 2009, the USFWS received this application from AOGA on behalf of its members and other participating parties, to promulgate renewed regulations for the nonlethal incidental take of small numbers of walruses and polar bears during year-round oil and gas industry exploration, development, and production activities in the Beaufort Sea for a period of five years August 3, 2011 through August 3, 2016. The USFWS published a final rule August 3, 2011 (76 FR 47010). The types of oil and gas activities described in this application (and the rule) were not significantly different from those covered by the previous 5-year rule effective August 2, 2006 through August 2, 2011. A detailed chronology of past regulations can be found in the most recent regulation August 2, 2006 (71 FR 43926). These past regulations were published on: November 16, 1993 (58 FR 60402); August 17, 1995 (60 FR 42805); January 28, 1999 (64 FR 4328); February 3, 2000 (65 FR 5275); March 30, 2000 (65 FR 16828); November

28, 2003 (68 FR 66744); and August 2, 2006 (71 FR 43926). This petition includes several detailed maps describing activities and lease ownership by company. Activities including seismic, geophysical, a range of environmental studies (i.e., archeology, hydrology, fish, avian, marine mammals, etc.), drilling, and ice road and pad construction are described. This application consists of the standard components, following agency guidelines, including a description of potential effects and take estimates. However, given that individual LOAs are issued to each operator, specific details on mitigation and monitoring are not included but instead deferred to those project-specific authorizations issued later.

BP Exploration Alaska (2009). Request for LOA BPXA Northstar Operation of Offshore Oil and Gas Facilities in the U.S. Beaufort Sea. Anchorage, AK. October 27, 2009. 113 pp.
Previous to this application, NMFS had issued a total of five LOAs under the first regulations covering activities 2000 – 2005 and four LOAs under regulations for activities occurring 2006 – 2011. This was the third application by BPXA to renew the regulations for Northstar and also included a request to issue an annual LOA effective July 7, 2010 through April 6, 2011 when existing regulations were due to expire. This application follows NMFS guidelines to include standard content including detailed descriptions for activities and associate effects on marine mammals. Beginning on page 35 is a helpful description of Northstar sound characteristics and references many annual studies that have occurred at the site since the late 90s. Table 8 provides a summary of subsistence harvest data (by community) for bowhead and other marine mammals as well as birds and terrestrial species. Page 82 describes proposed annual monitoring for ringed seals, bowhead whales acoustic monitoring of Northstar sounds and is followed by a description of planned reporting. Proposed mitigation measures during the ice covered season when ringed seals could be impacted included: commencing on-ice activities prior to seal denning; after March 1st surveying for seal dens using trained dogs; and avoiding any seal structures by 150 m. Mitigation measures in broke ice included: scheduling hovercraft to avoid whale migration periods; maintaining helicopter flight altitudes of 305 m and maintain a flight corridor from the mainland. To mitigate noise from pile driving safety zones were analyzed and maintained. BPXA concluded that based on previous studies on site and the scope of planned activities, that impacts on marine mammal species would be no more than negligible. Although some whales and seals are likely to occur near the planned activities, any disturbance effects were not anticipated to have serious consequences for individuals or their populations. Further, there would be no unmitigable adverse impact on the availability of seals or whales for subsistence uses.

NMFS (2009). 74 FR 55368 IHA Shell Open-water Marine Survey Program in the Chukchi Sea, Alaska, During 2009– 2010. *Federal Register*, 74:55368-55412.
On December 15, 2008, SOI and Shell Gulf of Mexico Inc., collectively known as Shell, applied for authorization for the taking by Level B harassment only of small numbers of 12 species of marine mammals incidental to conducting an open-water site clearance and shallow hazards survey, and a strudel scour survey in the Chukchi Sea. These surveys are a continuation of those conducted by Shell in the Chukchi Sea in 2008. On March 10, 2009, Shell cancelled all survey programs for the Beaufort Sea and the ice gouge survey for the Chukchi Sea in 2009, and submitted a second application addendum on May 19, 2009. NMFS published a proposed IHA on June 1, 2009 (74 FR 26217) for seismic surveys in the Chukchi Sea during open-water August 2009 through July 2010. Most of the cetaceans exposed to survey sounds with received levels greater than or equal to 160 dB (rms) were expected to include bowhead, gray, and beluga whales and harbor porpoise (see Table 6-7 for take estimates). Shell estimated that the average and maximum number of ringed seals exposed to sounds greater than or equal to 160 dB was 692 and 1,078, respectively. Mitigation and monitoring was the same as authorized for previous surveys including safety zones, shutdown and ramp-up procedures and the use of PSOs. No manned aerial overflights for monitoring were planned. Some mitigation measures were taken from the 2009 CAA

signed by Shell on June 24, 2009, and included: coastal stand-off distances for seismic and vessel transiting activities; a coastal community communication station; and emergency assistance to whalers, among other measures. Generally, MMPA applications for seismic activities in the Chukchi were more controversial than similar applications for the Beaufort Sea due to the lack of baseline biological data in the Chukchi, and concerns about the overlap between exploration and subsistence hunting beluga whales and walrus. The NSB and the Alaska Wilderness League (AWL) stated that Shell's discussion of impacts to subsistence was limited, only considered direct impacts on active scouting and whaling, and did not quantify the cumulative effects on subsistence from oil and gas activities throughout the Beaufort and Chukchi seas. AWL believed NMFS had not adequately supported its finding that activities would not result in an unmitigable impact to subsistence due to lack of baseline data. The NSB noted that Shell failed to provide details of how it intends to ''eliminate disturbance''. Concerns about nighttime PSO monitoring were raised. A recurring request was to address cumulative effects of the proposed activity and other industrial activities in the Arctic. NMFS determined that the impact of the surveys would result in the Level B harassment of small numbers of marine mammals, and that such taking would have a negligible impact on the species. NMFS also determined that the action would not have an unmitigable adverse impact on the availability of this species for taking for subsistence uses. NMFS determined that with the mitigation measures, impacts to bowheads and other marine mammals would be negligible. On October 27, 2009, NMFS issued an IHA to Shell effective August 19, 2009 through August 18, 2010.

NMFS (2010). 75 FR 60174 IHA USGS Marine Seismic Survey in the Arctic Ocean, August to September, 2010. *Federal Register*, 75:60174-60203.

On March 9, 2010, NMFS received an IHA application from USGS for the taking of nine cetacean species and five pinniped species incidental to conducting a seismic reflection/refraction and bathymetric survey in the Arctic Ocean August through September 2010. NMFS received a revised IHA application on June 1, 2010. The survey was to be conducted from a Canadian Coast Guard (CCG) vessel, the CCGS Louis S. St. Laurent (St. Laurent) and accompanied by the U.S. Coast Guard Cutter (USCGC) Healy, both of which are polar-class icebreakers. NMFS cannot issue an IHA directly to a non-U.S. citizen however, the Geological Survey of Canada (GSC) wrote a Categorical Declaration stating that ''while in U.S. waters (i.e., the U.S. 200 mile Exclusive Economic Zone), GSC will comply with any and all… mitigation measures required by [NMFS or USFWS].'' The IHA describes vessel specifications and equipment that may result in underwater noise, including the expected ensonified areas (see Table 2). Level B takes were expected to cause temporary changes in marine mammal behavior. Standard monitoring and mitigation measures for seismic surveys were required. Of particular interest with this IHA were public comments on the comment and authorization process. the USGS coordinated with local communities on implementation of the POC. However, during the comment period for the proposed IHA (75 FR 39336, July 8, 2010) considerable focus was on mitigation during ice-breaking activities. A unique situation occurred where the IHA was to be issued after the activity started which, according to the NSB, MMC, and AEWC, would not allow the public to know what was being approved by NMFS or what mitigation measures were required by the IHA. To address this concern, the USGC vessel remained offshore during transit, beyond the traditional whaling locations. NMFS concluded there would be negligible effects on marine mammal species or stocks, because only temporary modifications in behavior (Level B harassment) were likely. NMFS issued an IHA effective August 11, 2010 through October 21, 2010.

NMFS (2010). 75 FR 20482 Notice of Proposed IHA Shell Exploration Drilling Program Near Camden Bay, Beaufort Sea, AK. *Federal Register*, 75:20482-20509.

NMFS received an initial application on May 11, 2009 from Shell[1] for the taking by harassment of beluga, bowhead and gray whales, and bearded, ringed and spotted seals incidental to offshore exploration drilling on OCS leases at the Torpedo and Sivulliq prospects in Camden Bay. At NMFS request, Shell

subsequently revised the application twice to clarify specific issues and a final application was deemed complete by NMFS on March 18, 2010. This notification and request for comment for the final application was published April 19, 2010. Shell intended to drill two exploration wells during the 2010 Arctic open water season. Detailed information on real-time ice monitoring is described, including Shell's plans for deflecting ice away from drilling operations.
Drilling, vessel, and aircraft sounds are characterized relative to marine mammal hearing and regulatory thresholds. A lengthy discussion on the potential effects of these sounds on marine mammals is included, with dozens of references to previous publications. Potential impacts from ice management were also covered. Mitigation measures included standard requirements such as safety zones for monitoring and shutdown, PSOs, and reduced vessel speeds. Extensive aerial monitoring and an acoustic monitoring program were proposed by Shell along with the commitment to prepare a comprehensive joint monitoring report to include data collected since 2006. SOI's plan to drill exploration wells in 2010 was put on hold following the Deepwater Horizon incident in April of 2010. The Secretary of the Interior suspended all MMPA applications and the issuance of permits with no set timetable for lifting the suspension. As a result Shell 's application (as well as other IHA applications from other companies involving drilling for oil) were put on hold. In response Shell withdrew this IHA application.

[1]In previous applications from Shell, the company has been referred to as Shell Offshore, Inc. (SOI). In this and other future notices, the company refers to itself as Shell. Annotations reflect what is listed in the published notices.

NMFS (2010). 75 FR 49760 IHA Statoil Marine Seismic Surveys Chukchi Sea, Alaska. *Federal Register*, 75:49760-49811.
On December 24, 2009, Statoil USA E&P, Inc. (Statoil) applied for authorization for the taking by harassment of marine mammals incidental to 2D and 3D marine seismic surveys in the Chukchi Sea, during the 2010 open-water season. The 3D survey was planned in an area 241 km west of Barrow (Utqiaġvik) in water depths of 30 to 50 m. Four standalone 2D lines (with a total length of about 675 km) were planned as a second priority. The project area encompassed 2,370 km2. Eight cetacean and four pinniped species under NMFS jurisdiction could occur in the survey area and marine transit route. However, only four marine mammal species were considered likely to be encountered during the survey activities (bowhead, beluga, and gray whales, and harbor porpoise). Most encounters were likely to occur in nearshore shelf habitats or along the ice edge. The discussion of the potential effects of airgun sounds was similar to previous IHA and included tolerance, masking of natural sounds, behavioral disturbance, etc. The biological significance of behavioral disturbance to these sounds remained unknown but had not been shown to impact any marine mammal population. Public comments from NSB, MMC and AEWC were similar to previous comments on MMPA applications. NMFS standard mitigation for seismic were required including safety zones, PSO monitoring, shutdowns and reduced vessel speeds, etc. Table 3 summaries the estimated Level B harassment takes by species and type of survey (3D or 2D) including up to 184 beluga whales, 158 bowhead whales and 6,487 ringed seals. NMFS concluded that Statoil's marine surveys would have a negligible impact on the affected species or stocks and there would not be an unmitigable adverse impacts on subsistence uses. The IHA was issued August 6, 2010.

NMFS (2010). 75 FR 49710 IHA Shell Open Water Marine Seismic Survey in the Beaufort and Chukchi Seas, Alaska. *Federal Register*, 75:49710-49758.
NMFS received an application on December 24, 2009 from Shell for the taking by harassment of marine mammals incidental to marine site clearance and shallow hazards surveys in Harrison Bay, Beaufort Sea and portions of the Chukchi Sea. These surveys were continuations of those performed by Shell in the Beaufort Sea beginning in 2006, and in the Chukchi Sea in 2008. The equipment used to conduct these surveys use low level energy sources focused on limited areas to characterize the footprint of the

seafloor and shallow sub seafloor and the depth and distribution of ice gouges at prospective drilling locations which are characterized in detail in the notice (including estimated sound source levels). Impacts described for marine mammals were similar to those described for previous similar surveys. At this time, NMFS was in the process of completing a Programmatic EIS on Arctic oil and gas seismic activities (NMFS 2006; see Bin 3 for annotation) which is referenced in this notice as an additional source of information, particularly for cumulative effects. Table 5 presents the estimated number of marine mammal exposures for eight species likely to have been affected. Takes for three species (narwhals, minke whales, and ribbon seals) were not included because they were not likely to occur in the proposed survey area. AEWC and ICAS commented that NMFS should not issue incidental take authorizations for oil and gas related activities given the suspension (at that time) of offshore drilling and pending reorganization of the MMS following the Deepwater Horizon incident in 2010. They suggested that NMFS work closely with Alaska Natives when considering whether to permit the take of marine mammals incidental to oil and gas operations. NMFS noted that they had met with Alaska Natives over the years to address the MMPA program in the Arctic, and had also accounted for mitigation measures to reduce the impact of oil and gas operations on bowhead whales and ensure the availability of marine mammals for subsistence uses. AEWC and NSB argued that Shell did not demonstrate that the proposed activities would take only ''small numbers of marine mammals of a species or population stock,'' resulting in no more than a ''negligible impact'' on a species or stock. Regarding the ''small numbers'' issue raised by the AEWC and NSB, NMFS believed that the established monitoring and mitigation measures fulfill its obligations under the MMPA, and were effective in reducing impacts on marine mammals and their habitat. Shell's 4MP is outlined as well as the POC. NMFS concluded there would not be an unmitigable adverse impact on subsistence uses and found that Shell 's proposed surveys may result in the negligible incidental take of small numbers of marine mammals. An IHA was issued August 13, 2010, effective August 6, 2010, through November 30, 2010.

Shell Gulf of Mexico Inc. (2010). Application for IHA for the Non-Lethal Taking of Whales and Seals in Conjunction with Planned 2010 Exploration Drilling Program Chukchi Sea, Alaska. Shell Gulf of Mexico Inc. April 2010. 101 pp.

Citation Only. NMFS authorization is included as the annotation.

USFWS (2010). 75 FR 76086 Final Rule Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. *Federal Register*, 75:76086-76137.

In this final rule, the primary constituent elements of critical habitat for the polar bear in the U.S. are listed as: (i) Sea-ice habitat used for feeding, breeding, denning, and movements, that occurs over the continental shelf with adequate prey resources (primarily ringed and bearded seals) to support polar bears; (ii) Terrestrial denning habitat, which includes coastal bluffs and river banks; and (iii) Barrier island habitat used for denning, refuge from human disturbance, and movements along the coast to access maternal den and optimal feeding habitat, which includes all barrier islands along the Alaska coasts. A detailed summary of comments and responses sheds light on major issues raised with this rule. The majority of comments received (99%) were in support of this rule. The major complaint of oil industry was the designated area was too large. Nearly 95 percent of the designated habitat is sea ice in the Beaufort and Chukchi seas off Alaska's northern coast. Maps are included at the end of this notice that show the different habitat units referenced, however, they are broad scale. A history of lease sale activities in both seas is also provided at the end of the notice.

NMFS (2011). 76 FR 20180 Final rule Endangered and Threatened Species: Designation of Critical Habitat for Cook Inlet Beluga Whale. *Federal Register*, 76:20180-20214.

NMFS listed Cook Inlet beluga whales on October 22, 2008 (73 FR 62919) and proposed critical habitat on December 2, 2009 (74 FR 63080). Critical habitat was designated through this final rule published April 11, 2011 and included specific areas in Upper Cook Inlet (including Knik and Turnagain Arms), Kachemak Bay, and the nearshore waters along the west coast of Lower Cook Inlet. These areas are bounded on the upland by Mean High Water (MHW) datum, except for the lower reaches of four tributary rivers. Critical habitat did not extend into the tidally-influenced channels of tributary waters of Cook Inlet, with the exceptions noted in the descriptions of each critical habitat area. As standard, a summary of public comments and NMFS' responses provides additional rationale for the decisions behind this rule, including the use of "exclusions" in terms of activities that may continue in the area (i.e., Anchorage being listed as a National Strategic Port for military activities). Figure 1 also identifies a Critical Habitat Exclusion Area considered extremely important for beluga whale foraging and within which certain human activities may be restricted.

NMFS (2011). 76 FR 46729 IHA Statoil Chukchi Shallow Hazards Survey. *Federal Register*, 76:46729-46753.

NMFS received an application on March 1, 2011, from Statoil, for the taking by Level B harassment of 13 species of marine mammals in the Chukchi Sea and the marine transit route incidental to open-water shallow hazards site surveys using a towed airgun cluster consisting of four, 10-in3 airguns with a 600 m towed hydrophone streamer and lower-powered, higher frequency survey equipment for bathymetric and shallow sub-bottom profiling. No marine mammal injuries or mortalities were anticipated. Proposed surveys were to occur during open water July – November 2011 and cover a total area of 665 km2 located 240 km west of Barrow (Utqiaġvik) and 165 km northwest of Wainwright, in water depths of 30–50 m. Table 2 presents exclusion zones as supported by a description of estimated sound source measurements. Standard mitigation and monitoring are described including safety/exclusion zones, shutdown, power down, ramp-up and the use of PSOs. A brief overview of the 2011 Joint Environmental Studies Program with Shell and CPAI is included on page 46743). This notice also includes a summary of questions on the 4MP by a peer review panel, an approach used by NMFS for MMPA applications that may be complex or controversial. NMFS worked with Statoil to implement recommendations from the peer review. Statoil developed a POC for 2011 that summarized the actions taken to identify important subsistence activities, inform subsistence users of the proposed survey activities, and obtain feedback from subsistence users on how to promote cooperation. NMFS determined that Statoil's proposed activities would not have an unmitigable adverse impact on the availability of cetacean species or stocks for taking for subsistence uses. Similarly, adverse impacts were not anticipated on seal hunts because the majority occur in the winter and spring when Statoil would not be operating. On August 3, 2011, NMFS issued the IHA effective August 1 through November 30, 2011.

USFWS (2011). 76 FR 13454 Proposed Rule Industry O&G Activities Beaufort Sea, Alaska. *Federal Register*, 76:134554-113504.

In 2009, the USFWS received a petition from AOGA to promulgate a renewal of regulations for nonlethal incidental take of small numbers of walruses and polar bears in the Beaufort Sea for a period of 5 years (2011–2016) (see 2009 AOGA annotation). The proposed rule encompasses all Beaufort Sea waters east of a north-south line through Point Barrow and up to 200 miles north, including all Alaska State waters and Outer Continental Shelf waters, and east of that line to the Canadian border. The onshore region was the same north/south line at Utqiagvik (Barrow), 25 miles inland and east to the Canning River. ANWR was not included. The proposed rule follows the content of AOGA's 2009 application describing activities, species and habitat potentially affected, estimates for incidental takes and proposed mitigation and monitoring, all of which were similar to the previous 5-year Beaufort Sea regulations effective from August 2, 2006, through August 2, 2011. In the section titled "Negligible Impact", USFWS concluded that

total expected takings due to development and production would have a negligible impact on the species and would not have an unmitigable adverse impact on the availability of these species for subsistence use by Alaska Natives. Findings were based on 17 years of data on encounters and interactions between polar bears, Pacific walruses, and Industry; recent studies of potential effects of Industry on these species; oil spill risk assessments; potential and documented Industry impacts on these species; and current information regarding the natural history and status of polar bears and Pacific walruses. See also the annotation for the final rule 76 FR 47010 (USFWS 2011).

USFWS (2011). 76 FR 47010 Final Rule Industry O&G Activities Arctic. *Federal Register*, 76:47010-47054.
The proposed rule to renew the Beaufort Sea Incidental Take Regulations that authorized the nonlethal, incidental, unintentional take of small numbers of polar bears and Pacific walrus during year-round oil and gas industry activities was published March 11, 2011 (see annotation for 76 FR 13454). The previous regulations that have been issued and demonstrate strongly how they build upon each other (November 16, 1993 (58 FR 60402); August 17, 1995 (60 FR 42805); January 28, 1999 (64 FR 4328); February 3, 2000 (65 FR 5275); March 30, 2000 (65 FR 16828); November 28, 2003 (68 FR 66744) and August 2, 2006 (71 FR 43925) and proposed oil and gas activities covered were not significantly different over time. This rule acknowledges the Deepwater Horizon spill stating "BOEMRE still considers large oil spill estimates for the DEIS of the Beaufort Sea and Chukchi Sea Planning Areas to be valid despite the Deepwater Horizon oil spill event in the summer of 2010" and also mentions forthcoming requirements by BOEMRE to control well blowouts (page 47032). Despite a multi-page discussion about potential cumulative effects, the MMC recommended that the USFWS conduct a more comprehensive analysis of oil and gas activities combined with other natural and anthropogenic risk factors over time (i.e. climate change). The MMC also recommended that USFWS include a description of mitigation measures in the final regulations to minimize the impact on polar bears and require that the regulations include a monitoring program that can detect when and how polar bears and walruses are taken and verify that takes have a negligible impact on the affected populations. The USFWS found that total expected Level B takings of polar bear (150 per year) and Pacific walrus (10 per year) would have a negligible impact on these species and would not have an unmitigable adverse impact on the availability of these species for subsistence use by Alaska Natives. On August 3, 2011, the USFWS published a final rule effective through August 3, 2016.

NMFS (2012). 77 FR 65060 IHA ION Open Water Seismic Operations in Cook Inlet, Alaska. *Federal Register*, 77:65060-65090.
NMFS received an application on March 1, 2012 from ION for the incidental taking by Level B harassment of bowhead whales, and ringed and bearded seals during a marine seismic survey in ice in the Beaufort and Chukchi Seas from October through December 15, 2012. ION's proposed an in-ice seismic reflection/ refraction survey and related seismic vessel and medium class icebreaker operations. The primary survey area extended from the U.S.–Canadian border in the east to Point Barrow. Two survey lines extended west of Point Barrow into the northern Chukchi Sea, and three short tracks were proposed near the U.S.–Russian border. ION and NMFS' proposed mitigation measures including scheduling activities when bowhead whales were less likely to occur. Starting in the eastern Beaufort, the survey would move to the western survey area in late October or early November 2012; thereby avoiding bowhead whales to the maximum extent practicable. NMFS anticipated potential minor changes in pinniped behavior on small spatial scales as the seismic and ice-breaking vessels moved in-ice. These disturbances would not result in harm to individuals or populations. Commenters raised concerns that the proposed activity might result in serious injury or mortality to ringed seals, thereby requiring regulations and a LOA rather than an IHA. It was also recommended that NMFS revise density estimates for gray whales and bearded seals, and provide stronger assurances that the actual number of takes would be negligible. NMFS determined that the activity did not require the issuance of regulations and an LOA because marine mammals would avoid

staying close to the sound source long enough to result in permanent hearing loss. NMFS analysis accounted for uncertainties regarding marine mammal winter distributions and concluded there would be a negligible impact on any whale or seal species. Table 7 presents total estimated takes including up to 917 belugas, 281 ringed seals and 3 bowhead whales. On October 24, 2012 NMFS issued the IHA effective October 17, 2011 through December 15, 2012.

NMFS (2012). 77 FR 40007 IHA BPXA Marine Seismic Survey in the Beaufort Sea, Alaska. *Federal Register*, 77:40007-40023.

On December 20, 2011, BPXA applied for an LOA for the taking by harassment of marine mammals incidental to a 3D OBC seismic survey in Simpson Lagoon during the open water season of 2012. NMFS published a proposed IHA on May 1, 2012 (77 FR 25830). A total of three seismic source vessels planned to cover a total length of approximately 6,600 km, including line turns. Table 2 presents details on distances to received sound pressure levels (SPL) based on sound sources. Mitigation and monitoring measures were standard and consistent with previous IHAs. The 4MP was reviewed by an independent peer review panel which helped refine the plan. In addition, CAA committed BPXA to employ a PSO/Inupiat Communitor on each primary sound source vessel and that native residents of the eleven villages represented by the AEWC shall be given preference in hiring for such positions. The CAA also required all BPXA vessels report to the appropriate Communication Center (Com-Center) every six hours. The AEWC stated that BPXA was not to conduct geophysical activity inside the barrier islands prior to July 25, but the proposed IHA only posed restrictions on seismic activities after August 25 outside the barrier islands. Due to the timing of the project and the distance from the surrounding communities, it was anticipated to have no effects on spring harvesting and little or no effect on occasional summer harvest of beluga whales, subsistence seal hunts (ringed and spotted seals are primarily harvested in winter while bearded seals are hunted July– September in the Beaufort Sea), or the fall bowhead hunt. NMFS determined there would be no more than a negligible impact on affected species or stocks, and no unmitigable adverse impact on the availability of species or stocks for subsistence. On July 6, 2012, NMFS issued an IHA effective July 1, 2011 through October 15, 2012.

NMFS (2012). 77 FR 27720 IHA Apache Seismic Survey in Cook Inlet, AK. *Federal Register*, 77:27720-27736.

On June 15, 2011 Apache applied for an IHA to take by harassment several species of marine mammals incidental to a 3D seismic survey program in Cook Inlet. The proposed 3D seismic survey was to use two source vessels with air gun arrays and additional lower-powered, higher frequency survey equipment to collect bathymetric and shallow sub-bottom data. At the time, MMPA applications for takes due to seismic activity in Cook Inlet were very controversial because of the endangered status of Cook Inlet beluga whales, the concern over cumulative effects, and because survey activity was within Cook Inlet beluga whale designated critical habitat. Over a total period of 160 days, Apache planned to cover 829 km2 along the west coast of Cook Inlet from McArthur River up and to south of the Beluga river, in water depths 0–128 m. Apache also planned surveys near intertidal areas in water depths 0–54 m April through November 2012. Offshore areas would be surveyed between April and September 2012 in water depths of 54–128 m. Table 1 provides distances to sound thresholds and is the basis for established safety and shutdown zones. Other mitigation and monitoring included using PSOs (vessel-based monitoring), aerial monitoring near river mouths using helicopters, ramp-up, power down, and vessel speed restrictions. Specifically, whenever an aggregation of beluga whales, killer whales, or harbor porpoises (five or more whales of any age/sex class) were observed approaching a 160-dB safety zone, activities would not commence or would shut down until animals moved out of the exposure zone. NMFS concluded that surveys would result in negligible impacts on the affected species

or stocks. Of the five marine mammal species likely to occur in the proposed marine survey area, only Cook Inlet beluga whales and Steller sea lions are listed under the ESA and critical habitat had been designated. The proposed action was to occur entirely within critical habitat designated for Cook Inlet for beluga whales, but was not close to critical habitat designated for Steller sea lions. Significant comments received by NMFS included recommendations to defer issuance of the proposed IHA until NMFS can ensure all takes of marine mammals, especially beluga whales and harbor seals, were determinable. NMFS issued the IHA on May 11, 2012, effective April 30, 2012 to April 30, 2013. This is the first of two IHAs. The second IHA was issued February 23, 2013 (see annotation for 78 FR 12720).

NMFS (2012). 77 FR 27322 IHA Shell Exploration Drilling Program in the Chukchi Sea, Alaska. *Federal Register*, 77:27322-27356.

NMFS received an application on June 30, 2011 from Shell Gulf of Mexico, Inc. (Shell) for the taking by Level B harassment of 12 marine mammals incidental to offshore exploration drilling on OCS leases located 103 km from the coast in the Chukchi Sea (see also 76 FR 69958; Proposed IHA). Many of the activities proposed for 2012 were planned for 2010 and 2011 (see annotation for 75 FR 20482) but were put on hold following the Deepwater Horizon incident in April 2010. Since the 2010 application, Shell had developed plans and protocols including: Shell's Critical Operations Curtailment Plan; IMP; Well Control Plan; and Fuel Transfer Plan. Many of these safety measures were required by the Department of the Interior's interim final rule implementing certain measures to improve the safety of oil and gas exploration and development on the OCS in light of Deepwater Horizon (see 75 FR 63346, October 14, 2010). Shell was also required to have an extra drill ship on site as a cautionary measure during all drilling activities. Shell planned to drill up to three exploration wells at three sites and a partial well at a fourth site in the Burger prospect during July through October. Impacts to marine mammals were possible from noise from the drillship, VSP surveys (or ZVSP), support vessels (including icebreakers) and aircraft. Species potentially affected included: beluga, bowhead, gray, killer, minke, fin, and humpback whales; harbor porpoise; and bearded, ringed, spotted, and ribbon seals. No injury or mortality of marine mammals was expected. Mitigation measures included vessel-based PSOs, reduced vessel speeds, shutdown and power down procedures in safety zones, acoustic monitoring, and aerial monitoring including unmanned aircraft to collect photographs. The IHA includes a summary of recommendations on the 4MP from a peer review panel held January 5-6, 2012. Activities were scheduled to avoid interference with the annual subsistence hunts by Chukchi villages. To minimize impacts to subsistence activities, additional measures included: drillship and support vessels not entering the Chukchi Sea before July 1; vessels that can safely travel outside of the polynya zone would do so, but if necessary vessels would only enter into the polynya zone far enough so that ice breaking is not necessary; employ local Subsistence Advisors for guidance on whale migration and subsistence hunts; and signing a CAA with the AEWC. Several comments noted concerns regarding the cumulative impacts from the sum of all commercial and industrial activities. The AEWC and ICAS expressed concerns about deflection of bowhead whales by vessel traffic and underwater noise, as well as from icebreaking and geophysical exploration. NMFS determined that activities would result in no more than a negligible impact on affected species or stocks; and the taking by harassment would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence uses. NMFS issued an IHA on May 9, 2012, effective July 1 through October 31, 2012.

Apache Alaska Corporation (2013). Application for IHA for Apache Alaska Corporation 3D Seismic Program Cook Inlet, Alaska. Anchorage, AK. November 2013. 240 pp.

This application concerned a 3D seismic program encompassing 4,238 km2 in Cook Inlet beginning March 1, 2014. Apache proposed to acquire data in offshore areas during open water periods from March 1st through December 31st. The actual survey duration was to take approximately 160 days over the course

of eight to nine months. Apache planned to use airguns for 2-3 hours (total of 8-12 hours per day) during four slack tide periods within a 24-hour period, if weather conditions allowed. Table 10 provides the estimated distances to NMFS sound level thresholds. Species potentially affected by Level B harassment included: Cook Inlet beluga whales; harbor seals; killer whales; harbor porpoise; and Steller sea lions. Species descriptions are thorough but slightly dated. Only temporary disturbance or localized displacement was anticipated assuming implementation of the following mitigation measures: establishing a seasonal exclusion zone 1 in the Susitna Delta area to protect beluga whales; vessel-based PSO monitoring and shut down zones; aerial surveys; power down and ramp-up procedures; vessel speed and course alterations; and measures to reduce subsistence impacts.

NMFS (2013). 78 FR 75488 Final Rule BPXA Northstar LOA Operation of Offshore Oil and Gas Facilities in the U.S. Beaufort Sea 2014 - 2019. *Federal Register*, 78:75488-75510.

This is the final rule for new 5-year regulations for oil and gas operations at Northstar. It is the fourth rule since island construction in 1999 and 2000. On November 6, 2009, NMFS received an application from BPXA requesting authorization for the take of six marine mammal species (bowhead, gray, and beluga whales and ringed, bearded, and spotted seals) incidental to operation of the Northstar development in the Beaufort Sea. The proposed rule was published July 6, 2011 (76 FR 39706). Proposed activities for 2014–2019 included continuing drilling, production, and emergency training operations but no construction or activities of similar intensity to those conducted between 1999 and 2001 when the island was built. In addition to the Level B request, BPXA requested authorization to take five individual ringed seals by injury or mortality annually over the five years. Potential impacts to marine mammals and their habitat as a result of operation of the Northstar facility have been mainly associated with elevated sound levels. There was the potential for impacts to marine mammal habitat from ice road construction and an oil spill (should one occur). The amount of ringed seal winter habitat altered by Northstar ice-road construction was considered minimal compared to the overall habitat available in the region. This rule summarizes the long-term monitoring that has occurred at Northstar since construction including ringed seal observations and acoustic monitoring using DASARs which were extensively reviewed by a peer-review panel as summarized beginning on page 75493. NMFS concluded that activities would have a negligible impact on the affected species or stocks or their habitats, and no unmitigable adverse impact on subsistence. BPXA's POC including establishing a CAA with the AEWC, is described on page 75506. NMFS issued the regulations on December 12, 2013, effective January 13, 2014 through January 14, 2019.

NMFS (2013). 78 FR 12720 IHA Apache Seismic Survey in Cook Inlet, AK. *Federal Register*, 78:12720-12744.

On June 15, 2012, NMFS received an application for a second IHA application from Apache for the taking by harassment of Cook Inlet beluga and killer whales, harbor porpoise, harbor seals, and Steller sea lions incidental to a 3D seismic survey program in Cook Inlet. The first IHA was issued April 30, 2012 (see annotation for 77 FR 27720). Specified activities covered by this second authorization were described in detail in the proposed IHA (77 FR 73434, December 10, 2012). Proposed 3D seismic surveys were within the portion of beluga whale critical habitat identified as Area 2, which is based on dispersed fall and winter feeding and transit areas in waters where whales typically appear in smaller densities or deeper waters (76 FR 20180, April 11, 2011). Apache intended to mobilize in February to conduct surveys between April and May 2013, and expected to be finished by December 15, 2013. Apache proposed to nighttime operations only if a mitigation air gun (typically the 10 in3) was continuously operational from the time that PSO monitoring had ceased for the day. A dedicated PSO was to not be on nighttime duty but vessel crew were required to observe for marine mammals around the vessel and shutdown the airgun if any were observed. Other mitigation measures included shutting down in identified safety zones

(see Table 1), reduced vessel speeds, vessels avoiding quick or multiple changes in direction, etc. The most notable mitigation measure was that Apache must not operate air guns within 16 km of the MHHW line of the Susitna Delta (Beluga River to the Little Susitna River) between mid-April and mid-October (to avoid any effects to belugas in an important feeding and potential breeding area). A summary of the 2012 mitigation measures is provided. MMC recommended that Apache not conduct seismic activities in the inlet until after May and use aerial surveys or other means to confirm that the majority of beluga whales have moved out of the proposed survey area. NMFS authorized up to 30 beluga takes. NMFS concluded that the timing and location of the seismic survey would avoid areas and seasons that overlap with important beluga whale behavioral patterns. NMFS concluded that the total taking from the marine surveys would have a negligible impact on the affected species or stocks. On February 23, 2013, NMFS issued the IHA effective March 2013 and March 2014.

NMFS (2013). 78 FR 51147 IHA TGS–NOPEC Geophysical Company ASA Marine Seismic Survey in the Chukchi Sea, Alaska. *Federal Register*, 78:51147-51169.
On December 3, 2012, NMFS received an application from TGS requesting authorization for takes by harassment of small numbers of marine mammal incidental to conducting an open-water 2D seismic survey over 9,600 km in the Chukchi Sea off Alaska. Approximately 35 days of seismic operations were expected to occur over 45–60 days using two vessels (seismic vessel and a vessel dedicated to observing for marine mammals and scouting for ice). The proposed application was published on June 12, 2013 (78 FR 35508). NMFS convened an independent peer review panel to review TGS' 4MP on January 8 and 9, 2013, and provided their final report to NMFS in March 2013. Required mitigation included standard measures such as safety zones, shutdown, power down, ramp-up, monitoring by PSOs and the use of a mitigation airgun operated by the small vessel. Passive acoustic monitoring was required to collect sound source measurements to empirically refine modeled distance estimates to the 190 dB, 180 dB, and 160 dB isopleths. Table 3 presents estimated Level B harassment takes (i.e., up to 794 bowheads and 30,000 ringed seals). NMFS concluded that the total taking due to seismic surveys would have a negligible impact on the affected species or stocks and negligible effects on subsistence activities. On August 20, 2013, NMFS issued an IHA effective August 14, 2013 through October 31, 2013.

USFWS (2013). 78 FR 11766 Final Rule Endangered and Threatened Wildlife and Plants; Special Rule for the Polar Bear Under Section 4(d) of the Endangered Species Act. *Federal Register*, 78:11766-11794.
This is the final rule and notice of availability of the EA and FONSI. The rule became effective on March 22, 2013. USFWS was challenged via litigation on the final special rule for the polar bear published December 16, 2008. District Court for the District of Columbia found that although the final 4(d) special rule published was consistent with the ESA, USFWS violated NEPA by failing to conduct a NEPA analysis when it promulgated the final rule. USFWS promulgated a new final 4(d) special rule with appropriate NEPA analysis. Through the NEPA process, USFWS fully considered a suite of alternatives for the special rule. The 2008 listing of the polar bear as a threatened species was not affected by this final rule. In addition, nothing in this rule affects requirements applicable to polar bears under any other laws. The NEPA analysis accomplished three goals: 1) determine if the proposed action, or alternatives to the proposed action, would have significant environmental impacts; 2) address any unresolved environmental issues; and 3) provide a basis for a decision on promulgation of a final 4(d) special rule under the ESA for the polar bear. The EA was finalized on February 5, 2013. A copy of the final EA may be obtained from http://www.regulations.gov at Docket No. FWS-R7-ES-2012-0009.

USFWS (2013). 78 FR 19288 LOAs Industry Oil and Gas Beaufort Sea, Alaska. *Federal Register*, 78:19288-19290.
On August 3, 2011, USFWS published a final rule (see annotation for 76 FR 47010) to authorize the nonlethal, incidental, unintentional take of small numbers of polar bears and Pacific walrus during year-round oil and gas industry exploration, development, and production activities in the Beaufort Sea and adjacent northern coast of Alaska. Each LOA stipulated conditions or
methods that are specific to the activity and location. LOA recipients are listed in this notice.

BP Exploration Alaska (2014). Application for IHA for 2014 Liberty Geohazard Survey, Beaufort Sea, Alaska. February 4, 2014. 82 pp.
This is the application for which NMFS issued an IHA in December 2014 (see annotation for 79 FR 36769). The application follows the standard format for these requests and discusses the effects of the sound from airgun pulses including: tolerance, masking of natural sounds, behavioral disturbance, and temporary or permanent hearing impairment or non-auditory effects (e.g., disturbance by physical presence of vessel). The number of takes in the shallow waters of Foggy Island Bay were expected to be short-term Level B behavioral harassment (see Table 9 for total takes requested). BPXA's planned mitigation measures included PSOs, ramp-up, power down and shutdown procedures. Many of these measures were from the 2013 CAA and previous NSB Development Permits.

NMFS (2014). IHA SAExploration 3D OBN Seismic Surveys and Related Activities in the Beaufort Sea, Alaska. National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. August 21, 2014. 18 pp.
This is the IHA letter to SAExploration valid from August 25 through October 31, 2014 authorizing incidental Level B harassment takes of beluga (40) and bowhead (131) whales, and bearded (32), spotted (32), and ringed seals (638). The IHA notice was published in the FR September 2, 2014 (see annotation for 79 FR 51963). Mitigation measures are specified in detail including vessel-based POS monitoring of safety / exclusion zones, reduced vessel speed and restricted movements and the use of small airguns during transit and turning. In addition, no seismic survey from the Canadian Border to the Canning River from August 25 to close of the fall bowhead whale hunt in Kaktovik and Nuiqsut. From August 10 to August 25, SAExploration was to communicate and collaborate with AEWC on any planned vessel movement in and around Kaktovik and Cross Island. Prior to July 25th, between Point Storkerson and Thetis Island, no seismic surveys were to occur inside the Barrier Islands and no surveys were allowed outside the Barrier Islands after August 25th. Beginning August 25th to the close of the bowhead whale hunt, no seismic surveys were to occur between the Canning River to Point Storkerson. No seismic survey from Pitt Point on the east side of Smith Bay to a location about halfway between Barrow (Utqiaġvik) and Peard Bay from September 15 to the close of the fall bowhead whale hunt in Barrow.

NMFS (2014). Letter of Authorization: Northstar Facility in the Central Beaufort Sea, Alaska. National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. January 13, 2014. 10 pp.
This is the LOA issued to BPXA for the taking by Level B harassment of bowhead, gray, and beluga whales and ringed, spotted, and bearded seals incidental to O&G production at the Northstar Facility. The LOA was valid from Jan. 13, 204 though January 14, 2019.

NMFS (2014). 79 FR 36769 IHA BPXA Geohazard Foggy Island Bay Beaufort Sea, Alaska. *Federal Register*, 79:36769-36782.
On February 4, 2014, NMFS received an application from BPXA for the taking of marine mammal species incidental to conducting a shallow geohazard survey over a period of 20 days in federal and state waters of Foggy Island Bay in the Beaufort Sea during the open-water season of 2014 (see annotation for BPXA

2014). NMFS published a proposed IHA April 16, 2014 (79 FR 21522). The activity was to occur between July 1 and September 30; with airgun and sonar equipment ceasing on August 25 to minimize potential impacts on the bowhead whale hunt. The incidental take, by Level B harassment only, was possible of the following nine marine mammal species: beluga, bowhead, killer, and gray whales; harbor porpoise; and bearded, ringed, spotted and ribbon seals. While narwhal, minke whales and humpback whales are discussed in the IHA, take was not requested because these species are so rarely sighted in the area.. The two-phase survey planned to use an airgun array and towed streamer, multibeam echosounder, sidescan sonar, sub-bottom profiler, and magnetometer. In the proposed IHA, potential effects of airgun sounds were described including: tolerance, masking of natural sounds, behavioral disturbance, and temporary or permanent hearing impairment or non-auditory effects (e.g., disturbance by physical presence of vessel). 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. Level B takes in the shallow waters of Foggy Island Bay were expected to result from short-term, behavioral harassment. BPXA's proposed mitigation measures were standard for these activities including the use of vessel-based PSOs, exclusion zones, ramp-up, shutdown and power down, and limits on activities during poor visibility. Additional measures were from the 2013 CAA, and previous MMPA authorizations and NSB Development Permits. NMFS issued an IHA effective July 1, 2014 through September 30, 2014.

NMFS (2014). 79 FR 51963 IHA SAExploration Seismic Survey in the Beaufort Sea, Alaska. *Federal Register*, 79:51963-51980.

On December 8, 2013, SAExploration applied for an IHA for Level B harassment taking of five marine mammal species including beluga and bowhead whales, and bearded, ringed and spotted seals incidental to a 3D ocean bottom node (OBN) seismic survey program in the Beaufort Sea. The proposed IHA was published July 10, 2014 (79 FR 39914) which described in detail SAExploration's activity. Exclusion zones are listed in Table 2. As with other seismic surveys, PSOs would monitor the exclusion zones, instituting shutdown if a marine mammal entered their respective zone. Other measures included ramp-up and power down, as well as a mitigation airgun during turns and transit. Passive acoustic monitoring was also required to measure sound levels and refine exclusion zones as well as evaluate the project in retrospect after completion. To inform the planned survey, a 2014 monitoring program was conducted which included a biweekly boat-based survey with the last survey two weeks after the seismic survey finished for the year. The survey began at Nuiqsut and initially followed the far west channel of islands of the river delta, and then return to Nuiqsut following the farthest east river channel, traversing approximately 120 km. Survey data were combined with available TK and historical information to determine whether there are locations of consistent seal haulout use that might be affected. SAExploration operated under a signed CAA and POC with communities and specific measures to minimize impacts on subsistence are described on page 51978. NMFS determined the proposed activity would have no more than a negligible impact on species or stocks, and would not result in unmitigable impacts to the availability of species or stock for subsistence uses. NMFS issued an IHA on September 2, 2014, effective August 25, 2014, through October 31, 2014.

NMFS (2014). 79 FR 36730 IHA BPXA 3D Seismic Survey in Prudhoe Bay, Beaufort Sea, Alaska. *Federal Register*, 79:36730-36743.

On December 30, 2013, NMFS received an application from BPXA for the taking of marine mammals incidental to a 3D OBS seismic survey of an area approximately 492 km2 in the Northstar, Dewline, and Duck Island Units, as well as non-unit areas. BPXA proposed to conduct a 3D OBS seismic survey with a transition zone component on state and private lands and Federal and state waters in the Prudhoe Bay area of the Beaufort Sea during open-water in 2014. The activity would occur between July 1 and September 30; however, airgun operations would cease on August 25. A proposed IHA was published on

April 16, 2014 (79 FR 21522) for public comment. Level B behavioral disturbances or takes of the following species were possible: beluga, killer, bowhead and gray whales; harbor porpoise; and ringed, bearded, spotted and ribbon seals. NMFS required standard mitigation and monitoring measures including establishing and monitoring Level A harassment exclusion zones for all marine mammal species using vessel-based PSOs. At least one PSO was proposed to be Alaska Native with marine mammal experience. This person would also serve as an Inupiat Communicator to help communicate project activities to local villages. Other measures included course alteration, airgun power down, shutdown and ramp-up. NMFS convened an independent peer review panel on January 8–9, 2013 to review the 4MP. The panel provided their final report to NMFS February 25, 2013 and revisions to the 4MP were reflected in this IHA. No marine mammal injuries or mortalities were anticipated. NMFS concluded that activities would have a negligible impact on small numbers of affected marine mammal species or stocks and no unmitigable impacts on subsistence would occur. NMFS issued an IHA effective July 1, 2014 through September 30, 2014.

USFWS (2014). IHA BlueCrest Exploration & Drilling Program Cook Inlet, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Alaska Region. Anchorage, AK. November 10, 2014. 9 pp.
This is the IHA letter which granted BlueCrest the authority to take small numbers of sea otters by level B harassment incidental to O&G exploration activities in Cook Inlet. The IHA was valid from November 1, 2014 to October 31, 2015 (see annotation for 79 FR 51584).

USFWS (2014). IHA SAExploration 3D Seismic Lower Cook Inlet, Alaska. U.S. Dept. of the Interior, U.S. fish and Wildlife Service. Region, A. Anchorage, AK. November 10, 2014. 8 pp.
This is the LOA letter which granted SAExploration authority to take small numbers of sea otters by Level B harassment incidental to the 2015 3D seismic program in lower Cook Inlet. Specific mitigation and monitoring measures are described in this LOA letter. The authorization was valid from November 1, 2014 through October 31, 2015 (see annotation for 79 FR 51584).

USFWS (2014). 79 FR 17564 Notice of Issuance - LOAs Industry O&G Activities, Beaufort and Chukchi Seas, Alaska. *Federal Register*, 79:17564-17565.
This notice listed the 13 companies to which LOAs for the taking of Pacific walrus and polar bears were issued associated with oil and gas exploration, development or production in the Beaufort and Chukchi seas. Stipulated conditions specific to each companies' activities and location were further described in the LOAs. Holders of the LOAs were required to use methods and conduct activities to minimize adverse impacts on these animals, their habitat and their availability for subsistence which were listed in the actual LOAs, not this notice. Intentional take an lethal incidental takes were prohibited.

USFWS (2014). 79 FR 51584 Notice of Receipt of IHA Application Apache, SAExploration, Bluecrest Exploration Cook Inlet, Alaska. *Federal Register*, 79:51584-51600.
This is the notice of receipt for two IHAs. USFWS received applications from Apache on April 15, 2014, SAExploration On October 28, 2013, and BlueCrest on April 15, 2014 to take by harassment incidental small numbers of Southcentral stock northern sea otters in lower Cook Inlet from November 1, 2014 through October 31, 2015 during 3D nodal or OBN seismic surveys. Apache's area encompassed 4,882 km2 in water depths 0 to 128 m. BlueCrest planned to survey a 1,808 km2 area in lower Cook Inlet beginning east of Kalgin Island and the east side of lower Cook Inlet to Anchor Point. Since sea otters do not occur in Upper Cook Inlet, BlueCrest's activities in that area were not considered in this IHA. Table 2 presents the distances to noise thresholds for monitoring and Table 4 provides estimated takes for each applicant based on their proposal. The following mitigation measures were included in the individual IHAs: operational and support vessels must be staffed with trained and qualified observers to alert crew

of the presence of sea otters and initiate adaptive mitigation responses; vessel operators must take avoid harassment to sea otters when a vessel is operating near these animals; vessels must reduce speed and maintain a distance of 100 m from sea otters; all vessels must avoid areas of active or anticipated subsistence hunting for sea otters as determined through community consultations; aircraft must remain as far away as possible from sea otters and fixed-wing aircraft must operate at an altitude no lower than 91 m in their vicinity; helicopters must operate at an altitude no lower than 305 m in their vicinity. When aircraft are operated at altitudes below the required minimum altitudes, the operator must avoid known sea otter locations and should take precautions to avoid flying directly over these areas. USFWS determined that activities would result in no more than a negligible impact to sea otters, and would not result in any unmitigable impacts to subsistence. The proposed activities will occur entirely within the range of the Southcentral Alaska stock of the northern sea otter, which is not listed as threatened or endangered under the ESA. The IHAs were effective November 1, 2014, to October 31, 2015.

AOGA (2015). Petition for Incidental Take Regulations for Oil and Gas Activities in the Beaufort Sea and Adjacent Lands in 2016-2021. Alaska Oil and Gas Association. Anchorage, AK. June 16, 2015. 114 pp.
Following the previous final rule published on August 3, 2011 (see annotation for 76 FR 47010), this is a petition to the USFWS to renew regulations for the non-lethal unintentional taking of small numbers of polar bears and Pacific walrus incidental to oil and gas exploration, development, and production operations and all associated activities in the Beaufort Sea and adjacent northern coast of Alaska for the period August 3, 2016 through August 3, 2021. The requested regulations would be the ninth in a series dating from 1993. Consistent with the prior and existing regulations, and in consultation with USFWS, AOGA identified the class of activities that may affect small numbers of polar bear and walrus and provided detailed descriptions on the types of effects and estimated takes for each species. Proposed mitigation measures did not differ from previous requests and included: designating qualified individual(s) to observe, record and report any effects on polar bear and walrus; developing a polar bear and walrus interaction plan; minimizing effects on availability of these animals for subsistence hunting; consulting with subsistence communities; developing a POC; maintaining aircraft minimum altitudes over haulouts; using trained PSOs for some marine activities; identifying polar bear dens when conducting activities during denning season using FLIR or polar bear scent-trained dogs; limiting distance around known dens with a buffer of 1 mile; and maintaining ramp-up procedures for airguns, exclusion zones and shutdown zones as needed to mitigate impacts on walrus. See also the annotation for the final rule published by USFWS on August 5, 2016 (81 FR 52276).

NMFS (2015). 80 FR 35744 IHA Shell Exploration Drilling Program in the Chukchi Sea, Alaska. *Federal Register*, 80:35744-35780.
On September 18, 2014, Shell Gulf of Mexico Inc. (Shell) applied for the taking of marine mammals incidental to exploration drilling activities at up to four exploration drill sites at Shell's Burger Prospect. NMFS published the proposed IHA on March 4, 2015 (80 FR 11726). In 2012, NMFS issued two IHAs to Shell to conduct two exploratory drilling activities at exploration wells in the Beaufort (see also the annotation for 77 FR 27284; May 9, 2012) and Chukchi (77 FR 27322; May 9, 2012) Seas, which were similar though not identical to this proposal for 2015. NMFS authorized takes by Level B harassment of 12 marine mammal species incidental to Shell's offshore exploration drilling and along the marine transit route, including beluga, bowhead, gray, killer, minke, fin, and humpback whales; harbor porpoise; and bearded, ringed, spotted and ribbon seals. Specific activities were likely to result in the takes including: exploration drilling; supply and drilling support vessels using dynamic positioning; mudline cellar construction; anchor handling; ice management activities; and zero-offset VSP activities. This program was to be a continuation of the Chukchi Sea exploration drilling program that began in 2012. Throughout the IHA process, NMFS worked with stakeholders including the AEWC and other Alaska Native marine

mammal user groups regarding potential impacts of the drilling program on subsistence activities. A peer-review meeting to discuss industry's monitoring plans was held in early March 2015. The panel's major recommendation was for Shell to modify the configuration of it passive acoustic array to better evaluate the potential for spatial displacement of marine mammals. Shell signed a CAA with the AEWC on April 23, 2015. The AEWC also requested that NMFS include a condition requiring Shell to exit the area through the Bering Strait no later than November 15, 2015. Shell also submitted a POC with its IHA application. NMFS issued an IHA effective July 1, 2015 through October 31, 2015. However, Shell withdrew its application in September 2015.

NMFS (2015). 80 FR 34371 IHA Shell Ice Overflight Surveys in the Beaufort and Chukchi Seas, Alaska. *Federal Register*, 80:34371-34384.

On December 2, 2014, Shell Gulf of Mexico Inc. (Shell) applied for the taking of marine mammals incidental to ice overflight surveys in the Chukchi and Beaufort Seas. This IHA authorized the take of seven marine mammal species by Level B harassment: beluga, bowhead, and gray whales; and bearded, ringed, spotted, and ribbon seals. The proposed IHA was published March 3, 2015 (80 FR 11398). Shell planned to conduct break-up and freeze-up surveys using fixed wing and rotary aircraft operating out of Barrow (Utqiaġvik) and Deadhorse, Alaska. The AEWC commented that the IHA should require that aircraft routes are planned to minimize potential conflict with bowhead whales or bowhead subsistence whaling activities, not operate below 1,500 feet in areas of active whaling, and stay at least 5 miles in-land when traveling over land until taking a perpendicular route from land to the start of the offshore survey area. AEWC also commented that the reasonably likely impacts of the specified activities on marine mammals would be due to localized, short-term acoustic disturbance from aircraft flying over areas covered by sea ice and adjacent ice edges. A NMFS required PSOs aboard all flights, aircraft would not land on ice within 0.5 mi of hauled out pinnipeds or polar bears, and aircraft were to avoid flying over polynyas or along ice margins to minimize impacts to cetaceans. NMFS determined that activities were not expected to have any habitat-related effects that could cause significant or long-term consequences for marine mammals or on the food sources that they use. NMFS also concluded only negligible impacts on marine mammal populations or stocks and no unmitigable impacts of the subsistence harvests of bowhead whales. NMFS issued an IHA effective June 10, 2015 through June 9, 2016.

NMFS (2015). 80 FR 39062 IHA Hilcorp Shallow Geohazard Survey in the Beaufort Sea, Alaska. *Federal Register*, 80:39062-39076.

On December 1, 2014, Hilcorp submitted an application for the taking of marine mammals incidental to shallow geohazard surveys in the Beaufort Sea between July 1 and September 30, 2015. Hilcorp submitted a revised IHA application on January 5, 2015 and a revised 4MP on January 21, 2015. The proposed IHA was published May 15, 2015 (80 FR 27901). The description of activities, species, and potential effects were very similar to the 2014 survey for which an IHA was issued to BPXA (see annotation for 79 FR 36769) to BPXA however, this 2015 survey required 45 days while the 2014 survey was only 20 days. By this time, Hilcorp had acquired the Liberty asset from BPXA. Hilcorp requested Level B harassment takes for nine species including beluga, bowhead, killer, and gray whales; harbor porpoise; and bearded, ringed, spotted, and ribbon seals. Mitigation and monitoring measures were also the same as required by NMFS in 2014 with the exception that there was no exclusion zone for Level A harassment because of the low intensity high-frequency sonar equipment. Instead, Hilcorp proposed to shutdown operation of the sub-bottom profiler if PSOs observed a marine mammal within a 50 m zone of influence (ZOI). The 4MP was peer-reviewed in early March 2015 and the final measures reflected their input, specifically related to deployment and positioning of autonomous multichannel acoustic recorders (AMARs) to record sounds during the surveys. NMFS issued the following Level B takes: beluga (45); bowhead (9); gray whale (3); bearded seal (87); ringed seal (324); and spotted seal (103). NMFS

concluded effects were expected to be short-term, with no lasting biological consequence. On July 8, 2015, an IHA was issued, effective July 1, 2015 through September 30, 2015.

NMFS (2015). 80 FR 40016 IHA SAExploration Marine Seismic Survey in the Beaufort Sea, Alaska. *Federal Register*, 80:40016-40037.
On December 2, 2014, SAExploration applied for the taking of marine mammals incidental to a 3D OBN seismic survey program in the Beaufort Sea. After several revisions, NMFS deemed the application and 4MP adequate on February 17, 2015. The survey was expected to take 70 days between July and October 2015 during open water. Due to the request for Level A takes of six marine mammal species, this proposed IHA was of concern to the MMC which is reflected in their comments. MMC also recommended that NMFS develop criteria for determining when taking by Level A harassment should be authorized (i.e., types of sound sources, project locations, species, effectiveness of mitigation measures), and authorize any such takes through regulation under 101(a)(5)(A) of the MMPA and a LOA rather than through an IHA. NMFS disagreed and stated that because potential impacts on marine mammals from SAExploration's 3D seismic survey would be limited to small numbers of Level B takes, result in negligible impacts only and not result in unmitigable impacts to subsistence species or their availability, the issuance of an IHA to SAExploration under section 101(a)(5)(D) of the MMPA meets the legal requirements of the MMPA. The 4MP was peer reviewed in early March 2015. NMFS required SAExploration to implement all the standard mitigation and monitoring measures to detect marine mammals within or about to enter designated exclusion zones; to initiate immediate shutdown or power down of the airgun(s); refrain from initiating or cease seismic activities if an aggregation of bowhead or gray whales (i.e., 12 or more whales of any age/sex) was observed within the Level B harassment zone. Level A takes were authorized as follows: 1 bowhead, 4 beluga (Beaufort Sea stock); 4 beluga (E. Chukchi Sea stock); 0 gray whales; 20 ringed seals; 20 spotted seals; and 10 bearded seals. No serious injuries or mortalities were anticipated. On July 13, 2015, NMFS issued an IHA effective July 1 through October 15, 2015.

BSEE and BOEM (2016). 81 FR 46478 Final Rule Requirements for Exploratory Drilling on the Arctic Outer Continental Shelf. *Federal Register*, 81:46478-46566.
In this final rule, BOEM and BSEE revised and added new requirements to regulations for exploratory drilling and related operations on the OCS seaward of the State of Alaska (Alaska OCS). This rule focused solely on the OCS within the Beaufort Sea and Chukchi Sea Planning Areas (Arctic OCS). Due to the remoteness and a relative lack of fixed infrastructure, the rule was designed to ensure safe, effective, and responsible exploration of Arctic OCS oil and gas resources, while protecting the marine, coastal, and human environments, and Alaska Natives' cultural traditions and access to subsistence resources. Although a comprehensive OCS oil and gas regulatory program was already in place, DOI engagement with stakeholders revealed the need for new and revised regulatory measures for exploratory drilling conducted by floating drilling vessels and ''jackup rigs'' (MODUs) on the Arctic OCS. This rule which went into effect on September 13, 2016 to revise existing regulations in 30 CFR parts 250, 254, and 550 for Arctic OCS oil and gas activities.

Fairweather LLC (2016). Application for IHA for 2016 Anchor Retrieval Program Chukchi and Beaufort Seas Alaska. Fairweather LLC, Fairweather Science LLC. April 2016. 93 pp.
Citation Only. See the annotation for the proposed rule (NMFS 2016; 81 FR 31594).

NMFS (2016). 81 FR 47240 Final Rule: 2016 Apache Cook Inlet Taking and Importing Marine Mammals; Taking Marine Mammals Incidental to Seismic Surveys in Cook Inlet, Alaska. *Federal Register*, 81:47240-47280.

Apache began seismic surveys offshore of Cook Inlet under separate IHAs in May 2012 (see annotation for NMFS 2012; 77 FR 27720) and in 2014 (79 FR 13626). On July 11, 2014, NMFS received another application from Apache for the authorization of Level B take incidental to a seismic program in Cook Inlet. On February 23, 2015, NMFS published a notice proposing to issue regulations and subsequent LOAs with preliminary determinations (80 FR 9510). The activity would occur for approximately 8–9 months annually between August 2016 and July 2021 and consisted of conducting seismic over an area 5,684 km2. This was the most controversial rule during the period 2000-2020, and the first 5-year regulation issued for Cook Inlet. The MMC and NRDC recommended that NMFS defer issuance of the regulations until NMFS could support a conclusion that the activities would not contribute to the decline of Cook Inlet beluga whales with no more than a negligible impact on the population. MMC and NRDC requested better information on the cause or causes of ongoing decline of the population and a reasonable basis for determining that authorizing additional takes would not contribute to or exacerbate that decline. The beluga take estimates in this rule used the most current information (at the time) in a predictive beluga habitat model to estimate how many belugas are likely to occur in the area. The seasonal distribution and habitat use patterns of Cook Inlet beluga whales suggested that for much of the time, only a small portion of the population would be potentially subjected to impacts from Apache's activity, as most animals are concentrated in Upper Cook Inlet. Apache requested up to 30 beluga Level B harassment takes annually (a total of 150 over 5 years). NMFS prohibited Apache from operating airguns within 16 km of the Susitna Delta between April 15 and October 15 to protect beluga whales in designated critical habitat important for beluga whale feeding and calving between mid-April and mid-October. NMFS determined that the regulation would result in no more than a negligible impact on marine mammal species or populations. NMFS issued regulations on July 20, 2016.

NMFS (2016). 81 FR 57888 Withdrawal of IHA Bluecrest Drilling Activities at Cosmopolitan State Unit, Alaska, 2016. *Federal Register*, 81:57888.

On September 28, 2015, NMFS received an IHA application from BlueCrest for the taking of marine mammals incidental to an oil and gas production drilling program in Lower Cook Inlet during the 2016 open water season. NMFS published the proposed IHA on June 2, 2016 (81 FR 35548). The requested IHA would have authorized take by Level B harassment only of nine marine mammal species as a result from the specified activity. On July 21, 2016, NMFS accepted notice from BlueCrest withdrawing their IHA application for the proposed action due to their decision to forego operations in Cook Inlet at this time due to economic reasons. Therefore, NMFS withdrew the proposed IHA for the action on July 21, 2016.

NMFS (2016). 81 FR 40274 IHA Quintillion Subsea Cable Laying Chukchi and Beaufort seas, Alaska. *Federal Register*, 81:40274-40282.

On October 29, 2015, NMFS received an IHA application and 4MP from Quintillion to take small numbers of marine mammals by harassment incidental to subsea cable-laying activities in the Bering, Chukchi and Beaufort Seas, during the 2016 open water season. NMFS determined that the application and the 4MP were complete on February 5, 2016. Quintillion planned to install a subsea fiber-optic cable network between Nome and Oliktok Point, Alaska. The cable-laying vessel would use a dynamic positioning system and bury the cable using a plough in waters greater than 12 m in depth. Divers, a towed sled, and remotely-operated vehicle would be used for jet burial of the cable in waters less than 12 m in depth. The proposed activities were expected to occur on up to 150 days from 1 June to 31 October. Noise generated from the cable vessel's dynamic positioning thruster could impact marine mammals in the vicinity of the activities. Take by Level B harassment of individuals of 12 species of marine mammals was

authorized. NMFS and an independent peer-review panel worked with the applicant to ensure the 4MP was in place during operations. Measures included placing both Inupiat and non-native PSOs on three cable-laying vessels to conduct visual monitoring throughout the entire project during daylight, including all vessel transits; conducting in-situ sound source and sound propagation measurements and adjusting the Level B harassment zone, if necessary; and providing funding for passive acoustic monitoring to be conducted in 2016. The NSB requested Quintillion continue participation in the well-established CAA process. Quintillion also developed a POC which included completing activities in time to have all barges and vessels transit south through the Bering Strait no later than 15 November. Quintillion also met with the AEWC, which determined that developing a CAA was not necessary. NMFS determined that the taking would be small, result in no more than a negligible impact on any marine mammal population and not have an unmitigable adverse impact on the availability of marine mammals for subsistence use by Alaska Natives. On June 21, 2016, NMFS issued an IHA effective from June 1, 2016 through October 31, 2016.

NMFS (2016). 81 FR 31594 Notice of Proposed IHA Shell Anchor Retrieval Chukchi and Beaufort seas, Alaska. *Federal Register*, 81:31594-31612.

On February 2, 2016, Fairweather applied for the taking of 12 species of marine mammals incidental to anchor retrieval activities in the U.S. Chukchi and Beaufort seas between July 1 and October 31, 2016. This IHA was unique due to the nature of the activity and therefore includes some useful information about sound sources, proposed acoustic monitoring and the analysis. The 2016 anchor handling fleet consisted of two ice-classed vessels for ice management around Point Barrow. Vessels were to mobilize from Dutch Harbor in late June and arrive in the Kotzebue area by early July to start the anchor retrieval program. Anchor seating typically takes less than half an hour each. At each site anchor retrieval activities using thrusters occurred over two to seven days, with the thrusters operating only part of the time. Anchors were located using high-frequency sonar over one to three days at each site before and after anchor retrieval; take of marine mammals is not expected to result from exposure to these high frequency sources. Therefore, operations that may result in incidental harassment to marine mammals] occurred over approximately 10 days total on each site throughout the season with the noise sources operating only part of the time over those days. The modeled safety zone for anchor retrieval was 220 m from the source. PSOs were to establish and monitor a safety zone of 500 m during anchor retrieval and ice management. Other mitigation measures which were not unique to this action included: when the vessel was positioned, PSOs would clear the area by observing the 500 m safety zone for 30 minutes; f a marine mammal(s) was observed within the 500 m zone during the clearing, the PSOs would continue to watch until the animal(s) was gone and had not returned for 15 minutes if the sighting was a pinniped, or 30 minutes if it was a cetacean; once the PSOs cleared the area, anchor retrieval or ice management operations could commence. Species authorized for incidental harassment takings by Level B harassment were: bowhead, fin, gray, minke, beluga, killer and humpback whales; harbor porpoises; and ringed, spotted, bearded and ribbon seals. A Communication Plan was presented to the AEWC in February 3-5, 2016 to present the project components and develop mechanisms to work with the communities. NMFS proposed to issue the IHA provided the mitigation, monitoring, and reporting requirements were incorporated.

USFWS (2016). 81 FR 52276 Final Rule Industry O&G Activities Beaufort Sea, Alaska. *Federal Register*, 81:52276-52320.

On May 5, 2014, the USFWS received a petition from AOGA on behalf of its members to promulgate regulations for nonlethal incidental take of small numbers of walruses and polar bears in the Beaufort Sea and adjacent northern coast of Alaska for a period of 5 years (2016–2021) (see annotation for AOGA 2016). Under these regulations, USFWS would evaluate specific requests for LOAs for each company

specific to proposed projects at specific locations. As such, this final rule evaluates potential effects at a programmatic level, however, still authorizes a specific number of takes for each species. USFWS estimated there would be no more than
340 Level B harassment takes of polar bears during the 5-year period and all takes were anticipated to be nonlethal Level B harassment involving short-term and temporary changes in bear behavior. There would be no injurious Level A takes. USFWS estimated no more than 10 Level B harassment takes of Pacific walruses during the 5-year period and zero lethal takes. Public comments and USFWS responses provide additional rationale behind USFWS' conclusions and covered topics ranging from climate change and sea ice to how population-level effects or large oil spills were analyzed. The USFWS concluded that the total takings of Pacific walrus and polar bears would impact only small numbers of animals, would have a negligible impact on these species, and no unmitigable adverse impact on the availability of these species for subsistence use by Alaska Natives. The final rule was published August 5, 2016 and effective through August 5, 2021.

USFWS (2016). IHA Quintillion Subsea Cable Bering, Chukchi and Southern Beaufort Sea, Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Alaska Region. Anchorage, AK. August 11, 2016. 8 pp.
This is the IHA letter to Quintillion valid from August 11 through Nov. 15, 2016. It authorized incidental level B takes only of Pacific walrus. A description of activities are described in the annotation for the NMFS IHA issued June 21, 2016 (81 FR 40274).

Alaska LNG (2017). Alaska LNG Project Marine Mammal Protection Act Assessment Report Cook Inlet, Alaska. USAI-P2-SrZZZ-00-000007-000, April 14, 2017. 106 pp.
The Alaska Gasline Development Corporation (AGDC) planned to construct one integrated liquefied natural gas (LNG) Project with interdependent facilities for the purpose of liquefying supplies of natural gas from Alaska, in particular from the Point Thomson Unit (and Prudhoe Bay Unit production fields on the Alaska North Slope. The project would include a new gas liquefaction facility on the eastern shore of Cook Inlet just south of the existing Agrium fertilizer plant on the Kenai Peninsula, approximately 3 miles southwest of Nikiski and 8.5 miles north of Kenai. This facility would include the structures, equipment, underlying access rights, and all other associated systems for final processing and liquefaction of natural gas, as well as storage and loading of LNG, including terminal facilities and auxiliary marine vessels used to support marine terminal operations (excluding LNG carriers). This report provides detailed information on project risk factors, marine mammal species potentially affected and types/magnitude of effects, potential effects on marine mammal subsistence activities and proposed mitigation measures.

Hilcorp - Harvest Alaska LLC (2017). Application for IHA for Cook Inlet Pipeline Cross Inlet Extension Project. Anchorage, AK. May 16, 2017. 103 pp.
This is the application for which NMFS issued an IHA in 2018 (see annotation for NMFS 2018; 83 FR 19224). The project consisted of installing two new steel subsea pipelines, moving subsea obstacles out of the pipeline corridor, pulling two pipelines (one oil, one gas) into place on the seafloor, securing pipelines with sandbags, and connecting the pipelines to the existing Tyonek platform in Cook Inlet. Each section of the pipeline would be fabricated onshore then pulled offshore using a winch mounted on an anchored pull barge. Both pipelines were to be assembled simultaneously. A sonar survey would be used to confirm positioning of the pipelines. Effects could include masking and behavioral disturbance (e.g., avoidance, cessation of vocalizations). Mitigation measures included a 2,200 m safety zone from working vessels and along the pipeline corridor, and using PSOs to conduct marine mammal monitoring to ensure no mammals were within the safety zones. The project did not involve noise sources capable of inducing PTS and no injury was anticipated or authorized. Exposure would likely result in temporary avoidance

and modification of behavior consisting of diverting around the project area. Based on the analysis and proposed mitigation measures, the proposed activity was expected to have a negligible impact on affected marine mammal species or stocks.

NMFS (2017). 82 FR 38877 IHA Quintillion Subsea Cable Operations and Maintenance Activities in the Arctic Ocean. *Federal Register*, 82:NMFS received an IHA application and Marine Mammal Mitigation and Monitoring Plan from Quintillion for the taking of marine mammal species incidental to conducting subsea cable-laying and operation and maintenance activities in the Beaufort, Bering, and Chukchi seas. The request continued work conducted in the 2016 open-water season, which was covered under a previous IHA (81 FR 40274; June 21, 2016). NMFS determined that the application and the 4MP were complete on February 13, 2017, and proposed to issue the IHA subject to certain conditions on May 12, 2017 (82 FR 22099). Quintillion's proposed work in 2017 was considerably smaller in scope than the work done in 2016. Quintillion intended to complete the 76-km Oliktok segment in summer 2017 using a variety of cable laying equipment. Prior to cable-laying, seafloor sediment along the 60-km route segment was loosened plowing to varied depths. The dominant noise during plowing was from the ship's drive propeller and thrusters. NMFS convened an independent peer-review panel to review Quintillion's monitoring plan. Quintillion was required to communicate with subsistence users to prevent any unmitigable adverse impacts the cable laying may have on subsistence activities during the 2017 open-water season. The NSB requested that NMFS require Quintillion to develop and employ a more comprehensive monitoring plan than was required in 2016, which included monitoring of bowhead whales in the far-field. The NSB stated that during Quintillion's 2016 cable-laying operation, Barrow (Utqiaġvik) whalers had to travel considerable distances to the east and northeast to locate and harvest whales. NSB stated that several whalers expressed concerns that Quintillion's operations may have impacted the behavior and distribution of bowhead whales when they arrived near Barrow. Quintillion developed a POC outlining measures to be implemented to minimize adverse impacts on the subsistence including completing the proposed activities in time to have all barges and vessels transit south through the Bering Strait no later than 15 November. Quintillion also met with the AEWC, which determined that developing a CAA for the proposed activities was not necessary. Based on the proposed activities and mitigation measures, NMFS determined that the number of takes would be small, result in no more than a negligible impact on any marine mammal population and not have an unmitigable adverse impact on the availability of marine mammals for subsistence use. NMFS issued an IHA to Quintillion to take, by harassment, small numbers of 13 species of marine mammal incidental to conducting subsea cable-laying and maintenance activities in the Beaufort, Bering, and Chukchi seas, effective from July 1, 2017, through November 15, 2017.

NMFS (2017). Emergency Consultation, Hilcorp Platform A Gasline Repairs, Cook Inlet, Letter of Concurrence, NMFS# AKR-2017-9650, POA-1965-43. National Marine Fisheries Service. Alaska Region. NMFS# AKR-2017-9650, POA-1965-43, Juneau, AK. October 3, 2017. 17 pp.
This letter states that NMFS completed informal ESA section 7 consultation under regarding the USACE authorization to allow Hilcorp to conduct emergency repairs of the leaking natural gasline supplying Platform A in Cook Inlet. The USACE determined after-the-fact that the action did not likely adversely affect Cook Inlet beluga whales or adversely modify designated critical habitat for that species. Based on NMFS analysis of the information provided by the USACE and additional literature, NMFS concurred with the determination that the proposed action may have affected, but likely did not adversely affect Cook Inlet beluga whales or designated critical habitat. However, NMFS notes that some mitigation measures were not entirely implemented. For example, in their project description Hilcorp included the measure to conduct helicopter-based surveys for marine mammals 30 minutes prior to CaviBlaster use. However, the helicopter survey prior to the single CaviBlaster session ended 50 minutes prior to CaviBlaster use. This

type of mistake in mitigation measure implementation increases the risk of adverse effects to listed species, although for the reasons described above, such effect likely did not occur in this case. NMFS also states that in general the emergency consultation process worked very well for this proposed action. It was important for the health of humans and the environment to complete the repairs as soon as possible, and the emergency consultation process enabled NMFS to authorize potential take as quickly as possible, while providing mitigation measures to reduce the risk of impacts to listed species. The sound source verification study conducted by JASCO provided valuable information about the acoustic characteristics of the CaviBlaster, which will likely be used to inform mitigation measure development for future projects.

Quintillion Subsea Operations LLC (2017). Application for IHA for the Quintillion Subsea Operations Cable Project 2017. Quintillion Subsea Operations LLC. May 2017. 58 pp.
Citation Only. Please see annotation for IHA-17-01; USFWS 2017.

USFWS (2017). IHA Quintillion Subsea Cable Installation Bering, Chukchi and Southern Beaufort Sea, Alaska. July 18, 2017. 8 pp.
On November 28, 2016, Quintillion submitted an IHA application to USFWS for the nonlethal taking by Level B harassment of Pacific walruses and polar bears that may occur incidental to the completion of a cable-laying project begun earlier in 2016. The request was amended on February 10, 2017. Most of this project was completed in 2016 under a separate IHA issued on August 11, 2016, after opportunity for public comment (81 FR 40902; June 23, 2016). Quintillion requested this IHA for its planned fiber optic cable-laying activities in the northern Bering, Chukchi, and western portions of the southern Beaufort Seas, the marine waters of the State of Alaska, and coastal land adjacent to Nome, Kotzebue, Point Hope, Wainwright, Utqiagvik (Barrow), and Oliktok Point. USFWS anticipated no take by injury or death and included none in the authorization. In 2016, Quintillion installed fiber optic cable in the marine waters of the northern Bering, Chukchi, and southwestern Beaufort Seas. The 2016 program successfully installed the vast majority (96 percent) of the cable but did not complete the entire project. Work scheduled for the 2017 season included installation of 76 km of cable along the Oliktok branch line, system testing, and O&M. Mitigation measures included the following: Project vessels will not pass through or work in the Chukchi Sea prior to July 1, 2017; therefore, encounters with Pacific walrus and polar bears in June were unlikely. Underwater sound levels would be minimized by powering engines at the lowest possible level to complete work and by choosing the smallest appropriate vessel where multiple options existed. Quintillion's must avoid the sea ice habitat of Pacific walruses and polar bears to the greatest extent practicable. Operators worked with PSOs to apply adaptive measures as specified herein, and shall recognize the authority of PSOs, up to and including stopping work, except where doing so poses a significant safety risk to vessels and personnel. Project activities were conducted no closer than 805 m to Pacific walruses or polar bears; and Quintillion agreed to work in offshore waters away from nearshore subsistence harvest areas and schedule operations to avoid conflict with subsistence harvest. The USFWS found that any incidental take by harassment resulting from the proposed Quintillion cable laying operation could not be reasonably expected to, and was not reasonably likely to, adversely affect the Pacific walrus or the polar bear through effects on annual rates of recruitment or survival and would, therefore, have no more than a negligible impact on the species or stocks. The IHA was issued July 18, 2017 (IHA -17-01).

NMFS (2018). 83 FR 19224 IHA Harvest Cook Inlet Pipeline Cross Inlet Extension Project. *Federal Register*, 83:19224-19236.
On May 16, 2017, NMFS received a request from Harvest Alaska (Harvest) for an IHA to take beluga whales, humpback whales, killer whales, harbor porpoise, harbor seals and Steller sea lions incidental to

installing two new steel subsea pipelines in the waters of Cook Inlet, moving subsea obstacles out of the pipeline corridor, pulling two pipelines (one oil, one gas) into place on the seafloor, securing pipelines with sandbags, and connecting the pipelines to the existing Tyonek platform in Cook Inlet. The project was located a few km north of the village of Tyonek between Ladd Landing and the Tyonek Platform. The presence of vessels and noise generated, had the potential to take marine mammals by Level B harassment. The proposed IHA was published February 27, 2018 (83 FR 8487). NMFs authorized up to 40 Level B takes of Cook Inlet beluga whales, 972 harbor seals, and up to 100 harbor porpoise. Takes for the other species were lower. As described in more detail in the 4MP (see annotations for 2018 Fairweather and 2019 Castellote in Bin 4). NMFS required that PSOs monitor a 2,200 m safety zone from working vessels and along the pipeline corridor ensure no mammals were within the safety zones. Belugas use habitat in the project more in fall and winter when the project would not occur and their habitat would not be permanently impacted. NMFS believed that mitigation to address beluga whale critical habitat was not warranted. The MMC acknowledged that activities would likely have fewer impacts than other sound-producing activities but indicated that NMFS should explain why the activities, in combination with ongoing and other planned activities in Cook Inlet (i.e., cumulative effects), would affect only a small number of beluga whales and have no more than a negligible impact on the species. The project did not involve noise sources capable of inducing PTS and no injury was anticipated or authorized. Exposure would likely result in, at most, temporary avoidance and modification to behavior, and diverting around the project area. NMFS concluded that proposed activities would likely have a negligible impact on all affected marine mammal species or stocks. An IHA was issued effective April 25, 2018 through April 24, 2019.

USFWS (2018). 83 FR 18329 LOAs Industry Oil and Gas Beaufort and Chukchi Seas, Alaska. *Federal Register*, 83:183929-118330.

On August 5, 2016, the USFWS published a final rule (81 FR 52276) effective through August 5, 2021, allowing the authorization of nonlethal, incidental, unintentional take of small numbers of polar bears and Pacific walrus during year-round oil and gas industry exploration, development, and production activities in the Beaufort Sea and adjacent northern coast of Alaska. The 2016 rule prescribed a process under which the USFWS issue LOAs to applicants conducting activities as described under the provisions of the regulations. This notification provides a list of the LOAs issued by company. Each LOA (issued separately) was to stipulate conditions or methods that are specific to the activity and location. Holders of LOAs must use methods and conduct activities in a manner that minimizes to the greatest extent practicable adverse impacts on Pacific walruses and polar bears and their habitat, and on the availability of these marine mammals for subsistence purposes. Intentional take and lethal incidental take are prohibited.

NMFS (2019). 84 FR 70274 Final Rule Hilcorp Construction and Operation of the Liberty Drilling and Production Island, Beaufort Sea, Alaska. *Federal Register*, 84:70274-70325.

On August 2, 2017, NMFS received a request from Hilcorp to promulgate regulations and issue LOAs to authorize take of six species of marine mammals incidental to construction and operation of the LDPI in Foggy Island Bay. The proposed rule was published May 29, 2019 (84 FR 24926) and solicited public comments. In response to a request from the AEWC, an extension was granted to the 30-day comment period with a new end date of July 31, 2019 (84 FR 32697). Hilcorp proposed to construct and operate the Liberty LDPI, a self-contained offshore drilling and production facility located on an artificial gravel island. Ice roads would be constructed annually. Island construction using impact and vibratory pile driving would take one year to complete. Pile driving would primarily occur during ice-covered season (when only ringed and few bearded seals are present); up to two weeks of pile driving may occur during the open-water season only if not completed during winter. This was a large project that received

considerable scrutiny and comment. The MMC believed that Level A harassment takes for ringed seals were underestimated and claimed there was the potential for at least one ringed seal to be taken by Level A harassment each day that impact pile driving occurred. The AWL indicated that NMFS ignored the impacts of oil spills. Several commenters noted that all species potentially taken by Hilcorp's specified activities are key subsistence species, in particular bowhead whales and ringed and bearded seals. AEWC expressed support for Hilcorp's efforts to reduce impacts to subsistence use and offered no objection to the final rule. However, the AWL believed the proposed activities would adversely affect Nuiqsut's subsistence activities, and these impacts may not be able to be mitigated. Therefore, AWL asserted that NMFS's rule was inadequate because it failed to ensure that the activity would not have an unmitigable adverse impact on Nuiqsut's subsistence harvest of bowhead whales. Hilcorp's 4MP was peer reviewed and the final mitigation measures reflect modifications to proposed mitigation including collected acoustic data during winter months, specific placement of DASARs during island construction to collect acoustic data of both construction sounds and potential marine mammal vocalizations, as well as specific measures to reduce potential impacts to ringed seals during ice road construction and operations. Considering the coordination with the AEWC, Hilcorp's proposed work schedule (i.e., conducting the majority of work in winter when bowhead whales are not present), and the incorporation of several mitigation measures, NMFS determined that the total taking of affected species or stocks would not have an unmitigable adverse impact on the availability of such species or stocks for taking for subsistence purposes. The final rule was published December 20, 2019 and effective December 1, 2021 through November 30, 2026.

NMFS (2019). 84 FR 37442 Final Rule and LOA 2019-2024 Hilcorp Oil and Gas Activities in Cook Inlet, Alaska. *Federal Register*, 84:37442-37507.

On April 17, 2018, NMFS received a request from Hilcorp to promulgate regulations to take, by Level A and Level B harassment, marine mammals incidental to oil and gas activities in Cook Inlet, effective from July 30, 2019, to July 30, 2024. Hilcorp planned to collect 3D seismic data for approximately 45–60 days starting May 1, 2019 in Lower Cook Inlet. This rule reflects more recent data available regarding Cook Inlet beluga whale densities than earlier authorizations (i.e., for Apache). As with previous rules, several commenters recommended NMFS defer issuance of a final rule for sound producing activities in Cook Inlet until a reasonable basis for determining that authorizing any incidental harassment takes would not contribute to or exacerbate the decline of Cook Inlet beluga whales was clear. NMFS determined the activities would result in no more than a negligible impact and there would be no unmitigable adverse impact on availability of marine mammals for subsistence uses. NMFS required a rigorous mitigation plan to reduce impacts to Cook Inlet beluga whales and other marine mammals including but not limited to: vessel-based and shore-based visual mitigation monitoring using PSOs; marine mammal exclusion and safety zones; shutdown procedures; ramp-up procedures; and vessel strike avoidance measures. Specifically regarding Cook Inlet, Hilcorp was required to shutdown airguns if any beluga whale was observed within the Level B isopleth and to shutdown activities within a 16 km radius of the Susitna Delta from April 15 through October 15. These shutdown measures were more restrictive than the standard shutdown measures typically applied and combined with the Susitna Delta exclusion, were expected to reduce the number and severity of potential harassment takes. Additionally, no 2D seismic airgun activity was allowed between January 1 and May 31 within the Level B harassment radius of the Kasilof River. NMFS also required aerial overflights to clear the intended area of seismic survey activity of beluga whales on a daily basis. NMFS published final regulations on July 31, 2019.

NMFS (2019). 84 FR 53119 Modified LOA Hilcorp Oil and Gas Activities in Cook Inlet, Alaska. *Federal Register*, 84:53119-53122.

This notice was for modification of an LOA issued under the final rule published by NMFS July 31, 2019 (see annotation for 84 FR 37442). The original rule included ramp-up procedures at night even when the entire exclusion zone could not be visually cleared. Hilcorp equipped its source vessel with PV14 night vision devices and required that they be used for observations at night or during other periods of low visibility for 3D seismic surveying and the requirement was added to the modified LOA. These devices were only outfitted on the source vessel, not the mitigation vessel. The proposal to modify a LOA was published on August 16, 2019 (84 FR 41957) which described the necessity of the modification and affirmed that modifying the mitigation measure did not change any of the findings previously determined. The MMC recommended that NMFS reconsider requiring the use of towed PAM and night-vision devices to better assess whether the exclusion zone was clear prior to implementing ramp-up procedures at night. CBD and Cook Inlet Keeper submitted a similar comment and suggested that NMFS arbitrarily dismissed the use of PAM and thermal technologies for nighttime observations. The CBD and Cook Inlet Keeper further commented that if NMFS planned to allow nighttime seismic surveys without clearing the exclusion zone, the incidental take regulations and environmental analyses must be amended and re-circulated for public comment. The commenters emphasized that a nighttime exception to clearing the full extent of the exclusion zone did not appear in the incidental take regulations. NMFS stated that adaptive management measures as detailed in the regulations (50 CFR 217.167) allow NMFS to modify or renew LOAs as necessary if doing so creates a reasonable likelihood of more effectively accomplishing the goals of mitigation and monitoring set forth in those regulations. NMFS evaluated the nighttime ramp-up of seismic airguns and determined the data from previous seismic monitoring programs did not suggest that there would be a difference in the severity of impacts to marine mammals by not fully clearing the exclusion zone during nighttime ramp-up. NMFS considered its original determinations of small numbers and negligible impact determination to still remain valid, and subsequently NMFS issued a modified LOA to Hilcorp on October 4, 2019.

NMFS (2020). 85 FR 19294 IHA Port of Alaska's Petroleum and Cement Terminal Construction Anchorage, Alaska. *Federal Register*, 85:19294-19324.

On November 28, 2018, NMFS received an application for an IHA from the Port of Alaska (POA) to take humpback whales, Steller sea lions, harbor seals and Cook Inlet beluga whales by Level B or Level A harassment incidental to pile driving associated with the construction of the petroleum and cement terminal (PCT). NMFS previously issued IHAs and LOAs to the POA for pile driving (73 FR 41318, July 18, 2008; 74 FR 35136, July 20, 2009; and 81 FR 15048; March 21, 2016) for non-oil and gas related construction activities designed to upgrade and expand the Port by replacing aging and obsolete structures. Due to a modified construction schedule the POA submitted a new application on July 19, 2019, (two phased schedule instead of one), and a two revisions to the application on August 9, 2019, and October 15, 2019. NMFS published the proposed IHA on December 30, 2019 (84 FR 72154). The PCT Project includes several major components: (1) A loading platform and an access trestle (bridge-like structure allowing access to the loading platform) in Phase 1, and mooring dolphins in Phase 2. During both Phase 1 and Phase 2, temporary mooring dolphins will be required to accommodate construction barges and to moor construction vessels. The POA proposed using confined bubble curtain in Phase 1, expected to result in less noise propagating into the marine environment than an unconfined system. The temporal or spatial scale of the activities was also considered. For all non-Cook Inlet beluga whale species, for both the Phase 1 and Phase 2 IHAs, the amount of taking was less than 4 percent for all stocks considered. Harbor seals tend to concentrate near Ship Creek and have small home ranges; therefore, the amount of take authorized likely represents repeat exposures to the same animals. The following factors supported NMFS' determination that the impacts from the activities analyzed under

each of these two separate IHAs are not expected to adversely affect Cook Inlet beluga whales or their habitat: no mortality or serious injury; no critical foraging grounds (e.g. Eagle Bay, Eagle River, Susitna Delta) would be impacted; and while animals could be harassed more than once, exposures were not likely to exceed more than a few per year for any given individual and were not expected to occur on sequential days. NMFS also considered new analyses indicating the Cook Inlet beluga whale population is smaller and declining faster than previously recognized, but NMFS believed the authorized takes would have a negligible impact. A confined bubble curtain reduced noise entering the water and noise levels were verified upon the onset of pile driving. The exposure risk to Cook Inlet belugas was greatly minimized by incorporating monitoring measures including the use of two PSOs at each of four stations, simultaneously on watch at each station, such that NMFS found it unlikely whales would go undetected. NMFS issued two successive IHAs to POA on April 6, 2020 (85 FR 19294; effective April 1, 2020 through March 31, 2021 [Phase 1]) and Phase 2 effective April 1, 2021 through March 31, 2022.

NMFS (2020). LOA Hilcorp Liberty Production & Development Island Beaufort Sea, Alaska 2021-2026. National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. February 18, 2020. 10 pp.

This LOA was issued under the final rule published December 20, 2019 (84 FR 70274) to Hilcorp authorizing the take of marine mammals incidental to construction and operation of the Liberty Drilling and Production Island in Foggy Island Bay, Beaufort Sea, Alaska. The LOA, effective December 1, 2021 through November 30, 2026, specified terms and conditions of the authorization, the required mitigation and monitoring procedures, reporting requirements and authorized takes by species and harassment type, per year.

NMFS (2020). 85 FR 2988 Proposed Rule Hilcorp and Eni Ice Roads and Ice Trails Construction and Maintenance Activities on Alaska's North Slope. *Federal Register*, 85:2988-3010.

On December 2, 2018, NMFS received a joint application from Hilcorp and Eni requesting that NMFS promulgate regulations authorizing small takes of marine mammals incidental to construction activities related to North Slope ice roads and ice trails. This proposed rule was published January 17, 2020. Please see the annotation for the final rule published December 22, 2020 (85 FR 83451).

NMFS (2020). 85 FR 43382 Notice of Proposed IHA AGDC Alaska LNG Construction in Prudhoe Bay, Alaska. *Federal Register*, 85:43382-43412.

On March 28, 2019, NMFS received a request from AGDC for authorization to take a small numbers of bowhead, gray and beluga whales; and ringed, spotted and bearded seals by Level B harassment incidental to construction of the Alaska LNG Project in Prudhoe Bay. The application was considered complete by NMFS on May 21, 2020. NMFS proposed to authorize takes for six species (with seven managed stocks) that temporally and spatially co-occur with the activity to the degree that take was reasonably likely to occur. NMFS also requested comments on a possible one-year renewal that could be issued under certain circumstances and if all requirements were met. Generally, this represents a different process from before when renewals of IHAs were not authorized. AGDC proposed additional development of the West Dock facility and causeway which extends approximately 4 km into Prudhoe Bay. Vibratory and impact pile driving at West Dock would introduce underwater sound that may result in take by Level A and Level B harassment of marine mammals in Prudhoe Bay. Pile driving would occur up to 24 hours per day on approximately 123 days from July through October during the open water season. AGDC committed to employ the following mitigation measures: conduct briefings between construction supervisors and crews and the marine mammal monitoring team prior to the start of all pile driving activity; for in-water heavy machinery work other than pile driving, if a marine mammal comes within 10 m, operations shall cease and vessels shall reduce speed to the minimum level required to maintain

steerage and safe working conditions; for those marine mammals for which Level B harassment take has not been requested, in-water pile installation/removal would shut down immediately when it is safe to do so if such species are observed within or entering the Level B harassment zone; and If take reaches the authorized limit for an authorized species, pile installation would be stopped as these species approach the Level B harassment zone to avoid additional take. A break in pile driving during the Nuiqsut whaling season (approximately 25 August through 15 September) is required. A contingency period from February to April 2023 may be necessary in the event that pile driving or removal cannot be completed during the 2022 open-water season. AGDC entered into a POC, dated February 2020, and has also met with the AEWC several times since 2015 about potential impacts of the project on subsistence hunting activities. NMFS stated that the POC outlined AGDC's 'extensive coordination' with subsistence communities, and that it would be updated throughout the project review and permitting process (85 FR 43406). Based on the analysis of the likely effects of the specified activity on marine mammals and their habitat, and taking into consideration the implementation of the proposed monitoring and mitigation measures, NMFS preliminarily concluded that the total marine mammal take from the proposed activity would have a negligible impact on all affected marine mammal species or stocks. NMFS did not expect anything more than Level B harassment to occur to any marine mammal. No serious injury or mortality will be authorized.

NMFS (2020). 85 FR 50720 LOA 2021-2025 AGDC Alaska LNG Construction Cook Inlet, Alaska. *Federal Register*, 85:50720-50756.
On October 1, 2018, NMFS received an application from AGDC seeking issuance of regulations to allow the incidental take of small numbers of harbor porpoise, harbor seals, humpback whales and Cook Inlet beluga whales by harassment incidental to constructing the Alaska LNG facilities in Cook Inlet March 2020 through March 2025. On June 28, 2019, NMFS published a proposed rule (84 FR 30991)(see also the annotation for Alaska LNG 2017).The construction includes a Marine Terminal adjacent to the proposed onshore LNG Plant near Nikiski, and a mainline crossing in Cook Inlet. In addition a Mainline Material Offloading Facility may be constructed on the west side of Cook Inlet near Beluga Landing to support installation of the Cook Inlet shoreline crossing. As part of that project, AGDC would also lay a 42-in natural gas pipeline across the inlet between the two sites. AGDC's proposed activities include vibratory and impact pile driving, dredging, trenching, anchor handling, and use of associated support vessels and aircraft. NMFS determined that the proposed activities could cause small numbers of Level A and/or Level B harassment takes of up to 10 species or stocks of marine mammals. Most concern was about the potential cumulative impacts of human activities on the Cook Inlet beluga whale population. As with previous comments on MMPA authorizations in Cook Inlet, the MMC recommended the final rule be deferred until any other applicant proposing to conduct sound-producing activities in Cook Inlet until NMFS has a reasonable basis for determining that authorizing any additional MMPA takes for Cook Inlet beluga whales would not contribute to the population decline. Several other commenters recommended the request be denied. NMFS stated the analysis indicated that issuing MMPA authorizations would not contribute to or worsen the observed decline of the Cook Inlet beluga whale population. NMFS concluded that the activity would have a negligible impact on the population. The final rule was published August 17, 2000, effective January 1, 2021 through
December 31, 2025.

NMFS (2020). 85 FR 83451 Hilcorp-Eni Final Rule Ice Road Construction North Slope. On December 2, 2018, NMFS received a joint application from Hilcorp and Eni requesting that NMFS promulgate regulations authorizing small takes of marine mammals incidental to construction activities related to North Slope ice roads and ice trails. The proposed rule was published January 17, 2020. This regulation and the implementing LOAs would authorize takes of marine mammals incidental to construction,

operation and maintenance of Hilcorp's and Eni's ice roads, trails and pads during the ice-covered season at Northstar (Hilcorp), and Ooooguruk Development (Eni) and the SID (Eni) during a five-year period beginning in December 2019. Only the ringed seal spatially co-occurs with these activities to the degree that takes could occur. Impacts are likely to occur from visual exposure of seals to machinery and vehicles used for ice roads, trails and pads and from human presence. The associated noise from the machinery and vehicles could also cause minor behavioral harassment and temporary displacement within the vicinity of the action area. A series of reports from the Northstar development provide evidence of ringed seal reactions to human activity during ice road construction beginning in 1999. In a few unlikely cases, activities could result in serious injury or mortality if a seal is crushed by a construction machinery or vehicle. However, there is only one record of a dead seal discovered in 1989 due to a vibroseis project. Authorization to take ringed seals incidental to ice road and ice trail construction activities has been included in previous rulemakings associated with Northstar. However, this rule includes more specific mitigation and monitoring measures for these activities which include general measures to be implemented at all times as well as specific measures before and after March 1st to minimize disturbance during seal pupping season. Measures include but are not limited to: Vehicles do not stop within a 45.7 m radius of an identified seal lair or within 152.4 m of a seal; No initiation of ice road or trail construction if a ringed seal is observed within 150 ft of the action area after March 1 through May 30 of each year; requiring monitoring of construction areas to detect the presence of seals before beginning construction activities; . Hilcorp requested up to 80 Level B takes over 5 years while Eni requested 45 Level B takes (split between Ooooguruk and SID over 5 years. A total of 12 serious injury or mortality takes were authorized for the 5-year period (3 each for Eni's Oooguruk and SID, and 6 for Hilcorp's Northstar). Both Hilcorp and Eni signed a POC and indicated they would sign a CAA to ensure that there would be no unmitigable impact on subsistence during the proposed ice roads and ice trails construction and maintenance. Overall, the construction and maintenance of ice roads and trails is not expected to cause significant impacts on habitat used by ringed seals or on their food sources., effective December 22, 2020 through November 30, 2025.

Bin 3 - National Environmental Policy Act (NEPA) Environmental Impact Statements (EIS) and Environmental Assessments (EAs)

USACE (1999). Final Environmental Impact Statement Northstar Beaufort Sea Oil and Gas Development Project and Record of Decision. U.S. Army Corps of Engineers. Anchorage AK. 1000+ pp.
This EIS analyzed the impacts of the Northstar Development, the first offshore oil and gas development/production facility in the Alaskan Beaufort Sea without a causeway to shore. Traditional knowledge is discussed in Chapter 2 and may have information that is still relevant today for the area. The ROD included the following reequipments to protect marine mammals: minimize vessel operations after August 31 to avoid migrating bowhead whales; follow established vessel routes which maximize separation with the migration corridor; utilize agitation techniques to place sheetpile instead of pile driving where practicable; develop and conduct an acoustic monitoring study; construct studies to report the impact of the Northstar facility on the migrational path of bowheads; do not conduct ice-breaking prior to Oct. 15; and do not drill into oil producing strata during the broken ice period.

MMS (2002). Outer Continental Shelf Oil & Gas Leasing Program 2002-2007, Final Environmental Impact Statement. U.S. Dept of the Interior, Minerals Management Service. MMS 2002-006, Anchorage, AK. April 2002. 615 pp.
The EIS evaluated the impacts of lease sales in the Gulf of Mexico and in the Alaska OCS Beaufort and Chukchi seas, Hope Basin, Cook Inlet, and Norton Basin over 2002-2007. The analysis assumed future activities including: drilling oil and natural gas exploration and production wells; installing and operating offshore platforms and pipelines, and onshore support facilities; and transporting oil using ships or pipelines. Principal issues and concerns included: risk of oil spills; effects of noise; effects on subsistence; and effects on sensitive biological resources and critical habitat. Impacts on cetaceans would be negligible to moderate from noise associated with drilling and production. Noise from the proposed action could have minor to moderate impacts on Cook Inlet beluga whales. With the exception of these whales, the impacts of a large oil spill would range from negligible to moderate. Overall, potential impacts on fin, humpback, blue, sei, northern right, or gray whales would range from negligible to moderate, depending on the number of whales contacted by a spill and the number of spills. Moderate to major impacts could occur if a large spill were to contact individual beluga whales. Effects of large spills on Steller sea lions could be major if numerous or large rookeries were contaminated. Effects of oil spills on ringed, bearded, spotted, and ribbon seals would be minor to moderate. Very general mitigation measures are discussed in Appendix D and include: an industry site specific bowhead whale monitoring program and conflict avoidance mechanisms to protect subsistence whaling. The EIS is 18 years old and very broad in scope, but the detailed discussion of oil spill potential and effects might be useful to BOEM.

MMS (2002). Liberty Development and Production Plan, Final Environmental Impact Statement. U.S. Dept of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2002-019, Anchorage, AK. 760 pp.
This EIS analyzed the impacts of the original Liberty project. The project was similar to the 2019 Liberty project, but the location of the drilling island and pipeline routes are different. TK is highlighted in this document and may prove interesting to BOEM for present-day analyses. Major issues considered were: disturbance from project activities; oil spills; and cumulative effects. Potential effects on bowhead whales are discussed in detail along with effects on seals, walruses beluga whales and polar bears. The discussions provide historical context for current-day projects. A detailed discussion of effects of a large oils spill is provided. Mitigation required at the time by MMS included lease stipulations 1-5: protection of biological resources; orientation program; pipelines as preferred transportation of hydrocarbons; industry site specific bowhead whale monitoring; CAAs to protect subsistence. Mitigation measures incorporated TK. Additional mitigation measures for oil spills, many of which are applicable today, included seasonal drilling requirements; through ice oil spill monitoring; and protection of Cross Island from oil spills. This focus on oil spill mitigation may be useful to BOEM.

MMS (2003). Beaufort Sea Planning Area, Oil and Gas Lease Sales 186, 195, and 202, Final Environmental Impact Statement. U.S. Dept of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2003-001, 1597 pp.

This EIS assessed lease sales in the Beaufort Sea OCS Planning Area for 2003- 2007. The analysis found that bowhead whales may exhibit temporary avoidance behavior to noise from seismic surveys, vessels, aircraft, drilling, and construction, but overall effects to bowheads would be temporary and nonlethal. Pinnipeds, polar bears, and beluga and gray whales could be affected, with recovery expected in about 1 year. No resource or harvest area would become unavailable, and no resource population likely would experience an overall decrease. The study estimated less than a 0.5% chance of a large spill contacting the nearshore area. If a large spill occurred and contacted bowhead habitat during the fall migration, some whales would be contacted by oil, and a few could die as a result. A large oil spill could result in the loss of small numbers of seals, walruses, polar bears, and beluga and gray whales with populations likely recovering within about 1 year. Mitigation measures include 5 lease sale stipulations: protect biological resources; provide an orientation program; transport hydrocarbons though pipelines; provide a bowhead whale monitoring program; and protect subsistence whaling and other subsistence. These stipulations are similar to recent stimulations. Other recommended mitigation included not siting permanent facilities near Cross Island. Although the information in the EIS is outdated, it does provide historical context on how oil spill impacts were modeled and evaluated.

MMS (2003). Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199, Final Environmental Impact Statement. U.S. Dept of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2003-055, Anchorage, AK. 702 pp.

This EIS assessed lease sales in the Cook Inlet OCS Planning Area for 2002- 2007. The analysis found that local effects to endangered species could result from noise and other disturbances caused by exploration, development, and production. Steller sea lions near the Barren islands could be affected along with humpbacks and Cook Inlet belugas. Behavior of sea otters could be affected and they could be displaced from areas of activity. Overall a few individuals could be affected, but regional or migrant populations of non ESA-listed species would experience no measurable impacts. No resource or harvest area would become unavailable, and no resource population likely would experience an overall decrease. The study estimated the chance of a large spill greater than or equal to 1,000 barrles (bbls) entering offshore waters to be 19%. A few non-listed marine mammals could be lost with recovery taking 1-5 years. No measurable effects on regional or migratory populations with in the Cook Inlet area were expected to occur. Mitigation measures include the 4 lease sale stipulations modified slightly from previous Cook Inlet lease sales: protect fisheries; protect biological resources; provide an orientation program; and transport hydrocarbons though pipelines. Standard information to lessees (ITL) included identifying sensitive areas considered in an oil spill and information on endangered species. ITL clauses provide the lessee with information required by other federal agencies. Although the information in the EIS is outdated, it does provide historical context on stipulations and ITL clauses and on how oil spill impacts were evaluated.

MMS (2004). Proposed Oil and Gas Lease Sale 195 Beaufort Sea Planning Area, Environmental Assessment. U.S. Dept of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2004-028, Anchorage, AK. July 2004. 326 pp.

This EA was done to assess new information and impacts not addressed in the Lease Sale 186, 195, and 202 EIS of 2003. This EA found no new significant impacts that were not previously identified in the 2003 EIS. The Oil Spill Risk Analysis (Section IV.A.1) was revised to cover the fate of oil in broken ice and under landfast ice. This information is still valid and may be of interest to BOEM. The EA changed the probability of a large spill from 0.5% to 9-13%. The assessment included a reanalysis of the effects of climate change

and found ringed seals and other ice-dependent pinnipeds to be of primary concern. The EIS stated that research on spill response during broken ice was ongoing; the EA addressed this and stated that response is greatly reduced during broken ice, and noted the difference between spring and autumn broken ice conditions and response. The EA also updated information on polar bear; ringed, bearded, and spotted seals; walrus; and bowhead, beluga, and gray whales. The re-analysis of effects supported the EIS conclusions for bowhead whales and all other marine mammals. The EA stated that Lease Stipulations are identical to those in the 2003 EIS plus new requirements for pre-booming fuel transfers and non-permanent facilities sited seaward and shoreward of Cross Island.

MMS (2006). Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf Seismic Surveys 2006. U.S. Dept of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2006-038, Anchorage, AK 305 pp.

This Programmatic Environmental Assessment (PEA) assessed the general effects of 2D and 3D seismic surveys in the Chukchi and Beaufort seas. The PEA addressed similar or related actions as whole rather than individually in separate documents and addressed broad cumulative issues and impacts. Section III.B.1 provides a good discussion of ambient noise in the Arctic OCS and a discussion on the potential effects of climate change on ambient noise levels. This background information is still useful today. Background information on marine mammals is detailed but outdated. The PEA concluded that marine mammals could be harassed and possibly harmed by airgun use. Section IV.A.1 summarizes permit stipulations and mitigation measures including but not limited to: maintaining at least 24 km between seismic source vessels; using the lowest sound levels possible; avoiding concentrations of whales; maintaining altitudes of 305 m for aircraft and 152.5 m for helicopters over whales; reducing vessel speed and avoiding multiple directional changes when within 274 m of whales; monitoring and enforcing shutdown zones; using ramp up techniques; field verifying exclusion zones prior to start up; using aerial or equivalent monitoring; and not conducting surveys in the Chukchi prior to July 1 to protect bowhead cow/calf pairs.

MMS (2007). Outer Continental Shelf Oil & Gas Leasing Program 2007-2012, Final Environmental Impact Statement, April 2007. U.S. Department of the Interior, Minerals Management Service. Offshore Minerals Management Program. MMS 2007-003, 210 pp + appendices.

This EIS analyzed the impacts of the OCS leasing program on 11 states including Alaska. It is very broad in scope. Alaska marine mammals are discussed in section III.B.6, divided into Arctic, Bering, and South Alaska sub-regions. The information is dated but has some good basic life history. Section III.B.5 provides good ambient noise information for the three regions. Alaska exploration and development scenarios are presented in Table IV-2. Alaska region impacts are discussed in Section IV.B.3, with marine mammals discussed by region in Section IV.B.3.c. marine mammals in all three regions could be affected by noise from exploration and development or vessels. Impacts could be short or long term and could result in more significant impacts or population-level effects to some species if nor mitigated. Survival of young may be reduced. Collisions with OCS-related vessels may injure or kill some individuals. Oil spills could result in short- to long-term effects and could have population level impacts. Appendix C provides mitigation measures. Lease stipulations are the same: orientation program; protection of biological resources; protection of fisheries; transportation or hydrocarbons; industry site-specific bowhead monitoring program; conflict avoidance mechanisms. ITLs include advice to lessees on: bowhead monitoring program specifics; potential for presence of polar bears; limiting operations due to effects on subsistence bowhead whaling; determining if bowhead whales would be jeopardized; considering sensitive areas in spill planning; limiting potential interaction with Steller sea lions; and noting the importance of Cross Island for whaling.

MMS (2008). Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas lease Sales 209, 212, 217, and 221, Draft Environmental Impact Statement. U.S. Dept of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2008-0055, Anchorage, AK. 530 pp + appendices.

This EIS analyzed the effects of four lease sales in the Beaufort and Chukchi seas. As all other lease sale EISs it is broad in scope, Species descriptions are detailed, but abundance estimates cited are out of date. Potential effects to endangered cetaceans included: noise disturbance or damage to hearing from airguns, vessel traffic, aircraft, construction, production, and operations. The analysis considers impacts on potential large aggregations of bowhead whales. Overall impacts to both endangered and non-endangered marine mammals were displacement from area due to noise. Should an oil spill occur, the greatest threat to large cetaceans would likely be due to inhalation of volatile compounds, with calves being especially vulnerable. Mitigation measures are the same as previous lease sale EISs: using ramp up procedures; maintaining spacing of 24 km between source vessels; protecting subsistence whaling; and conducting industry site specific monitoring programs. TK is used throughout the document (for example Section 4.1.1.12.3, and may provide a good historical reference for future BOEM analyses.

BOEMRE (2010). Beaufort Sea and Chukchi Sea Planning Areas, ION Geophysical, Inc., Geological and Geophysical Seismic Survey, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management Regulation and Enforcement. Alaska OCS Region. BOEMRE 2010-027, Anchorage, AK. September 2010. 68 pp.

This EA assessed the impacts on cetaceans, ice seals, polar bears and Pacific walrus of a 2D seismic survey using air guns and echosounders in the Beaufort and Chukchi Seas. Overall effects on marine mammals were determined to be minor and short term with mitigation. A detailed marine mammal monitoring and mitigation plan is included and covers: vessel based monitoring using PSOs[1]; ramp up and shutdown procedures; and timing during periods of low marine mammal densities. Although the report is 10 years old, the EA is well organized and impacts and mitigation measures are easy to find.

[1]The document uses the outdated term Marine Mammal Observer, but we have changed it to PSO for simplicity.

Harley, B., Ireland, D.S. and Childs, J.R. (2010). Environmental Assessment for a Marine Geophysical Survey of Parts of the Arctic Ocean, August-September 2010. U.S Dept. of the Interior, U.S. Geological Survey. Open File Report 2010-1117, Version 2, 261 pp.

This EA assessed the impacts of joint USGS/GSC geophysical survey of Arctic Ocean waters. Airguns (primary source of impacts) and echosounders were used. Nine cetacean species, five pinnipeds species, and one ursid (polar bear) occur in or near the proposed study area. Table 3 provides habitat, abundance and conservation status of these species, but the information is 10 years old. Impacts on marine from underwater noise from vessel traffic and use of geophysical equipment would result in avoidance behavior or other disturbances. Injurious impacts to marine mammals have not been demonstrated near airgun arrays. To mitigate impacts, the survey was scheduled to avoid the spring and fall bowhead whale migrations north of Barrow. Measures to mitigate potential impacts included: using at least one dedicated PSO; maintaining watch during all daylight airgun operations; using two PSOs (when possible) to monitor 30 minutes before airgun operations; and initiating power downs or shut downs of the when mammals are detected in, or about to enter designated safety radii. With the planned monitoring and mitigation measures, impacts to marine mammals were expected to be limited to Level B Harassment, or short-term, localized changes in behavior and distribution near the seismic vessel. No long-term or significant effects were expected on individual marine mammals or marine mammal populations, or their habitats. The stated mitigation measures are very similar to other more-recent seismic surveys.

BOEMRE (2011). Beaufort Sea Planning Area, Shell Offshore Inc. 2012 Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Beaufort Sea, Alaska, Flaxman Island Blocks 6559, 6610 & 6658, Beaufort Sea Lease Sales 195 & 202, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management Regulation and Enforcement. Alaska OCS Region. BOEMRE 2011-039, Anchorage, AK. 238 pp.

This EA assessed the impacts of Shell's revised Exploration Plan for Camden Bay. Taking into account mitigation, the proposed action would have minor effects on bowhead, fin, humpback, and beluga whales; ringed, spotted, and bearded seals; pacific walrus; and polar bears through vessel and aircraft disturbance, and noise from aircraft, vessels, seismic air guns, drilling, icebreaking, and permitted discharges and oil spills. Lease stipulations include: conduct a site specific monitoring program if work is done during bowhead whale migration; employ PSOs[1] on support and ice-management vessels, and the drillship; conduct a cetaceans aerial monitoring program to identify, characterize underwater noise though a passive acoustic program, conduct sound monitoring and source verification, initiate a Plan of Cooperation (POC) to protect bowhead subsistence hunting, and suspend all operations beginning Aug. 25 for the Nuiqsut and Kaktovik bowhead whale hunts. Also, to minimize impacts to marine mammals drilling vessels and support fleet would not transit north through the Bering Strait until July 1. Although this report is 11 years old, it has compressive descriptions of lease stipulations and mitigation measures that are useful to BOEM.

[1]The document uses the outdated term Marine Mammal Observer, but we have changed it to PSO for simplicity.

DON (2011). Gulf of Alaska Navy Training Activities, Preliminary Final Environmental Impact Statement/Overseas Environmental Impact Statement. United States Department of the Navy. U.S. Pacific Fleet. Pearl Harbor, HI. 804 pp.

The EIS analyzed potential effects of Navy training activities in the Gulf of Alaska (GOA). Even though not oil and gas related, the information is useful to BOEM. There are good, well organized, descriptions, but possibly outdated densities, of 26 marine mammals including Cook Inlet beluga whales (Tables 3.8-1 and 3.8-2). Effects discussions are by species in Section 3; detailed descriptions of the mechanics of impacts due to underwater sound and acoustic effects that may be of interest to BOEM are discussed in Section 3.8.7.3. The analysis is very detailed and impacts to listed species are summarized in Table 3.8-18; (all MA – may affect). Mitigation measures are described in Section 3.8.8 including: use of trained personnel to detect and report the presence of marine mammals; staying at least 457.2 m from whales at sea, altering other vessels of an observed whale; conducting pre-training surveys, reducing the sound from sonar when marine mammals are in the vicinity of activities; moving activities to avoid marine mammals, maintaining exclusion zones; and coordinating with NMFS. The EIS also outlines mitigation measures that were considered and eliminated.

DON (2011). Record of Decision for Final Environmental Impact Statement/Overseas Environmental Impact Statement for the Gulf of Alaska Navy Training Activities. United States Department of the Navy. U.S. Pacific Fleet. 24 pp.

This is the Record of Decision (ROD) for the 2011 Navy GOA EIS announcing the decision to implement alternative 2, which was designed to meet Navy and U.S. Department of Defense (DoD) current and near-term operational training requirements. Twelve Native Alaskan Tribes and Nations were invited to participate in Government to Government consultation. The ROD states that marine mammal short-term behavioral responses from general vessel disturbance are possible, but injury or mortality from vessel collisions but it is very unlikely. Low level overflights could cause disturbance, but no long-term population-level effects are expected. Most likely impacts to marine mammals would be acoustic with both Level A and Level B takes estimated. Mitigation measures described in the EIS were adopted in the ROD.

LGL Ltd. and Marine Acoustics Inc. (2011). Environmental Assessment of Marine Vibroseis. Joint Industry Programme, E&P Sound and Marine Life, and the International Association of Oil & Gas Producers. LGL Report TA4604-1, London, UK. 232 pp.
This study evaluated environmental impacts from seismic surveys that use marine vibroseis (MarVib) as compared to airguns. The report concluded that use of MarVib sources would reduce behavioral, auditory, and physiological effects in marine mammals. It is succinct and well-organized. Recommended mitigation measures useful to BOEM are generally the same as those for air guns and include: reducing the duty cycle, suppressing sound components below about 100 hetz (Hz), using frequency modulation (FM) signals rather than pseudorandom noise (PRN) signals (unless PRN allows a much lower sound source), avoiding any signal type that might elicit resonance in air filled body cavities, and using modelling to determine whether adjusting operating depth might reduce impacts to marine mammals. An analysis of data gaps and a list of recommended studies concludes the report; more information is needed regarding weighting functions, masking, disturbance effects of MarVib sounds, sound levels needed to elicit a Temporary Threshold Shift TTS, and resonance effects in marine mammals.

Shell (2011). Environmental Impact Analysis, Revised Chukchi Sea Exploration Plan OCS Lease Sale 193, Chukchi Sea, Alaska: Burger Prospect: Posey Blocks 6714, 6762, 6764, 6812, 6912, and 6915. U.S. Department of the Interior, Bureau of Ocean Energy Management Regulation and Enforcement. Alaska OCS Region. Anchorage, AK. 555 pp.
This EA analyzes the impacts of Shell's 2011 Exploration Plan for the Chukchi Sea Burger Prospect. Shell planned to use a single drillship at six well locations on six leases beginning in 2012. The drill sites were over 103 km offshore in pack ice. Marine mammal descriptions and figures in Sections 3.7 and 3.8 are good, but abundances are out-of-date. Analysis results were the same as in the 2007 Lease Sale 193 EIS: minimal or negligible direct or indirect environmental impacts, and the impacts which do occur are expected to be short term unmeasurable the following year; negligible or minor short-term effects on marine mammals limited to temporary disturbance or displacement. Also the existence of any ESA-listed or subsistence species, particularly bowhead whales, were not threatened. The work was not expected to pose a statistically significant risk of a large or very large oil spill (blowout). Lease stipulations are described in section 4.4 and are the same as those in the lease sale EIS.

BOEM (2012). ION Geophysical 2012 Seismic Survey Beaufort Sea and Chukchi Sea, Alaska, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2012-081, Anchorage, AK. 102 pp.
This EA assessed the impacts on cetaceans, ice seals, polar bears and Pacific walrus of a 2D seismic survey using air guns and echosounders in the Beaufort and Chukchi Seas conducted in 2012. BOEM approved an ION Geophysical (ION) application and issued a permit to ION for a similar survey in 2010. The survey was later cancelled by ION. This study replaced the one cancelled in 2010 and includes mitigation measures from the 2010 IHA application request and EA (BOEM 2010), as well as other measures specifically designed to prevent or minimize any incidental harm to marine mammals. Those additional BOEM-proposed measures include: 1)Vessels must remain at least 48 km from whaling activities when transiting from the West Survey Area to the East Survey Area. 2)Vessels shall maintain communication with the Alaska Eskimo Whaling Commission and the Barrow Whaling Captains' Association during the eastward transit around Pt. Barrow. BOEM can use the information from this EA in combination with that in the 2010 EA.

NMFS (2012). Environmental Assessment for the Issuance of Regulations and Letters of Authorization to BP Exploration (Alaska) Inc. for the Take of Marine Mammals Incidental to Operation of Offshore Oil and Gas Facilities in the U.S. Beaufort Sea. National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. 177 pp.

This EA provides NEPA compliance for the authorization of takes of takes of six marine mammal species incidental to operation of the Northstar facility over 2012-2017. There is good historical information on the construction and operation of Northstar and a summary of historical take authorizations for the facility. Drilling was not specifically planned for the period. Potential non-acoustic effects would be temporary displacement of pinnipeds from haul-out areas; and mortality or injury of seals during on-ice construction or transportation. A major oil spill might cause serious injury or mortality to small numbers of marine mammals. Because of the low source levels for the majority of equipment used, hearing impairment is not expected. Overall the operational activities at Northstar were expected to have only minimal impacts on marine mammals, based on the limited noise footprint. On ice and open water mitigation measures are presented, but the use of trained dogs to identify and avoid seal lairs during the ice covered season is no longer accepted practice. Open water mitigation measures included: scheduling vessel and air traffic to avoid bowhead whale migration; limiting helicopter flights to a corridor form Seal Island to the mainland at a height of 305 m; using PSOs to monitor exclusion zones and enact shutdown procedures for pile driving activities; using ramp up techniques; and not drilling into oil-bearing strata during either open water or spring broken ice conditions. The EA is dated but provides historical context for impacts and mitigation measures associated with Northstar.

NMFS (2012). Final Environmental Assessment for the Issuance of Incidental Harassment Authorizations for the Take of Marine Mammals by Harassment Incidental to Conducting Exploratory Drilling Programs in the U.S. Beaufort and Chukchi Seas National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD May 2012. 262 pp.

This EA provides NEPA compliance for the authorization of takes of 12 marine mammal species incidental to conducting offshore exploratory drilling in the Chukchi and Beaufort seas. The proposed activities that have the potential to take marine mammals include: drillship operation; ice management/icebreaking; and Zero-offset Vertical Seismic Profile (ZVSP) surveys. The most likely impacts were behavioral disturbance from underwater noise and vessel and aircraft activity. Though bowhead and beluga whales would be calving during the activities, they were not expected to be impacted significantly. Mitigation measures included ceasing operations on August 25 and not resuming fall bowhead whale hunts were complete (around September 15). Other mitigation measures included: using PSOs to monitor exclusion zones and enact shutdown procedures for seismic activities; using ramp up techniques for air guns; conducting aerial survey and acoustic monitoring programs; identifying transit routes and timing to avoid other subsistence use areas and communicating with coastal communities; conducting pre-season sound propagation modeling to establish the appropriate exclusion and behavioral radii; and, modifying the Kulluk to reduce sound propagation. The EA is outdated but provides historical context for impacts and mitigation measures associated with exploration.

USACE (2012). Point Thomson Project Final, Environmental Impact Statement. U.S. Army Corps of Engineers. Alaska District. Anchorage, AK. 564 pp + appendices.

This EIS analyzed the impacts of the development 97 km east of Prudhoe Bay. Most development is on shore, but service pier, sealift facility, and mooring dolphins in the nearshore Beaufort Sea are included. Seven marine mammal species were expected in the Project area, but due to construction timing, project activity locations, and known marine mammal distribution, beluga and bowhead whales, polar bear, and bearded and ringed seal were determined to be of greatest concern. The analysis determined that noise from barging could adversely affect bowhead whales and ringed seals; 158 hectares (ha) of polar bear

critical habitat would be lost; 399 ha of seasonal polar bear critical habitat would be seasonally altered; and there would polar bear disturbance zones of 1,305 and 10,750 ha around permanent and seasonal project features, respectively. Applicant's proposed design measures to avoid or minimize impacts to marine mammals included: minimizing offshore infrastructure; installing mooring dolphins in less than 2.4 m of water during winter; using PSOs on barges, vessels and convoys; planning sealift barging to be completed prior to the main fall bowhead whale migration and subsistence whaling; routing coastal barging inside barrier islands and minimizing barge trips; following CAAs with the Alaska Eskimo Whaling Commission (AEWC); avoiding seal habitat when constructing ice roads; conducting dredging in winter; implementing spill prevention and response plans; obtaining LOAs for polar bear disturbance; closing an ice road if a polar bear den is within 1.6 km; monitoring for and deterring polar bears from project activities; training and communicating with workers; and discouraging wildlife encounters.

BOEM (2013). TGS 2013 Geophysical Seismic Survey Chukchi Sea, Alaska, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2013-01153, Anchorage, AK. July 2013. 110 pp.

This EA assessed the impacts on cetaceans, ice seals, polar bears and Pacific walrus of a 2D seismic survey using air guns and echosounders in the Chukchi Sea conducted in 2013. The survey was located at least 80.5 km from the coast and 88.5 km from the closest community. The EA concluded that with mitigation measures negligible effects for all marine mammals is expected, with the exception of walrus. Walrus could be encountered more frequently during their brief migration period; the potential for adverse impacts to walruses could be minor. Monitoring and mitigation included: at least eight PSOs to monitor modeled exclusion zones during daylight hours; Sound source verification against modeled sounds; monitoring for 30 minutes prior to startup; use of night vision binoculars as needed; use of a single airgun as a mitigation seismic source, if the source remains in operation the 30 minutes observation period will not be needed; soft start procedures with a ramp up rate of no more than 6 dB per 5 minutes; implementation of a 180 dB exclusion zone for cetaceans and 190 dB zone for seals. The information in this is EA is useful in combination with previous assessments for geophysical studies.

NMFS (2013). Environmental Assessment for the Issuance of Incidental Harassment Authorizations to Take Marine Mammals by Harassment Incidental to Conducting Open-Water Marine and Seismic Surveys in The Beaufort And Chukchi Seas National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. July 23, 2013. 206 pp.

This EA provides NEPA compliance for the authorization of takes of 13 marine mammal species (six of which are ESA-listed) incidental to conducting open water 2D and 3D seismic surveys. Section 3.1.3 provides good discussions of ambient noise in the area including sources of natural ocean and anthropogenic sounds. This background information is useful for historical context and can be compared to that in MMS's 2006 PEA for OCS Seismic Surveys. Background information on marine mammals is detailed but some abundances are out-of-date. This EA determined that marine mammals could be adversely affected by noise and disturbance from the acoustic sources, the seismic vessels, and related support ships. Marine mammals conceivably could be struck by ships or boats during surveys. These adverse effects were determined to be negligible or minor. Chapter 5 summarizes mitigation measures including but not limited to: conducting sound source measurements prior to the survey; establishing exclusion and disturbance zones based on sound source radii; monitoring those zones using PSOs; employing ramp ups, power downs, and shutdowns to protect marine mammals from exposure; using small volume airguns during turns and transits; employing speed and course alterations to avoid marine mammal. To mitigate subsistence impacts POCs, participation in the Com-Center program, and signed CAAs were required.

BOEM (2014). SAExploration Inc. Colville River Delta 2014 3D Geophysical Seismic Survey Beaufort Sea, Alaska, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2014-605, Anchorage, AK. July 2014. 135 pp.
This EA assessed the impacts on cetaceans, ice seals, polar bears and Pacific walrus of a 3D seismic survey using cableless, ocean bottom recording nodes and air gun arrays in the Colville River Delta in Harrison Bay. The EA concluded that effects would be negligible for bowhead, gray, and beluga whales, ringed seals, polar bears, and walrus. Effects on bearded seals would be negligible to minor, and minor for spotted seals. Mitigation measures are the same as those for previous geophysical surveys, but there are specific requirements for 2-3 PSOs (including Inupiat personnel) on a dedicated mitigation vessel and additional 2 PSOs on each source vessel, and specific measures to reduce impacts to subsistence users including a Com-Center; vessels remaining 8 km offshore while transiting, and 32 km offshore from August 31 to October 31; and vessel speeds less than 10 kts near feeding whales or whale aggregations, and 5 kts if within 1.6 km of bowhead whales. This EA is useful to BOEM because it provides additional details on mitigation for subsistence.

BOEM (2014). SAExporation 2014 Geophysical Seismic Survey, Beaufort Sea Alaska, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2014-007, Anchorage, AK. February 2014. 68 pp.
This EA assessed the impacts on polar bears and ringed seals of a 3D seismic survey on bottomfast ice using 12 rubber-tracked vibroseis vehicles in the Beaufort Sea. Subsistence resources are described using TK Project effects with mitigation would be negligible to ringed seals and polar bears. Mitigation measures included: surveying all on-ice travel routes and operation areas where ringed seals may occur using a 150 m buffer around each travel route; using PSOs to detect any ringed seal activity; stopping work immediately if damage to a seal lair or injury occurs and notifying BOEM before restarting. The EA is useful to BOEM because of the inclusion of TK and the specific measure to protect seal lairs.

DON (2014). Gulf of Alaska Navy Training Activities, Draft Supplemental Draft Environmental Impact Statement/Overseas Environmental Impact Statement. United States Department of the Navy. Naval Facilities Engineering Command, N. Silverdale, WA. 652 pp.
This SEIS was prepared to address new information and analytical methods that emerged after the 2011 GOA Final EIS. By applying new scientific information and modelling, the Navy reanalyzed direct, indirect, cumulative, short-term, long-term, irreversible, and irretrievable impacts resulting from the Navy's training activities on marine mammals. Abundances described in Section 3 are updated as applicable, heating groups are considered. The SEIS provided a more accurate quantification of the acoustic effects to marine mammals and the analysis determined an approximate 90 percent reduction in the number of predicted effects from sonar and other active acoustic sources and an approximate 80 percent reduction in the number of predicted effects from the use of explosives compared to the conclusions of the 2011 Final EIS/Overseas Environmental Impact Statement. BOEM may find the new methods and modeling described in Section 3.8. useful.

NMFS (2014). Environmental Assessment for the Issuance of Incidental Harassment Authorizations to BP Exploration (Alaska) Inc. for the Take of Marine Mammals Incidental to Seismic and Geohazard Surveys in the Beaufort Sea, Alaska. National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. 52 pp.
This EA provides NEPA compliance for the authorization of takes of 9 marine mammal species (three of which are ESA-listed) incidental to conducting a 3D OBS seismic survey near Prudhoe Bay utilizing two source vessels each with two airguns. Background information on marine mammals is detailed but some abundances are out-of-date. This EA determined that impacts to marine mammal habitat would not

occur, but marine mammals could be adversely affected by acoustic stimuli through tolerance, masking of natural sounds, behavioral disturbance, and temporary or permanent hearing impairment. These adverse effects were determined to be minor. Standard mitigation measures included: maintaining aircraft altitudes of 304 m when within 483 m of a group of five or more whales; reducing vessel speed when visibility drops and when within 274 m of whales; ensuring that vessels do not separate groups of whales; monitoring and enforcing exclusion zones and shutdown zones using two PSOs per vessel; employing ramp ups, power downs, and shutdowns to protect marine mammals from exposure; not initiating surveys from shutdown at night or during low light conditions; and setting shot intervals a one shot per minute. These mitigation measures provide good historical context for comparison with other EAs.

BOEM (2015). Chukchi Sea Planning Area Oil and Gas Lease Sale 193 In the Chukchi Sea, Alaska, Final Second Supplemental Environmental Impact Statement. U.S. Dept of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2014-669, Anchorage, AK. 1596 pp.
This second SEIS was initiated to address a deficiency in the original EIS for the lease sale. The second SEIS determined that the impacts of the scenario on marine mammals range from negligible to moderate for all routine activities, depending on the species, nature and timing of activities. The potential impacts from large oil spills range from negligible to major. The EIS includes good but dated descriptions of marine mammal populations found in the lease sale area. Mitigation measures include the following lease sale stipulations pertaining to marine mammals: industry site-specific monitoring for marine mammal subsistence resources; and conflict avoidance mechanisms to protect subsistence whaling and other subsistence harvest activities. A detailed description of mitigation measures is provided as an appendix to the ROD

BOEM (2015). SAExploration, Inc. 3D Cook Inlet 2015 Geological and Geophysical Seismic Survey, Lower Cook Inlet, Alaska, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2015-007, Anchorage, AK. February 2015. 98 pp.
This EA assessed the impacts of a 3D seismic survey using cableless recording nodes and air gun arrays in eastern Lower Cook Inlet. The EA determined that the 1,760-cubic-inch airgun arrays were the primary impact producing element, and concluded that seismic surveys are audible to all groups of marine mammals, the Low Frequency Cetacean (LFC) mysticetes would be most affected. All others would only detect seismic noise in the very bottom of their audibility bandwidths and would not be greatly affected. Monitoring and mitigation included: vessel-based and visual monitoring of the 160 dB threshold area for potential impacts, using shore-based PSOs to monitor for beluga whales during summer nearshore seismic surveys in Cook Inlet beluga whale designated critical habitat areas; implement shutdown procedures for the190 and180 dB safety zones; sound source verification; and ramp up and power down procedures. Where necessary, SAExploration communicated with the subsistence users and agencies to minimize adverse effects on subsistence uses. The EA provides good summaries of marine mammals in the Lower Cook Inlet and outlines typical mitigation measures in use at the time of the study.

BOEM (2015). Shell Gulf of Mexico, Inc. Revised Outer Continental Shelf Lease Exploration Plan Chukchi Sea, Alaska Revision 2, Environmental Assessment. U.S. Depart. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2015-020, May 2015. 276 pp.
This EA assessed the impacts of Shell's Chukchi Sea Exploration Plan within the Burger Prospect. The EA summarizes marine mammals potentially in the Action Area, and determined that acoustic disturbance is the greatest potential impacts of the preferred alternative to cetaceans ice seals, polar bear and walrus. Detailed descriptions of all impacts are provided. Shell committed to scheduling drilling and support to avoid interference with subsistence harvests. Other mitigation measures are summarized in Appendix C

and include: up to a 38-day hiatus on drilling into the hydrocarbon zone based on sea ice; complying with avoidance plans, limiting vessel traffic to avoid sensitive times and locations, maintaining an exclusion zone of 805 m from walrus; following ice management plans to avoid walrus; specifying air craft altitude limits; using PSOs on drilling ships, ice management vessels, anchor handlers, and ocean going vessels; specifying measures for ZVSPs including monitoring, shutdown zones, and ramp up procedures; monitoring marine mammals using aerial surveys; and deploying of acoustic net array. The detailed mitigation measures found in Appendix C are well organized an would be useful to useful to BOEM.

NMFS (2015). Final 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. National Marine Fisheries Service. Office of Protected Resources. Silver Spring, MD. June 2015. 74 pp.

This EA provides NEPA compliance for the authorization of takes of nine marine mammal species (three of which are ESA-listed or candidate) incidental to conducting 3D OBN seismic surveys during open water. It is very similar to the NMFS 2014 EA described above. Background information on marine mammals is detailed but some abundances are out-of-date. This EA determined that impacts to marine mammal habitat would not occur, but marine mammals could be adversely affected by acoustic stimuli through tolerance, masking of natural sounds, behavioral disturbance, and temporary or permanent hearing impairment. These adverse effects were determined to be minor. Standard mitigation measures included: establishing exclusion zones and zones of influence based on received levels of 190, 180, or 160 dB; monitoring those zones using PSOs; employing ramp ups, power downs, and shutdowns to protect marine mammals from exposure; reducing vessel speed when visibility drops and when within 1.6 km of bowhead whales; not initiating surveys from shutdown at night or during low light conditions, unless operating before poor conditions then it can continue to do so. These mitigation measures provide good historical context for comparison with other EAs.

USDOI (2015). Chukchi Sea Outer Continental Shelf Oil and Gas Lease Sale 193, Record of Decision. U.S. Department of the Interior. Washington, DC. 231 pp.

This ROD affirms lease Sale 193 and preserves the opportunity to explore and develop leases issued in the sale. Mitigation measures include the following lease sale stipulations pertaining to marine mammals: industry site-specific monitoring for marine mammal subsistence resources; and conflict avoidance mechanisms to protect subsistence whaling and other subsistence harvest activities. The ROD includes BiOps for the lease sale by NMFS and USFWS. Appendix A Section 13 is a detailed list of mitigation measures presented by BOEM, which is useful to compare to measures provided in EISs for other Beaufort Sea projects.

BOEM (2016). Cook Inlet Planning Area Oil and Gas Lease Sale 244 in the Cook Inlet, Alaska Final Environmental Impact Statement. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2016-069, Anchorage, AK. December 2016. 832 pp.

This EIS assessed the impacts of the lease sale in Cook Inlet. Although the EIS is large in scope and a few years old there is good information on species potentially impacted in Cook Inlet. The analysis determined that the main impact of exploration and development to marine mammals would be disturbance by underwater noise from seismic surveys, drilling activities, and vessel and helicopter traffic; risk of vessel strikes; and lethal and sublethal effects of spills. Routine impacts would be negligible to minor while the impacts of small sills would be negligible and the impacts of large spills would be negligible to moderate. Lease stipulations are clearly described in Section 2.6 and include considering sensitive beluga whale, sea otter, Steller sea lion, and North Pacific right whale critical habitat in spill

response plans. The EIS evaluated impacts on subsistence uses and included mitigation measures to reduce them.

NMFS (2016). Effects of Oil and Gas Activities in the Arctic Ocean, Final Environmental Impact Statement. National Marine Fisheries Service. Anchorage, AK. October 2016. 1276 pp + appendices.
This EIS analyzes a range of management alternatives to authorize or permit offshore oil and gas exploration activities in the Beaufort and Chukchi seas, and updates and replaces MMS's 2006 Final Programmatic Environmental Assessment: Arctic Ocean Outer Continental Shelf Seismic Surveys. Six alternatives were analyzed with Alternative 2 "Authorization for Level 1 Exploration Activity" being the preferred alternative. The alternative assumed that one survey may be conducted during ice covered conditions. Disturbance impacts to marine mammals were the same as those discussed in the PEA and other EAs. Standard mitigation measures included; establishing and executing shutdown/power down zones; following specified ramp-up procedures for airgun arrays; requiring PSOs on all seismic source and monitoring vessels and icebreakers; conducting activities at least 152 m from any observed ringed seal lair. And not placing energy sources over a ringed seal lair. The use of trained dogs to identify and avoid seal lairs during the ice covered season is no longer accepted practice. Additional mitigation measures are provided in Section 2.8 that might be useful in a historical context.

USFWS (2016). Environmental Assessment For a Final Rule to Authorize the Incidental Take of Small Numbers of Polar Bear and Pacific Walrus During Oil and Gas Activities in The Beaufort Sea and Adjacent Coastal Alaska. U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Marine Mammals Management. Anchorage, AK. 128 pp.
This EA assessed the impacts of non-lethal unintentional taking of small numbers of polar bears and Pacific walruses incidental to oil and gas exploration, development, and production operations, in the Beaufort Sea from Aug. 3, 2016 to Aug. 3, 2021. The EA determined that issuance of the regulations would result in negligible impacts to small numbers of polar bears and Pacific walruses. However, there would not be unmitigable adverse impacts on availability of these species for subsistence uses. The Service concluded that any impacts from an operational spill would be limited to a small number of animals, given the sparse distribution of polar bears (low density over a large area, with only a few tens of bears congregating even in the highest density areas). Under the worst circumstances, a very large spill could potentially contact and kill at most tens of polar bears and would not cause population level effects. Mitigation measures are described beginning on pg 70 and include: safety and awareness plans; locating onshore polar bear dens; establishing operational exclusion zones; not approaching within 805 m of walruses or polar bear in the water, or on land or ice; not transiting through the Chukchi Sea before July 1; employing ramp up procedures, monitoring using PSOs, maintaining aircraft altitudes of 457 m; and consulting with communities and developing POCs for subsistence protection.

BOEM (2017). Eni U.S. Operating Company Inc. Outer Continental Shelf Lease Exploration Plan Harrison Bay Block 6423 Unit - Leases OCS-Y-1753, OCS-Y-1754, and OCS-Y-1757, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2017-047, Anchorage, AK. July 2017. 181 pp.
This EA assessed the impacts of Eni's Beaufort Sea Exploration Plan within the Harrison Block. The EA determined that overall effects on marine mammals, their populations, and their habitat from would be negligible. Detailed descriptions of all impacts are provided and would be useful to BOEM. Impacts to subsistence activities and harvest patterns would be minor for seal hunting and for travel to and from Cross Island for whaling; BOEM expected no impacts to whaling in the Cross Island area. Mitigation measures included: posting PSOs onboard vessels during transit between Oliktok Point and the SID so that seals, beluga whales, or polar bears could be detected and avoided; following vessel avoidance

protocols and speed restrictions; and posting PSOs on any structure producing noise levels exceeding the 120 dB (non-impulse noise) or 160 dB (impulse noise) to monitor for marine mammal exposures. Additional lease seal stipulations are provided in Appendix C.

BLM (2018). ConocoPhillips Alaska, Inc. Exploration 2018-2019, Northeast National Petroleum Reserve in Alaska, Environmental Assessment. U.S. Dept. of the Interior, Bureau of Land Management. DOI-BLM-AKR000-2019-0003EA, Anchorage, AK. 85 pp.

The EA was prepared to disclose and analyze the environmental consequences of granting a Right of Way (ROW) and approving Application Permits to Drill (APDs) for activity proposed by ConocoPhillips Alaska, Inc. All of the work is onshore so no marine mammals other than polar bears are discussed. The Bureau of Land management (BLM) ESA process determined that the project was not likely to adversely affect polar bears. Mitigation measures useful to BOEM include standard adherence to All field a Wildlife Interaction detailing how crews will manage wildlife attractants (food and non-food materials) and respond to human-polar bear interactions. This interaction plan must include all guidelines for safely and non-lethally deterring polar bears from damaging property and endangering the public. In addition a polar bear den detection survey was required each year during the maternal denning period (November to mid-April).

BOEM (2018). Liberty Development and Production Plan, Final Environmental Impact Statement. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2018-050, Anchorage, AK. August. 621 pp + appendices.

The Liberty Development is located in Foggy Island Bay in the Beaufort Sea, northeast of Prudhoe Bay. It lies in federal waters. The analysis of effects determined that the proposed construction and development of the offshore oil facility would have from negligible to minor impacts on marine mammals caused primarily by activities occurring during the open water season. The analysis also determined that a very large oil spill from the development would have significant adverse effects on marine mammals. The document provides a fairly succinct analysis of potential impacts on marine mammals including ESA-listed marine mammals and designated critical habitat. It concludes that the proposed action is similar to other permitted projects in the region and that to date those projects have not produced documented changes in marine mammal populations or chronic behavioral responses. The objective conclusions in the EIS were accepted by NMFS as a cooperating agency. The information is current but does not present any significant new findings. Mitigation measures described in the EIS may be useful to BOEM for future projects including: conducting most noise producing activity during the winter months, using marine traffic routes that avoid bowhead whale migration paths, implementing polar bear protection plans, and managing ice roads to control access in areas where marine mammals may be encountered.

BLM (2019). Coastal Plain of the Arctic National Wildlife Refuge Oil and Gas Leasing Program, Final Environmental Impact Statement and Record of Decision. U.S. Dept. of the Interior, Bureau of Land Management. Anchorage, AK. 515 pp + appendices.

This EIS covered oil and gas leasing in ANWR. While the majority of the actions assessed are onshore, potential impacts to marine mammals including: human-polar bear interactions and disturbance; loss of polar bear and seal habitat; noise disturbance from seismic activities, aircraft and boat traffic, and onshore facilities; and accidental, unplanned take by vessel strikes or oil spills are discussed. Of interest to BOEM would be the finding that in addition to impacts to on-ice seal habitat from tracked vehicles on sea ice, ringed and bearded seal seafloor foraging habitat could be affected by alterations at the barge landing site. Typical mitigation measures for polar bear impacts are included such as training, monitoring, developing interaction plans, locating dens, enforcing den exclusion zones. Mitigation measures for ice seals include but are not limited to: conducing sound source verification to determine the extent of

vibroseis sound levels under ice; after May 1st, requiring PSOs to ensure basking seals are avoided by 152 m and ice paths are not wider than 3.7 m; and not allowing camps or unnecessary equipment on sea ice. Conflict avoidance agreements would be used to protect subsistence whaling. Impacts of vessel traffic would be mitigated by: staffing operational and support vessels with PSOs; no use of these vessels before July 1st; staying at least 1.6 km from groups of three or more whales; remaining at least 19 km from Cross Island during bowhead subsistence hunting; and reducing vessel speeds, especially in Northern right whale habitat. These and other mitigation measures applicable to marine mammals are summarized in Table 2-3, Lease Stipulations, Required Operating Procedures, and Lease Notices by Alternative. While the EIS focuses on on-shore impacts and is very broad in scope, recent background information on marine mammals is provided, and on shore and offshore mitigation measures are described to protect these marine mammals.

FERC (2019). Alaska LNG Project, Draft Environmental Impact Statement. Federal Energy Regulatory Commission. Office of Energy Projects. FERC/EIS-0296D, Washington, DC. 495 pp + appendices.
This EIS assessed the impacts of constructing and operating the Alaska LNG Project. The EIS found that construction and operation would affect marine mammals in the Beaufort Sea and Cook Inlet. Vessel traffic through the GOA, and Bering and Chukchi seas could affect marine mammals. The Project would affect marine mammal foraging, mating, and migration in oceanic and coastal habitats. Sections 4.6.3.1 and 4.8.1.2 provide good life history summaries of ESA-listed and non-listed marine mammals, but densities are not provided. Table 4.6.3-2 provides a good summary of marine mammals potentially present during seasonal construction activities. Underwater noise and vessel strikes are assessed as the main impact on marine mammals. Mitigation measures to protect ESA-listed and non-listed marine mammals include: maintaining Level A and B shutdown and harassment zones for pile driving dredging, screeding and anchor handling operations for all species based on species hearing range; using PSOs in Cook Inlet and Prudhoe Bay for all at sea activities; conducting pile driving during daylight hours; collecting data on marine mammals monitoring; not conducting pile driving during June and July in cook Inlet to minimize impacts on Cook Inlet belugas. To minimize vessel strikes, the applicant would develop a transit management plan that include but are not limited to: training; maintain marine mammals watches; reporting marine mammals sightings; reducing speeds if whales are spotted; reducing speeds to 9 kts within 274 m of whales avoiding groups of whales; staying landward of Cross Island and staying within established navigation routes. Mitigation measures for listed species are nicely summarized in Table 4.8.1-2. The majority of the mitigation measures described in the EIS are not different from other projects, but detailed measures focused on vessel activities could be useful.

BLM (2020). National Petroleum Reserve in Alaska, Integrated Activity Plan and Final Environmental Impact Statement. U.S. Dept. of the Interior, Bureau of Land Management. DOI-BLM-AK-R000-2019-0001-EIS, Anchorage, AK. 558 pp + appendices.
This EIS covered oil and gas leasing in NPR-A. While the majority of the actions assessed are onshore, potential impacts to marine mammals including are discussed. The analysis area for marine mammals included the coastal and estuarine areas of the NPR-A, marine waters within 8 km of the NPR-A boundary, and the vessel transit route between the NPR-A and Dutch Harbor. The analysis assumed that: impacts on polar bears are directly related impacts on historical dens, amount of potential maternal denning habitat mapped, and likelihood of use by polar bears of the areas subject to various lease types and stipulations; impacts on pinnipeds are directly related to the length of coastline available for coastal infrastructure development; and impacts on whales are related to the amount of industrial activity facilitated by coastal areas open for leasing, as this would influence the demand for commercial vessel transport, and thus the risk of injury and mortality to marine mammals. All of the alternatives would affect large areas of the designated terrestrial-denning unit of critical habitat for polar bears. All

alternatives would also affect the marine environment along the shipping corridor from Dutch Harbor to the planning area and pose three risks to marine mammals in these areas associated with vessel traffic: hazardous substance spills, disturbance from noise, and ship strikes. Mitigation measures for marine mammals including polar bears are not as detailed as in BOEM 2019. While the EIS focuses on on-shore impacts and is very broad in scope, some recent background information on marine mammals is provided.

BLM (2020). Willow Master Development Plan, Final Environmental Impact Statement. U.S. Dept. of the Interior, Bureau of Land Management. DOI-BLM-AK-0000-2018-0004-EIS Anchorage, AK. August. 393 pp + appendices.

The Willow Development is located in NPR-A. The project includes infrastructure for drill sites, roads, pipelines, and ancillary facilities for oil and gas development and production. While all of the facilities are onshore the EIS considered an analysis area for marine mammals within 1.6 m of onshore construction and operation activities and within 2.4 km of offshore screeding, and vessel traffic construction This area represents the maximum distance that underwater or airborne noise or vibration could affect marine mammals and their habitats. The majority of the impacts to ringed, spotted, and bearded seals, and polar bears would be from marine or onshore construction or operations. Whales, walrus, Steller sea lions and Northern sea otters would be impacted by activities in the barge transit route. Table 3.13.2 summarizes lease stipulations and best practices to mitigate impacts to marine mammals and is useful to BOEM. Measures noted in the table are not different from similar analyses and include: preparing and implementing a Bear Interaction Plan, surveying for bear dens and seal lairs before beginning work in coastal areas between oct 30 and April 15, limiting airborne sound levels, providing PSOs for on ice work after March 1st. The Marine Mammals Technical Appendix (E13) provides good descriptions of all species potentially affected and lists additional mitigation measures for vessel traffic and screeding at Okiktok Dock.

Bin 4 – Mitigation and Monitoring

MacLean, S.A. (1998). Marine Mammal Monitoring of an On-Ice Seismic Program in the Eastern Alaskan Beaufort Sea, April1998. BP Exploration (Alaska) Inc. 17 pp.
In 1998, BPXA conducted a Vibroseis operation both onshore and offshore near Bullen Point in the eastern Beaufort Sea between January and mid-April. This monitoring report is one of the first to document marine mammal observations as required by the MMPA Letter of Authorization issued by NMFS for incidental harassment of ringed seals. The objectives of the monitoring program were to: locate and record seal breathing holes or lairs; observe and record seals hauled out on ice; assess the number of seals potentially harasses during seismic; and record effects of Vibroseis and resulting noise on marine mammals. Observations were made by vehicle. One seal mortality was recorded when a Caterpillar clearing a road destroyed a seal lair. The report states that the observation methods may have been insufficient to detect all seal lairs. This report is brief and while it does not provide conclusive information on the effects of seismic on seal behavior, it sets the foundation for comparing results from other marine mammal monitoring programs during oil and gas activities.

Richardson, W.J. and Williams, M.T. (2000). Monitoring of ringed seals during construction of ice roads for BP's Northstar oil development, Alaskan Beaufort Sea, 1999. BP Exploration (Alaska) Inc. 153 pp.
In 1999 and 2000, as part of the requirements of an interim IHA, BP conducted on-ice monitoring for ringed seals and polar bears as well as fixed-wing aerial surveys for ringed seals in the vicinity of ice roads planned as part of initial construction activities for BPs Northstar Development. For on-ice monitoring, this report describes the methods and results for: locating and recording ringed seal breathing holes and lairs; identifying potential ringed seal habitat and areas requiring monitoring for seals; minimizing harassment of marine mammals due to construction of ice roads; and identifying areas for Forward Looking Infrared (FLIR) to identify potential polar bear denning habitat and warning construction crew of polar bear presence. Fixed-wing aerial surveys for seals conducted for both the Northstar and Liberty sites in 1999 are also summarized including an assessment of potential factors influencing ringed seal density in the study area such as ice conditions, water depth, date, weather, air temperature, etc. in addition to construction-related activities. Helicopter surveys for ringed seal breathing holes were conducted in 1999 and are also summarized. Appendices C-E provide raw data on the number of marine mammals sighted during specific conditions such as cloud cover, air temperature, water depth, date, sea ice conditions, and distance from land-fast ice.

Wursig, B., Greene, C.R., Jr. and Jefferson, T.A. (2000). Development of an air bubble curtain to reduce underwater noise of percussive piling. *Marine Environmental Research*, 49:79-93.
The effectiveness of using a bubble curtain to reduce sound transmission in the open ocean was tested over two days during a pile-driving project off western Hong Kong. A single pile driver consisted of a 6 metric tonne diesel hammer with blow rates between 0.95 and 1.35 per second. The bubble curtain anchored to the sea bottom consisted of a 160-m circumference rubber hose with 3-mm diameter holes spaced ever 0.3-0.4 m. The hose was placed in a circle approximately 25 m outside the piling barge. Three boats recorded sound from a hydrophone at a depth of 6 m in water depths of 8 m. Day one results showed a reduction in noise from the bubble curtain at three distances (250 m, 500 m and 1,000 m). Overall, a reduction of 3-5 dB was noted in the overall broadband sound level. In one-octave frequency bands, bubbles reduced sound 8-10 dB in the 400-800 Hz bands and 15-20 dB in 1.6-6.4-kilohetz (kHz) bands. Observations of dolphins by two observers from a shore-based station at 56.5 m elevation above mean water. Dolphins were observed within 300-500 m of the site before, during and after pile driving. No significant difference in average degree of directional change or surfacing of dolphins was noted however average swim speed was over twice as high during active piling. While bubble curtains may not be effective for mitigation in all areas of Alaska, this paper provides some evidence of noise reduction

using this type of mitigation measure. Notably this experiment was conducted in Hong Kong which may have limited applicability to Alaska.

Caltrans (2001). San Francisco – Oakland Bay Bridge East Span Seismic Safety Project, Pile Installation Demonstration Project: Marine Mammal Impact Assessment. PIDP 04-ALA-80-0.0/0.5, August 2001. 49 pp.

In 2000, the effectiveness of sound attenuation devices during pile driving on a pier in central San Francisco Bay were evaluated through marine mammal monitoring and noise measurements. Steel piles were 8 feet in diameter. Pile 1 had no attenuation device while Pile 2 used a bubble curtain and Pile 3 a fabric barrier system with aerating mechanism. Marine mammal monitoring was conducted during two days of pile driving within a 500m safety zone and a harbor seal haulout on Yerba Buena Island a semi-protected cove approximately 1,500 m from the pile driving site. Two observers were located at the haulout, three observers were on vessels and two from the pier. Monitoring was conducted three days prior to and one day after construction was complete and all equipment removed. Sixty-eight individual pinnipeds were sighted during construction, including 55 harbor seals and 13 sea lions. Both species were observed before pile driving but, with the exception of two sea lions, only harbor seals were seen post-driving. While differences are noted between the behavioral responses of species observed, the paper acknowledges that the limited number of observations make it difficult to draw conclusions about the impacts of noise on marine mammals or effectiveness of sound attenuation devices in reducing noise impacts.

Richardson, W.J. and Williams, M.T. (2001). Monitoring of industrial sounds, seals, and whale calls during construction of BP's Northstar Oil Development, Alaskan Beaufort Sea, 2000. [Draft]. BP Exploration (Alaska) Inc. April 2001. 316 pp.

This 10-chapter document is one of the early versions in series of comprehensive reports prepared by BP to fulfill MMPA requirements for Northstar monitoring before, during and after construction as well as ongoing operations. This report consists of an introduction, two chapters describing construction activities during the ice-covered and open-water seasons, six chapters describing specific monitoring tasks and a concluding chapter estimating the numbers of seals and whales potentially affected. The detailed information on construction activities remains one of the most useful sources for understanding how the offshore island was built and importantly, the sound measurements recorded during the activities. Ringed seal and seal lair/breathing hole observations summarized in this report are useful for comparison of other projects that have occurred since Northstar construction in 1999-2000. This report includes a unique chapter to future reports by including a summary of island-based visual monitoring of seals during spring break-up during pile driving of 24- and 42-inch conductor pipes. Acoustic monitoring during bowhead whale migration in 2000 is provided in Chapter 9, including a discussion of potential solutions to problems encountered during monitoring. Discussions are also provided on potential effects of BP's activities on seals and whales and their availability to subsistence hunters.

Richardson, W.J. and Lawson, J.W. (2002). Marine Mammal Monitoring of WesternGeco's Open-Water Seismic Program in the Alaskan Beaufort Sea, 2001. BP Exploration (Alaska) Inc. TA2564-4, April 2002. 50 pp.

An open-water Ocean Bottom Cable (OBC) seismic program was conducted in the central Alaskan Beaufort Sea in August 2001 as a continuation of programs conducted in during open water in 1998, 1999 and 2000. The monitoring program documented by this report was required by the MMPA IHA issued by NMFS and incorporated input from subsistence hunters and other stakeholders. Two airgun arrays (12-airgun array and 8-airgun array) alternately surveyed nearshore waters about 48 km west of Prudhoe Bay around Simpson Lagoon. Vessel-based observers recorded 38 seal sightings over 336.2 observation

hours. Seals were categorized as “swimming”, “looking”, or “diving”. The report also summarizes data collected during previous seismic surveys 1996 – 2000, noting that in most years, seals tended to be observed at greater distances from source vessels during airgun operations but the difference was not significant. No whales were observed during the 2001 operations. The report states if any whales were in the area but unobserved, the numbers were undoubtedly low. The comparison of datasets during seismic surveys 1996 – 2001 are a useful component of this report.

Richardson, W.J. and Williams, M.T. (2002). Monitoring of industrial sounds, seals, and whale calls during construction of BP’s Northstar Oil Development, Alaskan Beaufort Sea, 2001. BP Exploration Inc. 337 pp.

This nine chapter document continues the reporting effort for Northstar construction initially summarized for 2000 in Richardson and Williams 2001. During this period, three ice roads were constructed (November 2000 - March 2001), ice cutting and gravel placement along the pipeline alignment was completed, construction of facilities on the island occurred and five wells were drilled (December 2000 - June 2001). This report follows the organization of the 2001 report including an introduction, two chapters describing construction activities during the ice-covered and open-water seasons, chapters describing specific monitoring tasks and conclusions on the numbers of seals and whales potentially affected. Based on ringed seal observations, authors suggest that “any negative effects to seals may have been minor and highly localized”. Vessel-based acoustic recordings are reported for construction activities. Results of aerial surveys for seals around Northstar and Liberty are summarized in Chapter 5. Chapter 8 discusses the analysis of potential bowhead whale displacement during activities and acknowledges the variability from year to year due to ice conditions and other environmental factors. The bowhead subsistence hunt was reported as difficult partly because of weather and ice but whales were also described as “skittish”. If any displacement effect occurred, the report concludes it was attributable if not entirely to sound from vessels rather than the island itself.

Moulton, V.D., Richardson, W.J., Williams, M.T. and Blackwell, S.B. (2003). Ringed seal densities and noise near an icebound artificial island with construction and drilling. *Acoustics Research Letters Online*, 4:112-117.

The potential effects of Northstar construction and drilling operations on the abundance and distribution of ringed seals on landfast ice were evaluated based on aerial surveys in the springs of 1997 – 1999 (preconstruction) and again 2000 – 2001 (construction and drilling). While underwater sounds, in-air sounds, and ice borne vibrations from Northstar were above background levels to distances of 1–5, 0.5–4, and 1–4 km, respectively, seal densities close to Northstar in 2000 and 2001 were not reduced relative to farther away or when compared to the 1997-1999 monitoring period. This report is succinct and includes nice graphics demonstrating the results including a map and charts. It also acknowledges the importance of accounting for “natural” factors that can affect ringed seal distribution including but not limited to variability in ice, survey date, and temperature, etc.

Richardson, W.J. and Williams, M.T. (2003). Monitoring of industrial sounds, seals, and bowhead whales near BP’s Northstar Oil Development, Alaskan Beaufort Sea, 1999–2002. BP Exploration (Alaska) Inc. December 2003. 343 pp.

As a continuation of the 2001 and 2002 reports by Richardson and Williams, this document begins to compile results of monitoring efforts since 1999. This report provides a useful table that lists seven different monitoring tasks and the years they were undertaken 1999-2002 including three chapters describing monitoring during ice-covered seasons and five chapters on monitoring during open water. Sound recordings report levels, characteristics, and range-dependence of sounds and vibrations produced by Northstar-related industrial activities when Northstar is surrounded by shore-fast ice during

winter. Drilling sounds had a maximum of 124 dB re 1µPa 1km from the drill rig. Repeated measurements allowed for computation of propagation loss. A comparison of recorded sounds to seal audiograms showed sounds were likely audible out to about 1.5 km in water and 5km in air. Fixed-wind seal surveys in 2002 covered 3,618 km^2 of landfast ice habitat. Seal density was reported as 0.72 seals/km^2. Sightings were most common in 5-15 m of landfast ice. Seal densities near Northstar during spring were not significantly affected by industrial activities in 2000, 2001 and 2002. A total of 10,587 bowhead whale calls were recorded in ~24 days in September 2002 and were detected by two or more DASARs, thus providing the intersecting bearings. The report acknowledges that data quality from the Directional Autonomous Seafloor Acoustic Recorders (DASARs) was better in 2002 than in 2001. The results in this report are helpful in beginning to build an understanding of potential effects on marine mammals from Northstar over time.

Blackwell, S.B., Greene, C.R., Jr. and Richardson, W.J. (2004). Drilling and operational sounds from an oil production island in the ice-covered Beaufort Sea. *Journal of the Acoustical Society of America*, 116:3199-3211.

To document potential underwater and in-air noise from drilling and oil production at Northstar Island during winter when the island is surrounded by shorefast ice, sounds were recorded in early March 2001 as well as in February and March 2002. Sensors including a hydrophone, microphone and 3-axis geophone, obtained data north and northwest of the island where water depth increases in those directions out from the island. Drilling and production activities during field recordings are documented in this paper and comparisons are made against periods of no activity. Therefore, underwater background noise levels were recorded (77 dB re: 1 µPa in 2001 and 76 dB in 2002 (broadband, 10 – 10 000 Hz band) and provide information on ambient sound levels in this area. Drilling produced a maximum broadband level underwater of 124 dB re: 1 µPa. Background ambient sound levels were reached at 9.4km during drilling and 3-4km without drilling while in-air and ice, background levels were reached at 5-10 km and 2-10 km from Northstar, respectively. A discussion is included on the audibility of sounds to seals however, more is currently known about seal hearing since this publication. Detectability of vibrations through ice by seals are not discussed due to lack of publications on the topic. The paper also introduces the concept that snow may dampen the detectability of industrial noises to seals that are in lairs (~40dB per meter of snow thickness).

Blackwell, S.B., Lawson, J.W. and Williams, M.T. (2004). Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving and construction sounds at an oil production island. *Journal of the Acoustical Society of America*, 115:2346-2357.

In June and July 2000, reactions of ringed seals (in water or on ice) were documented during impact pipe-driving at Northstar. The study was aimed at addressing concern that impact pipe driving could cause auditory harm to nearby seals. Sounds underwater and in air were recorded at distances 63-3,000 m from the source to determine unweighted peak and rms SPLs and sound-exposure levels (SELs). At 63 m, mean underwater levels reached 157 and 151 dB re: 1 µPa and 145 dB re: 1 µPa 2 · s, respectively. In air, values were 112 and 96 dB re: 20 µPa and 90 dB re: (20 µPa) 2 · s, respectively. Underwater SPLs were <180 dB re: 1 µPa at all distances. Twenty-three seals observed exhibited little or no reaction to any industrial noise except approaching Bell 212 helicopters. Ringed seals swam as close as 46 m from the pipe-driving operation leading authors to conclude seals are tolerant of or habituated to these sounds. The paper briefly compares noise data to published papers on impact-pipe driving in similar locations. Table 1 provides a summary of seal behavior observations and the discussion includes important details for context including observer locations, eye height, weather and number of observation hours. Table 2 provides even more specific details regarding seal behavior observations and separates specific human

activities occurring simultaneously. The paper presents a robust combination of noise data as well as marine mammal behavioral data and draws evidence-based conclusions regarding potential effects.

Richardson, W.J. and Williams, M.T. (2004). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2003. [Annual and Comprehensive Report, December 2004.]. BP Exploration (Alaska) Inc. LGL Report TA4002, 297 pp.
This report is a continuation of the multi-year monitoring effort at Northstar as documented by Richardson and Williams (2001, 2002 and 2003) and represents not only the annual report for 2003 but the comprehensive report for the period 1999 - 2004. Following previous reports, there are 10 chapters that summarize data from the 2001 – 2003 seasons including ice-covered and open water conditions. Seven monitoring tasks are listed in a helpful chart to show which years they have been undertaken (1999 – 2003) such as fixed-wing aerial surveys of ringed seals or winter acoustic measurements. As of approximately 2002, Northstar construction was complete and monitoring summarized in this report focused on operations (i.e., oil production, ice road construction and personnel transfers by various transport modes). Information on the potential effects of the project and ongoing operations on overwintering ringed seals is a key component of the report including a comparison of methods to locate seals or seal lairs (i.e., aerial surveys or trained dogs). Results follow the same conclusions as previous studies that densities of ringed seals occupying landfast ice within a few kilometers of Northstar were not significantly affected by initial construction or ongoing operations and that some seals tolerate periodic exposure to sounds and vibrations from Northstar activities. Vessels were again reported as contributing the most significant underwater sounds, more so than drilling. This is also one of the first reports to include information on hovercraft noise. A total of 45,622 bowhead calls were recorded in 30 days compared to 10,587 calls in 20 days in 2002. Finally, the report again addresses the question of whether Northstar activities deflects bowhead whales from shore. Data from 2001 provided the only evidence of a slight offshore displacement whereas results from 2003 and 2002 were inconclusive.

Miller, G.W., Moulton, V., Davis, R.A., Holst, M., Millman, P., Macgillivray, A. and Hannay, D. (2005). Monitoring seismic effects on marine mammals-southeastern Beaufort Sea, 2001-2002. *Offshore Oil and Gas Environmental Effects Monitoring: Approaches and Technologies*, 511-542.
Chapter in book. Not annotated

Richardson, W.J. and Williams, M.T. (2005). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2004: Summary Report; Appendix H in Richardson 2008. BP Exploration (Alaska) Inc. LGL Report TA4143, 77 pp.
This report documents the 2004 monitoring program at Northstar, summarizing the findings on the acoustic environment, bowhead whale migration and ringed seal presence and behavior, an program that began in 1999. The 2004 report focuses on three key topics including a summary of BP's activities in late 2003 – early 2004, seal sightings (266 total), acoustic monitoring of bowheads from 10 DASARs over a 31-day period (66,232 bowhead calls recorded), and details about the 2004 bowhead subsistence hunt by Nuiqsut hunters (four whales struck and three landed). Data from 2004 are compared to previous years to assess whether bowhead whales are deflected from their migration due to Northstar sounds. In previous years, these reports also included monitoring results on ice seal structures, fixed-wing aerial surveys of seals, and an estimate of the numbers of seals and whales affected by Northstar activities which are not included in this report for 2004. The results of a sensitivity analysis of bowhead call data are presented and discussed in terms of how accurate bowhead localization is/has been over the course of the 5-year monitoring program (1999 – 2004). The results from this report were presented to the Northstar Scientific Advisory Committee organized by the North Slope Borough, as agreed, regarding the potential for Northstar activities to affect the subsistence hunt of bowhead whales. The detail in this

report supersedes the required MMPA 90-day report for 2004 as it provides a more detailed description of the monitoring results.

Blackwell, S.B. and Greene, C.R., Jr. (2006). Sounds from an oil production island in the Beaufort Sea in summer: characteristics and contribution of vessels. *J Acoust Soc Am*, 119:182-196.
Based on data collected during the open water seasons 2000 – 2003, the report concludes that vessel noise is the main contributor of underwater sound, with boat-based recordings at distances out to 37 km from Northstar, while broadband island sounds reached background levels of 2-4 km. The stated objectives include assessing potential effects of noise from Northstar on bowhead whales and ringed seals during construction and production activities during open water in 2000, 2001, 2002 and 2003. Specifically, the study aimed at differentiating sounds from the island itself compared with support vessels around the island. Results showed that background ambient sound levels were not reached unless vessels were removed from the analysis. The report includes sections describing ambient sound measurements and airborne sounds, providing important context for the results. These results track with previous studies from Northstar, showing evidence that operational (i.e., drilling and production) sounds do not contribute significantly to underwater noise in the area

Richardson, W.J. (2006). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2005: Annual Summary Report. BP Exploration (Alaska) Inc. LGL Report TA4209 (rev.), August 25, 2006. 86 pp.
This is the seventh report summarizing the results of monitoring sounds at Northstar as part of the multi-year monitoring effort at since 1999. However, following the report content for 2003-2004, this report focuses on three key topics including a description of BP's activities 2004 – 2005, seal sighting data, acoustic monitoring of bowhead whales during the 2005 migration and a summary of the 2005 subsistence whaling season at Cross Island. For the second year, this report does not include chapters on ice seal structures, fixed-wing aerial surveys of seals, and an estimate of the numbers of seals and whales affected by Northstar activities. The near-island sound monitoring in 2005 was identical to that 2001-2004, however, the array of DASARs offshore was changed from 10 or 11 recorders at 10 locations to 4 recorders at 3 locations. Additionally, unusually high wind speeds and sea states than in previous years caused some of the DASARs to move from their deployed locations. As a result, except for with one DASAR, the calibrations were not sufficiently reliable for localizing bowhead calls. This report includes a good description of the issues with calibration and how that may have affected data collection. Baseline conditions under the high wind and sea state conditions are also discussed relative to underwater sound data collected.

Blackwell, S., Richardson, W.J., Greene Jr., C.R. and Streever, B. (2007). Bowhead whale (*Balaena mysticetus*) migration and calling behaviour in the Alaskan Beaufort Sea, autumn 2001– 04: an acoustic localization study. *Arctic*, 60:255-270.
This peer-reviewed paper presents the consolidated results of acoustic localization data for migrating bowhead whales in the Beaufort Sea as part of the Northstar monitoring program 2001-2004; data which were previously presented separately in the respective annual reports. The analytical process is well described beginning with bowhead whale call "classification", discussion of diel call patterns, call numbers and locations. In this sense, this paper provides a more in-depth analysis of bowhead calls than is presented in each annual report. In addition, a comparison is made between call data and MMS aerial survey data for the same years. Generally, except for 2003, data from aerial surveys mirrored the acoustic monitoring dataset. Authors concluded that acoustic recorders (i.e., DASARs) allow for collection of high-resolution, continuous information independent of time-of-day and, for the most part, weather. Year-to-year variations in the location of the migration corridor are reported. The paper concludes by

providing recommendations for future work including additional collection of call recordings not only at Northstar but other locations which may be helpful in comparing call behavior during different seasonal activities by the whales such as feeding, mating and migrating. The paper also acknowledges that data collection of bowhead whale calls may also help identify changes due to warming Arctic climate.

Gailey, G., Würsig, B. and McDonald, T.L. (2007). Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia. *Environmental Monitoring and Assessment*, 134:75-91.
Citation only. Out of geographic scope.

Greene, C.R., Jr., Blackwell, S.B. and McLennan, M.W. (2007). Sounds and vibrations in the frozen Beaufort Sea during gravel island construction. *Journal of the Acoustical Society of America*, 123:687-695.
Underwater and airborne sounds and ice-borne vibrations were recorded from sea-ice near an artificial gravel island during its initial construction in the Beaufort Sea near Prudhoe Bay, Alaska. Such measurements are needed for characterizing the properties of island construction sounds to assess their possible impacts on wildlife. Recordings were made in February-May 2000 when BP Exploration (Alaska) began constructing Northstar Island about 5 km offshore, at 12 m depth. Activities recorded included ice augering, pumping sea water to flood the ice and build an ice road, a bulldozer plowing snow, a Ditchwitch cutting ice, trucks hauling gravel over an ice road to the island site, a backhoe trenching the sea bottom for a pipeline, and both vibratory and impact sheet pile driving. For all but one sound source (underwater measurements of pumping) the strongest one-third octave band was under 300 Hz. Vibratory and impact pile driving created the strongest sounds. Received levels of sound and vibration, as measured in the strongest one-third octave band for different construction activities, reached median background levels <7.5 km away for underwater sounds, <3 km away for airborne sounds, and <10 km away for in-ice vibrations.

Illinworth & Rodkin (2007). Compendium of Pile Driving Sound Data. The California Department of Transportation. Sacramento, CA. September 27, 2007. 129 pp.
This compendium has been referenced frequently by applicants seeking MMPA authorizations as well as agencies (NMFS and USFWS) issuing them. The authors readily acknowledge that underwater noise during pile driving is directly related to the size of the pile and the size of the hammer. Table I.2-3 is particularly helpful as it lists the projects compiled for reference in the report, including useful information such as pile type, pile size, project location, water depth, distances to measured sounds and comments specific to each unique project. Each project is discussed in detail, complete with photographs that provide visual context. While this is an older source of information, it contains useful reference data.

Johnson, S.R., Richardson, W.J., Yazvenko, S.B., Blokhin, S.A., Gailey, G., Jenkerson, M.R., Meier, S.K., Melton, H.R., Newcomer, M.W., Perlov, A.S., Rutenko, S.A., Würsig, B., Martin, C.R. and Egging, D.E. (2007). A western gray whale mitigation and monitoring program for a 3-D seismic survey, Sakhalin Island, Russia. *Environmental Monitoring and Assessment*, 134:1-19.
Citation only. Out of geographic scope.

MacGillivray, A., Ziegler, E. and Laughlin, J. (2007). Underwater Acoustic Measurements from Washington State Ferries 2006 Mukilteo Ferry Terminal Test Pile Project. JASCO Research, Ltd for Washington State Ferries and Washington State Department of Transportation. March 2007. 27 pp.
This report presents results from acoustic recordings during pile driving of 36-inch steel piles, 36-inch concrete piles, and a 24-inch concrete pile as part of a ferry terminal construction project in Washington

state. While the project is not oil and gas or within the geographic area of interest, the results are frequently referenced in NMFS authorizations. In addition to acoustic measurements of pile driving, three experimental attenuation systems to mitigate effects of underwater noise were also evaluated including a bubble curtain, foam walled steel noise attenuation pile (i.e., Temporary Noise Attenuation Pile or TNAP), and double-walled steel TNAP. Empirically measured source levels were 226.6 dB re Pa m and 218.8 dB re Pa m, respectively, for peak and rms levels during pile driving of 36-inch piles. Daytime ambient noise in the channel was measured at 123.7 dB re Pa (50th percentile average continuous sound level [L_{eq}). the range to background for the unmitigated steel piles, mitigated steel piles and concrete piles were estimated to be 26.5 km, 13.9 km and 9.1 km, respectively.

Marine Mammal Commission (2007). Marine Mammals and Noise, A Sound Approach to Research And Management: A Report to Congress from the Marine Mammal Commission. A Report to Congress from the Marine Mammal Commission. March 2007. 370 pp.

In 2007, MMC published this comprehensive synthesis on the issue of underwater sound and marine mammals, summarizing the history of research and regulatory actions related to underwater sound, the current state of knowledge, challenges (three identified) in gaining a better understanding of the issue, and specific recommendations (seven total) for developing a "national approach to the sound issue". Expanding research and a more "effective, comprehensive management approach to ensure marine mammal conservation" while minimizing constraints on noise-producing activities were identified by the MMC as the cornerstone of a future "national approach". The report discusses the regulation of sound in the marine environment and concerns regarding the process under the MMPA for NMFS to authorize incidental take of marine mammals due to anthropogenic sound. The report includes background on the nature of sound from specific sources ranging from sonar to seismic to vessels. High-level summaries are provided on marine mammal uses of sound and research progress on the overall topic. Three appendices include the following background reports: 1) Advisory Committee on Acoustic Impacts on Marine Mammals; 2) Report from an International Workshop: Policy on Sound and Marine Mammals (2004); and 3) briefings on the impacts of anthropogenic sound on beaked whales. As one of the first comprehensive reports published in the U.S. on anthropogenic sound in the ocean, it provides helpful information not only from the scientific perspective but regulations and policy implementation as well.

MMS (2007). Outer Continental Shelf Oil & Gas Leasing Program: Draft EIS Appendix C Mitigation Measures. 2007. 8 pp.

This appendix includes mitigation measures for all regions within the OCS, not just Alaska. Notably, in the Alaska section, the site-specific bowhead whale monitoring program is listed as applicable to exploratory drilling activities and seismic. While not region-specific, based on mention of the Alaska AEWC and NSB, it is obvious the reference of the monitoring program is intended for activities in the Beaufort Sea. In addition, conflict avoidance (referred to as a "mechanism") with bowhead whale subsistence whaling is described and again, while not region-specific, is intended for oil and gas activities in the Beaufort Sea. Finally, a section entitled "Information to Lessee" lists specific mitigation measures, some of which are broad and apply across the Alaska OCS, while others are specific to bowheads and the subsistence hunt in the Beaufort Sea. This document is superseded by mitigation measures required in more recent Environmental Impact Statements (i.e., since 2007) as well as final rules and associated LOAs under the MMPA. For this reason, while interesting from a history perspective, may be outdated and should not be used as a source for designing mitigation measures.

Patterson, H., Blackwell, S.B., Haley, B., Hunter, A., Jankowski, M., Rodrigues, R., Ireland, D. and Funk, D.W. (2007). Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–September 2006: 90-day report. Shell Offshore, Inc. LGL Report P891-1, January 2007. 150 pp.

This is the first monitoring report (a requirement of the NMFS-issued IHA), to include activities in both the Chukchi and Beaufort seas. While exploration activities previously occurred in the Chukchi, since renewed interest in the Chukchi Sea beginning around 2006. A concise 7-page Executive Summary provides quick reference for report contents. The Introduction includes a brief overview of species that may be encountered, including those listed under the ESA, and an overview of the IHA requirements including mitigation and monitoring measures. A detailed description of seismic activities includes sizes and output from airguns, dates and duration of surveys, and areas surveyed. Acoustic modeling used to prepare the IHA application is described accompanied by graphics and tables summarizing modeling results. Acoustic measurements collected in the field between July and October 2006 during 3D seismic and shallow-hazard surveys are summarized including detailed methods, analysis and results. Empirical and modeled radii to specific received SELs and SPLs)are compared in Table 4.7. The effects of M-weighting (i.e., accounting for marine mammal hearing sensitivity) are evaluated (see Section 4). Since most shut-downs during production are due to the presence of ringed seals, using M-weighted data could decrease the number of shut-downs during production if the M-weighted 190 dB ratios were used as the safety radius. Vessel sound measurements reported received levels at 500 m distance were 125–132 dB re 1 µPa for the seismic ship *Gilavar*, and 127–135 dB for the chase vessel *Jim Kilabuk*, depending on aspect (bow, stern, broadside). Both of these ships were recorded in the Chukchi Sea. In the Beaufort Sea, the received broadband level for the tug *Henry Christoffersen* at 500 m distance was ~122 dB re 1 µPa. This is a complex report that is helpful for comparing modeled estimates to field measurements in both the Chukchi and Beaufort seas.

Richardson, W.J. (2007). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2006: Annual Summary Report. LGL Report TA4441, March 30, 2007. 84 pp.

This is the eighth report summarizing the results of monitoring sounds at Northstar as part of the multi-year monitoring effort at since 1999. Three chapters comprise this report including a summary of human activities at Northstar, acoustic monitoring of the autumn 2006 bowhead whale migration and the 2006 whaling season at Cross Island. Tables 1.7 – 1.9 provide a record of material spilled and cleaned up on site, and a summary of helicopter, hovercraft, and other vessel trips during open water season June through October 2006. The only impact pile driving during this period was within the island perimeter which has not been shown to create underwater noise greater than 190 dB re 1 µPa rms in the water around the island. More seals were observed in 2005 than 2006 and no seals were observed from Northstar after July 15th during either year. The authors again report lack of behavioral response by seals to Northstar activities except for one observed seal raising its head in 2005. Annex 1.1 includes an internal letter to Northstar operations discouraging vessel traffic in late August in order to minimize potential effects on bowhead whales such as deflection offshore due to underwater sounds. A comparison of bowhead whale bearings to previous monitoring years showed a distribution similar to previous years, except 2005. Low call counts (1,509 total) were reported over 18 days in 2006 which may have been related to the heavy ice near shore that year. Several tables and figures in Chapter 2 present the results of acoustic monitoring, accompanied by brief descriptions of the activities that occurred during the monitoring period. Traditional knowledge reported by whalers during the hunting season is also summarized and concludes that whalers reported more bowheads offshore in 2006 likely due to the heavy ice nearshore.

URS (2007). Final Underwater Noise Report: Port of Anchorage Marine Terminal Development Project Underwater Noise Survey, Test Pile Driving Program, Anchorage Alaska. United States Department of Transportation; Port of Anchorage; Integrated Concepts & Research Corporation. December 2007. 60 pp.

As a requirement of the MMPA authorization and U.S. Army Corps of Engineers permit (POA-2003-502-N) as well as a check on the agreed upon shutdown zone, underwater acoustic measurements were recorded during a test pile program at the Port of Anchorage in October 2007. Acoustic measurements were recorded of ambient conditions, dredging operations, tug and barge sounds and during impact and vibratory driving of 26-inch steel H Piles and sheet pile. The report notes that Knik Arm ambient noise is typically 120 dB or higher, therefore, discerning vibratory sounds difficult. Vibratory sounds ranged from 168 dB re 1 µPa at 10 m to less than 120 dB re 1 µPa at 600 m with the greatest peak at 14m of 179 dB re 1 µPa. Received peak SPLs during impact pile driving ranged from 173 dB re 1 µPa at 300 m to 194 dB re 1 µPa at 19 m. Received SPLs ranged from 160 dB re 1 µPa at 300 m to 177 dB re 1 µPa at 19 m. Based on acoustic measurements, the report concludes the NMFS Level A shutdown zone was appropriate but suggests the Level B harassment zone was overly conservative (i.e., too large). The report includes helpful details including definitions, the depth of each recorder, and clear tables and figures showing results.

Aerts, L., Blees, M., Blackwell, S., Greene, C., Kim, K., Hannay, D. and Austin, M. (2008). Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report. LGL Rep. P1011-1, 2008. 199 pp.

BPXA conducted a 3-D OBC seismic survey in Foggy Island Bay during July and August 2008. Sighting data, estimates of the numbers of marine mammals potentially exposed to seismic pulses exceeding 160 dB and observations regarding potential behavioral reactions to seismic sounds are summarized. Airgun arrays ranged from 220 in^3 to 880 in^3, with a smaller 70 in^3 airgun used as a mitigation source. Eight marine mammal species were sighted during seismic surveys and thirteen species were also sighted during transit from Anchorage to West Dock. Three shutdowns and one power down for a 190 dB safety zone were implemented for marine mammals (two shutdowns were for carcasses observed while airguns were operating). Table 3.5 compares recommended, modeled and empirically determined seismic safety radii, with empirical distances generally smaller. Section 3.4 presents results for three acoustic recorders located inside, between, and outside the barrier islands to compare how sound may or may not be buffered by the islands. Sections 4 and 5 describe mitigation measures implemented and the results of monitoring and monitoring, respectively, including the number of marine mammals potentially exposed during seismic. Figure 5.4 provides a helpful map showing locations of marine mammal sightings which include the marine transit route from Anchorage.

Aerts, L.A.M. and Richardson, W.J. (2008). Monitoring of Industrial Sounds, Seals, and Bowhead Whales Near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2007: Annual Summary Report. BP Exploration (Alaska) Inc. LGL Rep. P1005b, March 2008. 79 pp.

This is the ninth report summarizing the long-term monitoring effort at the Northstar facility. Following previous reports, there are three chapters that describe: 1) BPXAs activities in 2007 and provides results for the acoustic monitoring during bowhead whale migration; 2) subsistence bowhead hunting at Cross Island; and 3) ringed seal observations proximal to Northstar. Tables provides data on vessel traffic as well as spill incidents (Chapter 1). The report states that ringed seal observations May 15 through July 15 seemed low compared to the previous three years however, Northstar staff commented that observations may not have represented typical conditions that year (2007). Nuiqsut whalers reporting "skittish" behavior of bowhead whales is summarized in Chapter 3. "Skittish" is defined as whales traveling faster, spending more time on the surface or near the ice edge, or exhibiting a more erratic course during migration. In 2007, whalers noted that bowheads were more difficult to follow. As stated in

previous annual reports, whalers do not want vessel activity east of Cross Island but tolerate vessels to the west. Northstar is located west of Cross Island. Figures 3.1 and 3.2 show whaling tracks from Cross Island by year since 2001. Annex 3.1 provides daily accounts of observations by whalers and is a good reference for traditional knowledge on these topics.

Hauser, D.D.W., Moulton, V.D., Christie, K., Lyons, C., Warner, G., O'Neill, C., Hannay, D. and Inglis, S. (2008). Marine mammal and acoustic monitoring of the Eni/PGS open-water seismic program near Thetis, Spy and Leavitt islands, Alaskan Beaufort Sea, 2008: 90-day report. Eni US Operating Co.; PGS Onshore, Inc. LGL Report P1065-1, December 27, 2008. 194 pp.

This required 90-day report summarizes the results of acoustic and marine mammal monitoring during seismic surveys for Eni's Nikaitchuq Unit seaward from Oliktok Point in August and September 2008. Data are categorized for seismic, post-seismic and non-seismic periods for comparison. Details of the seismic survey including airgun arrays (440 and 880 in^3) are described including dates airguns were operating. Both vessel-based and aerial marine mammal monitoring were conducted. The shallow water environment within the survey area affects acoustic propagation therefore, sound source verification was conducted to measure distances to regulatory thresholds using acoustic recorders at two sites including a deep site (9-14 m) seaward of the barrier islands, and a shallow site (1.5-2.5 m) shoreward of the barrier islands. Many figures and tables present results of acoustic monitoring but perhaps the most helpful section is the summary beginning on page 51. Table 4.1 presents measurements for each seismic vessel for both deep water and shallow water sites. Chapter 5 describes marine mammal monitoring and mitigation including a baseline description of each species potentially affected, repeating the information from the IHA application. Figure 5.1 shows locations of mammal observations however the maps are a little small and hard to decipher. Table 5.5 compares vessel-based sighting data for seismic, post-seismic and non-seismic monitoring periods. Problems implementing mitigation measures during seal sightings are discussed on page 86. As required, the estimated number of seals and cetaceans is summarized in Table 5.10. Chapter 7 provides this same information for aerial-based surveys. The NMFS-issued IHA is Appendix A and the USFWS LOA is Appendix B.

Moulton, V.D., Williams, M.T., Blackwell, S. and Richardson, W.J. (2008). Zone of displacement for ringed seals (*Pusa hispida*) wintering around offshore oil-industry operations in the Alaskan Beaufort Sea. BP Exploration (Alaska) Inc. 49 pp.

This paper integrates findings from three studies designed (collectively) to assess the extent to which overwintering ringed seals (*Pusa hispida*) were displaced during construction and oil production at Northstar, a man-made island in the nearshore Alaskan Beaufort Sea. The three studies were as follows: (1) Intensive, replicated aerial surveys of seals hauled out on landfast ice before and after Northstar was built. (2) On-ice searches using trained dogs to locate seal breathing holes and lairs at varying distances from Northstar and to follow the fate of these structures. (3) Acoustic measurements to determine sound and vibration levels vs. distance from Northstar sources. In winter, levels of sound and vibration in the strongest 1⁄3rd octave band often exceeded background levels out to ≥5 km underwater and in air, and ≥3 km in ice. However, Poisson regression analysis of aerial survey data (with allowance for natural covariates) showed that seal densities closer to Northstar were not significantly reduced relative to distant areas or to years prior to construction of Northstar. Dogs located many active seal structures near Northstar, some within 200 m and 100 m of the island during construction and drilling, respectively. Structure abandonment rate was unrelated to distance from Northstar facilities. The Zone of Displacement was smaller than predicted. It was more closely related to physical alteration of sea ice by industry than to exposure to detectable levels of industrial sound during winter and spring.

Richardson, W.J. (2008). Table of Contents: Monitoring of Industrial Sounds, Seals and Bowhead Whales Near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999 - 2004. BP Exploration (Alaska) Inc. 2 pp.
This Table of Contents provides a full list of the 90-day, annual and other associated monitoring reports for the Northstar Facility.

Scientific Fishery Systems Inc and Alaska Native Technologies LLC (2008). Port of Anchorage Marine Terminal Redevelopment Project: 2008 Underwater Noise Survey During Construction Pile Driving. United States Department of Transportation; Port of Anchorage; Integrated Concepts and Research Corporation. Report No. 08-06, January 2009. 231 pp.
While this is not an oil and gas project, it provides useful information with respect to pile driving in Cook Inlet. This report summarizes results from an underwater noise survey September 19 through October 9, 2008 at the Port of Anchorage in order to capture representative noise measurements during in-water construction pile driving and other Port operations.

Streever, B., Ahmad, L., Barley, B., Edwards, J., Gnecco, C., Herlugson, C. and Walls, A. (2008). Managing Marine Mammal Issues: Corporate Policy, Stakeholder Engagement, Applied Research, and Training. Society of Petroleum Engineers International. SPE 111479, April 15 - 17, 2008. 9 pp.
This paper is written from the perspective of industry and discusses marine mammal management, scientific studies, stakeholder engagement and policy at a programmatic level. Specifically, the potential effects of industry sounds (underwater and airborne) on marine mammals are discussed in terms of the challenges industry faces to address business risks (cost), biological knowledge, research, scientific uncertainty, litigation, stakeholder concerns and corporate reputation. A strategy to address these challenges (risks) is presented and can be helpful for understanding the boundaries within which industry must often operate when developing oil and gas facilities. Industry perspective on stakeholder engagement is summarized based on specific experience and therefore, may present some lessons learned.

Aerts, L.A.M. and Richardson, W.J. (2009). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2008: Annual Summary Report. BP Exploration (Alaska) Inc. LGL Rep. P1081, March 2009. 144 pp.
This is the tenth required monitoring report since 1999 for the Northstar facility and following the general structure of previous versions includes the following key topics as chapters: description of Northstar activities and ringed seal sightings November 2007 – October 2008; methods used for acoustic monitoring during autumn 2008 bowhead migration; sounds recorded at and near Northstar; acoustic localization of bowhead whales near Northstar; and a summary of the 2008 subsistence whaling season at Cross Island. This report contributed to the 2008 comprehensive report by Richardson required by 50 CFR § 216.206. Table 1.2 provides a list of peer reviewed publications based on Northstar research which is a helpful reference. As with every annual report, vessel, aircraft, and hovercraft traffic is summarized as well as spill incidents and construction activities. The report states there is no clear trend in ringed seal abundance around Northstar but data show large within-year variation indicating high variability in the data. In 2008, a new model of DASARs were deployed that were intended to have better accuracy for calibrating bearings for recordings. Analyses were performed to compare the 2008 dataset to the previous years since 2000 in addition to new analyses given the new equipment. Notably, in 2008 the density of vessel spikes was lower than in 2007 and 2006, but short-term variability in sound levels was higher than previous years. This was attributed to the presence of a new impulsive sound recorded by near-island DASARs, referred to as "pops". The source of these pops is not known but they were broadband, short in duration (~0.05 s), and with

received sound pressure levels at the near-island DASAR from 107 to 144 dB re 1 µPa (see p. 3-23). These "pops" continue to be discussed and as of 2020, the source has not yet been identified. Also in 2008, airgun pulses not from Northstar were recorded by DASAR J, the farthest from the facility (see p. 3-34). Numerous graphs and charts present survey data, with comparisons to previous years. Pages 4-10 and 4011 discuss the relationship of the bowhead migration to low (i.e., 2008) or heavy ice years which is very relevant to analyzing potential effects of oil and gas activities.

Integrated Concepts & Research Corporation (2009). Construction and Scientific Marine Mammal Monitoring Associated with the Port of Anchorage Marine Terminal Redevelopment Project. Port of Anchorage, United States Department of Transportation. October 2009. 83 pp.
To fulfill requirements of the MMPA, this report summarizes mitigation and monitoring efforts July 2008 through July 2009 for in-water construction activities at the Port of Anchorage including dredging, placement of fill, and pile driving. The IHA issued by NMFS authorized incidental Level B harassment takes of four species including Cook Inlet beluga whales (34), harbor porpoise (20), killer whales (20) and harbor seals (20). Shutdown measures included 50 m for dredging and placement of fill and 200 m for vibratory or impact pile driving. The report describes the locations of project PSOs as well as the independent marine mammal monitoring program undertaken by Alaska Pacific University to help fulfill IHA condition 5(e)(1). The IHA is attached as Appendix A. There is a comparison of pile driving hours in Section 4 for the 2008 and 2009 seasons. Section 4.2.2.1 also describes improvements that were made to the monitoring program between 2008 and 2009. While this project is not oil and gas, sighting data, pile driving data, the summary of measures implemented and lessons learned are useful given the location in Cook Inlet.

Koski, W.R., Allen, T., Ireland, D., Buck, G., Smith, P.R., Macrander, A.M., Halick, M.A., Rushing, C., Sliwa, D.J. and McDonald, T.L. (2009). Evaluation of an Unmanned Airborne System for Monitoring Marine Mammals. *Aquatic Mammals*, 35:347-357.
This peer-reviewed journal article presents analytical results to evaluate the use of an unmanned airborne system (UAS) to conduct surveys for marine mammals near Port Townsend, Washington. The use of UAS to monitor marine mammals has been proposed as an option as part of the Liberty Development Marine Mammal Monitoring Program and for this reason, the results of this paper may be useful for evaluating monitoring measures that may be used for projects in Alaska. The article provides a brief history on the use of UAS for monitoring animals and the methods used for this study including the use of "simulated" marine mammals (i.e., inflatable kayaks, etc.) and clearly describes the variables considered that can affect marine mammal detection rates, from type of UAS equipment to environmental conditions during surveys such as Beaufort sea state. Authors conclude by summarizing advantages and disadvantages of unmanned systems versus manned aircraft versus vessels, including that pinnipeds (California sea lions and harbor seals) observed from the vessel were not observed by the UAS. The article is easy to understand and interpret.

Aerts, L.A.M. and Richardson, W.J. (2010). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2009: Annual Summary Report. BP Exploration Inc. LGL Report P1132, 152 pp.
The authors in this report described BP's activities during the period 1 November 2008 through 31 October 2009, and the results of the marine mammal and acoustic monitoring studies conducted during 2009. The structure of this report was similar to that of the annual report for 2008 (Aerts and Richardson [eds.] 2009). The following methods and results were presented: 1) descriptions of BP's activities and the seal counts (Chapter 1), 2) information on the methodology for the acoustic measurements and localization of bowhead whale calls (Chapter 2), results from measurements of the

underwater sounds from Northstar and other industrial activities (Chapter 3), 4) a description of the results from the localization of bowhead whale calls (Chapter4), and 5) a summary of the 2009 whaling season at Cross Island, consistent with the descriptions provided in the annual reports of 2005, 2006, 2007 and 2008 (Galginaitis 2006, 2007, 2008, 2009). The authors noted that since 2005, observations by subsistence whale hunters at Cross Island have been integrated into the Northstar monitoring study, following a recommendation from the NSB's Scientific Advisory Committee. It was further noted that this report satisfies annual reporting provisions of the existing Letter of Authorization issued by NMFS for incidental "taking" of whales and seals by Northstar activities, as of 2009. This report also addresses BP's company goal of implementing studies intended to understand and minimize the environmental effects of BP operations on the marine environment. Table 1.2 provided a list of publications based on the Northstar marine and acoustics studies program from 1999 through 2009. Thirteen publications were included, while a number of manuscripts in preparation were also listed. In the last chapter, the authors noted the following based on interviews with the whalers – "the 2009 Cross Island hunt was challenging; only three of Nuiqsut's four strikes were used, and only two bowheads were landed. Although whalers were able to scout for whales on most days, overall sea-state and weather conditions often made it difficult to reliably observe whales and relatively few whales were seen. The whalers thought that the whales they did see were behaving strangely. "

Beland, J. and Ireland, D. (2010). Marine Mammal Monitoring and Mitigation During a Marine Geophysical Survey in the Arctic Ocean, August - September 2010: 90-Day Report. LGL Rep. P1123-1, December 2010. 55 pp.

The USGS conducted a marine geophysical survey in the Arctic Ocean north of Alaska in cooperation with the Geological Survey of Canada (GSC) from August to early September 2010. A mitigation program was conducted to avoid or minimize potential effects on marine mammals and to ensure compliance with the provisions of the IHA. PSOs were employed onboard the seismic vessel to detect marine mammals within or about to enter the designated safety radii around the active airgun array, and in to initiate an immediate power down or shut down if necessary. During seismic survey operations in the U.S. Exclusive Economic Zone (EEZ,) eleven individual marine mammals in nine groups were observed by vessel-based PSOs. Eight of the sightings (nine individuals) were of ringed seals, and one sighting (two individuals) was of a polar bear. No power downs or shut-downs of the airguns were necessary. The number of marine mammals visually detected by PSOs likely underestimated the actual numbers that were present. Alternative estimates of the number of marine mammals potentially exposed to various sound levels were made based on densities calculated from earlier marine mammal surveys in and near the Arctic Ocean and the actual amount of seismic activity that occurred during the 2010 survey. Based on average (best) density estimates calculated from previous surveys and the actual amount of seismic activity conducted in the U.S. EEZ, the authors estimated that ~189 individual cetaceans and ~901 individual seals may have been exposed to seismic sounds ≥160 dB re 1 µPa (rms) during the survey. Less than one polar bear is likely to have been exposed to sound levels ≥160 rms. PSO survey effort was also broken down into icebreaking and non-icebreaking periods. PSOs aboard the Healy recorded an additional 81 marine mammal sightings of 89 individuals when it was outside U.S. waters or not in close proximity to the seismic work. Based on available data on marine mammal densities in the Arctic Ocean and the area ensonified, the authors estimated that between ~303 and ~1137 individual marine mammals may have been exposed to icebreaking sounds ≥120 dB re 1 µPa (rms) during the survey.

Funk, D.W., Ireland, D.S., Rodrigues, R. and Koski, W.R. (2010). Joint Monitoring Program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. Shell Offshore, Inc., ConocoPhillips Alaska, Inc., Eni U.S. Operating Co., Inc. and other Industry Contributors. LGL Alaska Report P1050-3, November 2010. 499 pp.

This report is an overview of the results of the marine mammal monitoring and mitigation program, and the research programs conducted by Shell in the Chukchi and Beaufort seas during Shell's seismic activities in 2008, as well as other offshore industry and agency activities that occurred in both seas. Mitigation and monitoring during seismic exploration activities were conducted in a small portion of the Chukchi Sea Lease Sale Area 193 and in specific lease holdings in the Beaufort Sea. Studies included vessel–based monitoring and mitigation programs in the Chukchi and Beaufort seas, and an aerial–based monitoring and mitigation program in the Beaufort Sea. Marine mammals seen during both aerial and vessel-based surveys in the Chukchi Sea were similar to those previously reported for the area. Species uncommon to the area were documented including 14 sightings of 16 Minke whales, four sightings of six humpback whales, and two sightings of four fin whales. Gray whales were most frequently sighted from seismic and monitoring vessels and during aerial surveys in all three years and increased in relative abundance each year. Other cetacean species reported regularly included bowhead and beluga whales. Trends in seasonal sighting rates corresponded with previous research during the bowhead migration. Data collected in July (2008) indicated that east–migrating bowheads tended to travel near the shelf break. In contrast, fall surveys conducted from Aug to Oct (2006–2008) documented bowheads feeding and traveling at shallower depths on their westward migration. The report concluded that it appears unlikely that populations of marine mammals would be affected at current levels of exploration although it remains unclear how other types of impacts, like changes in temperature across the Arctic may ultimately affect these populations and their ability to adapt to additional human influence in their habitats.

JNCC (2010). JNCC Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys. Joint Nature Conservation Committee. Aberdeen, UK. August 2010. 16 pp.

The Joint Nature Conservation Committee (JNCC) is the public body that advises the United Kingdom (UK) Government and devolved administrations on UK-wide and international nature conservation. These guidelines were written for the UK but the organization and content are useful sources of information. The document clearly outlines key components of a monitoring program, beginning with the planning stage, PSO1 requirements in terms of experience and training, reporting requirements including forms, and a discussion about pre- and post-seismic survey observation duties. Figure 1 is a flow chart that shows key steps for MMOs during the monitoring process. A key difference with this guidance is the definition of the mitigation zone (defined as 500 m). In the US, these zones are determined during the permitting stage and are project-specific. This guidance document is concise and while specifically tailored to UK operations, provides a good overview of the monitoring process undertaken during seismic operations.

[1]The report uses the outdated MMO which we have changed to PSO for simplicity

Neff & Associates LLC and Battelle (2010). Continuation of the Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA): Synthesis, 1999 - 2007. Bureau of Ocean Energy Management, Regulation, and Enforcement. Contract No. M03PC00014, December 2010. 337 pp.

This review provided a summary and integration of the results of the Arctic Nearshore Monitoring in the Development Area (ANIMIDA) Project (1999 - 2003) and the Continuation of Arctic Nearshore Monitoring in the Development Area (cANIMIDA) Project (2004 - 2007). The review included a: 1) summary of sources and partitioning of sediments, metals, and hydrocarbons in the Beaufort Sea, 2) summary of metals and hydrocarbons in tissues of marine animals from the development area (i.e., for

non-marine mammal species, it was noted that these results indicate that the metals and hydrocarbons in sediments of the development area have a very low bioavailability, 3) summary of the findings from a monitoring program of the Boulder Patch ecosystem, and 4) summary of the findings from a monitoring program of the subsistence bowhead whaling at Cross Island (i.e., during ANIMIDA/cANIMIDA, Northstar went from construction/development to production). Cross Island whalers noted few if any direct effects of Northstar on their whaling activities, other than that the whalers themselves avoided scouting for whales near Northstar. The lack of effects was attributed primarily to Northstar being west of Cross Island, while the whales were coming from the east and so did not encounter any potential disturbance from Northstar until they had passed Cross Island and the Nuiqsut whalers). The authors concluded regarding bowhead subsistence whaling that the most important factors affecting the success of the whale hunt included stormy weather, ice drift into nearshore waters, and unexplained differences from year to year in the time of arrival, numbers, and distance from shore of bowhead whales.

Reiser, C.M., Funk, D.W., R. Rodrigues and Hannay, D. (2010). 90-Day Report Shell Chukchi Open Water Seismic Exploration Marine Mammal Monitoring. 104 pp.

This report has five chapters, each authored by multiple authors. The report format is similar to other 90-day reports, and includes sections on: 1) background and introduction, 2) shallow water and site clearance surveys described, 3) underwater sound measurements, 4) monitoring, mitigation and data analysis methods, and 5) vessel-based marine mammal monitoring results. A literature cited section is part of each chapter. The results reported included: 1) in total, 12 sightings of 18 cetaceans, 69 sightings of 71 seals, and 59 sightings of 114 Pacific walruses were recorded during periods that met the data analysis criteria, 2) no cetaceans displayed any observable reaction to the vessel, 3) the most frequently observed seal reaction to the Mt. Mitchell was to "look" at the vessel, followed by "change direction" of travel, 4) over 70% of Pacific walruses demonstrated no detectable reaction to the vessel regardless of seismic activity state, 5) one power down and two shut downs of the airgun array were requested and implemented due to Pacific walruses approaching or within the ≥180 dB (rms) safety radius of the active array. No power downs of the airguns were requested or implemented for cetaceans, seals, or polar bears during the 2009 survey, and 6) based on densities calculated from sighting rates during non-seismic periods, less than one individual cetacean would have been exposed one time to seismic sounds ≥180dB (rms). Based on similar density calculations for seals and Pacific walruses, three individual seals would have been exposed once each to received levels ≥190 dB (rms), and ~six individual walruses would have been exposed once to received levels ≥180 dB (rms) if these animals did not avoid the active airgun array.

Statoil (2010). Marine Mammal Monitoring and Mitigation Plan for 2010 Marine Seismic Surveys of Selected Lease Areas in Chukchi Sea, Alaska. 18 pp.

This report describes a marine mammal monitoring and mitigation plan, and does not include information on observations from the 2010 season. The 4MP developed for Statoil's ST10001 Marine Seismic Survey was designed to protect the marine mammal resources in the area, fulfill reporting obligations to the MMS, NMFS, and the USFWS, and establish a means for gathering additional data on marine mammals for future operations planning. Statoil's 4MP was a combination of active monitoring of the area of operations and the implementation of mitigation measures designed to minimize project impacts to marine resources. If marine mammals were observed within or about to enter specific safety radii around the proposed survey activities, mitigation would be initiated by vessel-based PSOs[1]. The size of the 180 and 190 dB re 1 µPa (rms) safety radii were modeled and were described in the section of the report titled "Mitigation Measures during Survey Activities". The authors added that a detailed report describing the sounds produced by the airguns would be provided to NMFS as part of the 90-day

report following the end of the survey. Table 1 and Table 2 provided a summary of distances to received sound levels (190, 180, 160 and 120 dB) for two large airgun arrays and two small airgun arrays. Figure 1 and Figure 2 presented a detailed summary of the specific locations of the survey work.

[1]The report uses the outdated MMO terminology which we have changed to PSO for simplicity.

Erbe, C. and JASCO Applied Sciences Inc. (2011). Underwater Acoustics: Noise and the Effects on Marine Mammals. 35 pp.

This handbook can be used as reference regarding underwater anthropogenic noise and its effects on marine mammals. The book is divided into three sections: Part A) the fundamentals of underwater acoustics, Part B) the effects of noise on marine mammals, and Part C) the noise effects on animals other than mammals. Part A was a dense compilation of text, equations and figures that address acoustic terminology and describe different sound sources, sound propagation, and sound receivers. Part B provided a summary of marine mammal distribution (detailed maps), marine mammal acoustics, and the effects of noise on marine mammals. The section on marine mammal acoustics included a description of noise audibility, behavioral responses, masking, auditory threshold shifts, non-auditory physiological effects, chronic noise effects, biological significance, mitigation and cumulative stressors. In Fig 40, the author presented the Population Consequences of Acoustic Disturbance (PCAD) model, which was a conceptual framework for linking acoustic disturbance to population effects. Regarding cumulative stressors, the author noted the difficulty in ranking the impact of noise as a stressor with other stressors on marine mammals (e.g., pollution, competition with fisheries, ocean debris, vessel strikes, etc.). The list of references was found to be comprehensive.

Genesis Oil and Gas Consultants Ltd. (2011). Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Genesis Oil and Gas Consultants Ltd. July 29, 2011. 72 pp.

The authors in this report examined information on underwater sound generated by the offshore oil and gas industry, and reviews the main activities, these being: geophysical surveys, use of explosives, construction of oil and gas infrastructure, impact piling, production, vessel and drilling noise. The authors of this report decided that oil and gas activities that produced sound in excess of the levels deemed capable of inducing a TTS in hearing of cetaceans using the Southall impact exposure criteria, were likely to qualify for reporting requirements within UK waters. This assessment identified the following activities as being most likely for reporting under the Marine Strategy Framework Directive (MFSD): high powered sparker systems, high powered boomers, single airguns in excess of 100 cubic inches, airgun arrays, pile driving activities and use of explosives. The noise descriptor as specified in the MSFD is for low and mid frequency impulsive sounds within the frequency range of 10 Hz – 10 kHz. A number of oil and gas activities, whose sound levels were documented in this review, do not qualify under these criteria because they either produce continuous sounds (shipping and dredging) or generate high frequency sounds in excess of the upper limit of the noise descriptor (multibeam and side scan sonar). This report provided a comprehensive review of sound pressure levels that are available for oil and gas activities and details the processes used by the Department of Energy and Climate Change (DECC) to record information on activities most likely to be reported. Table 15 presented a summary of anthropogenic noise from oil and gas activities and compares exposure criteria from Southall et al. (2007) and the MSFD Task Group and European Union (i.e., proposed by Germany). The authors further noted that anyone who wishes to undertake a geophysical survey for an oil or gas activity must submit details of the proposed activity to DECC within a Petroleum Operation notice (PON14a) application form. The authors added for each sound source the application and reporting

requirements (summary provided in Table 16). Finally, the appendix included a non-technical summary of underwater acoustics

Hartin, K.G., Bisson, L.N., Case, S.A., Ireland, D.S. and Hannay, D. (2011). 90-Day Report: Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August–October 2011. Statoil USA E&P Inc. LGL Rep. P1193, December 2011. 202 pp.

This report contains seven chapters written by different authors. This report summarized the mitigation and monitoring efforts performed by Statoil USA E&P, Inc. (Statoil) during the 2011 site surveys and geotechnical coring in the Chukchi Sea. Statoil conducted both a shallow hazard and site clearance survey and a geotechnical soil investigation in the Chukchi Sea during the 2011 open-water period. The site clearance survey was conducted from the R/V *Duke* and the geotechnical soil investigation survey was conducted from the R/V *Synergy*. The *Duke* towed a small airgun array in addition to other geophysical survey equipment. The *Synergy* drilled boreholes into sediment layers on the seabed to collect soil samples for geotechnical analysis. A mitigation program was conducted to avoid or minimize potential effects of Statoil's marine surveys on marine mammals and subsistence hunting, and to ensure that Statoil was in compliance with the provisions of the IHA and LOA. The primary objectives of the monitoring and mitigation program were to: 1) provide real-time sighting data needed to implement the mitigation requirements; 2) estimate the numbers of marine mammals potentially exposed to strong seismic pulses or coring sounds; and 3) determine the reactions (if any) of marine mammals to industrial sounds. This 90-day report described the methods and results for the monitoring work specifically required to meet the above primary objectives. As a part of the 2011 operations, Statoil was required to measure and report underwater sound levels from its offshore survey operations. JASCO Applied Sciences carried out the monitoring studies on behalf of Statoil in August and September 2011, and the results were reported in Chapter 3 of this report. As part of the mitigation protocol, the single 10 in^3 airgun was also used as a sound source during turns and on line approaches to encourage marine mammals to stay away from the survey vessel and avoid being exposed to higher-level sounds from the 40 in^3 array when it was ramped up. Sound level threshold distances were presented in Table 1 and 2. During the Statoil site survey, PSOs[1] observed a total of 11 sightings of 35 cetaceans, 109 sightings of 111 seals, no sightings of polar bears, and 61 sightings of 98 Pacific walrus. Gray whales were the most frequently identified cetacean. Bearded seals were the most frequently identified seal species, although nearly a third of the seals sighted could not be identified to species. Only one of the eleven cetacean sightings occurred while airguns were active, and in that case only the single mitigation airgun was operating. Three power downs and one shutdown were requested during the Statoil site survey as a result of Pacific walrus sightings within or approaching the applicable safety radius. No power downs or shut downs of the airguns were necessary for cetaceans or seals. Based on densities calculated from sighting rates during non-seismic periods, approximately 21 individual cetaceans, mostly gray whales, would each have been exposed to airgun pulses with RSLs ≥160 dB (rms) during the survey if they showed no avoidance of active airguns or vessels. Density based calculations also estimated that ~169 individual seals may have been exposed to airgun pulses with Received Sound Levels (RSLs) ≥160 dB (rms) during the survey, including ~80 bearded seals, ~46 ringed seals, ~3 spotted seals, and ~42 individual pinnipeds of unknown species. An estimated ~132 individual walruses were potentially exposed to airgun pulses with RSLs ≥160 dB (rms) during the survey.

[1]The report uses the outdated MMO terminology which we have changed to PSO for simplicity.

International Association of Oil & Gas Producers (2011). Model based assessment of underwater noise from an airgun array soft-start operation. International Association of Oil & Gas Producers. Report No. 451, February 2011. 108 pp.
This report focused on potential physiological impacts on marine mammals. It does not constitute a peer-reviewed paper. The authors noted that there were no experimental studies that provide specific information on the 'levels of sound' that can cause harm to marine mammals (harm is usually expressed in terms of permanent impairment of hearing – Permanent Threshold Shift or PTS). No animal has ever been tested to the point of PTS and experiments have been limited to generating TTS. The authors further noted that there are relatively few experiments that measure TTS as a result of exposure to pulsed sounds. Finally, the authors commented that in 2008, a group of leading scientific experts in the field of bioacoustics conducted a major review of the available scientific (peer-reviewed) literature and derived a series of Noise Exposure Criteria for marine mammals (often referred to as the "Southall Noise Exposure Criteria", See Southall et al. 2007. Aquatic Mammals 33(4)). The criteria, whose derivation contained a number of conservative assumptions, were expressed both in terms of sound pressure level and sound exposure level (a measure of the energy received by an animal). One aim of the work reported herein was to provide regulatory authorities with a more scientific basis for establishing permit conditions and mitigation requirements. In this report, the authors summarized the results of a modelling study that was conducted to investigate whether soft-start to a seismic survey– in a worst-case scenario – might result in hearing damage to marine mammals. Two modelling approaches were used in the study. The authors concluded that "No instances were found in which the threshold levels for hearing injury for cetaceans were reached during the initial stages of the soft-start sequence. This suggests that the animals are not at significantly greater risk of harm when a soft-start is initiated in low visibility conditions. The threshold criterion for pinnipeds was approached in the worst-case model. Thus, for example, where seismic surveys operate in the vicinity of a pinniped 'haul-out', additional mitigation might be in order to manage potential risks to animals".

Parente, C.L. and de Araújo, M.E. (2011). Effectiveness of Monitoring Marine Mammals during Marine Seismic Surveys off Northeast Brazil. *Revista de Gestão Costeira Integrada*, 11:409-419.
In this publication the authors evaluated the effectiveness of programs to monitor the impacts of anthropogenic noise related to conducting seismic surveys on marine mammals during marine seismic surveys off northeast Brazil. Monitoring is required by the government of Brazil to 1) avoid collisions with cetaceans and manatees, 2) collect information on how anthropogenic noise impacts the distribution of marine mammals in the vicinity of the survey area, and 3) to record the behavioral responses of marine mammals to seismic noise and noise from vessel operations. The authors concluded that the monitoring program did not meet the management objectives. The following recommendations to existing monitoring protocols were made: 1) more intensive training of marine mammal observers; 2) development of rigorous quantitative survey protocols; 3) evaluation of the functionality of acoustic monitoring techniques as an alternative for the night period; and 4) conduct independent baseline studies and analyses of marine mammal population distribution, density and behavior.

Shell Gulf of Mexico Inc. (2011). 2011 Marine Mammal Monitoring and Mitigation Plan for Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea. Shell Gulf of Mexico Inc. May 2011 Revised August 2011. 30 pp.
This report described the 4MP for exploration drilling activities in the Chukchi Sea during the 2012 exploration drilling season. The work was to be directed by Shell Gulf of Mexico, Inc. The 4MP developed for Shell's exploration drilling program supports protection of the marine mammal resources in the area, fulfills reporting obligations to the BOEMRE, NMFS, and USFWS and establishes a

means for gathering additional data on marine mammals for future operations planning. Shell planned to conduct exploration drilling within existing lease holdings in the Chukchi Sea. Exploration drilling was to be conducted from the drillship M/V *Noble Discoverer* (*Discoverer*) owned and operated by Noble Corporation. Mitigation measures during drilling operations were described. Monitoring included both vessel and aerial operations, as well as an acoustic monitoring program. The vessel-based work was to provide: 1) the basis for real-time mitigation, if necessary, as required by the various permits that Shell receives; 2) information needed to estimate the number of "takes" of marine mammals by harassment, which must be reported to NMFS and USFWS; and 3) data on the occurrence, distribution, and activities of marine mammals in the areas where the exploration drilling program is conducted; 4) information to compare the distances, distributions, behavior, and movements of marine mammals relative to the drillship at times with and without exploration drilling activity; 5) a communication channel to coastal communities including Inupiat whalers; and 6) employment and capacity building for local residents, with one objective being to develop a larger pool of experienced Inupiat PSOs[1]. Past aerial operations between 2006 and 2010 were reported. Similar survey operations were anticipated in the 2012 season. The objective of the aerial observations were to: 1) collect data on the distribution and abundance of marine mammals in coastal areas of the eastern Chukchi Sea; and 2) collect and report data on the distribution, numbers, orientation and behavior of marine mammals, particularly beluga whales, near traditional hunting areas in the eastern Chukchi Sea.

[1]The report uses the outdated MMO terminology which we have changed to PPO for simplicity.

Shell Offshore Inc. (2011). Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska. Shell Offshore Inc. May 4, 2011. 368 pp.

This Plan detailed the policies and procedures adopted by Shell, which will be implemented at its operations in Camden Bay as well as its project support activities throughout Alaska's North Slope in 2012. No data from existing operations were reported herein. The Plan was intended to support activities that may encounter polar bears (*Ursus maritimus*) and Pacific walrus (*Odobenus rosmarus divergens*), both trust species of the USFWS, as well as grizzly bears (*Ursus arctos horribilis*), which are under the jurisdiction of the Alaska Department of Fish and Game (ADF&G). The drilling operation described in this report was to be conducted by two vessels. Support vessel requirements were also described. Regarding oil spill response (OSR) and mitigation protocols, the OSR vessels included a primary OSR barge (the *Arctic Endeavor* and or similar vessel), an oil storage tanker (OST - M/V *Mikhail Ulyanov* or a similar vessel), and a containment barge (Table 1.2-3). Aircraft operations were to include logistic support from two helicopters and fixed wing support (Twin Otter) for daily aerial survey monitoring. In addition, Shell has requested authority to conduct geophysical surveys at drill sites (i.e., seismic surveys). Peak SPL was reported to be approximately 240 dB at 1 uPa at 1 m. Ice management measures related to drilling vessel operations were described in detail. Shell's oil spill mitigation program included a response for a Worst Case Discharge and was compliant with State of Alaska and Federal regulations. Mitigation measures for human-polar bear and human-walrus interactions were described.

Bisson, L.N., Reider, H.J., Patterson, H.M., Austin, M., Brandon, J.R., Thomas, T. and Bourdon, M.L. (2012). Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi and Beaufort seas, July – November 2012: Draft 90-Day Report. Shell Offshore Inc. February 20, 2013. 290 pp.

Shell's exploratory drilling activities and other exploration activities in the Chukchi and Beaufort seas were conducted under the jurisdiction of IHAs issued by NMFS and LOAs issued by the USFWS. The IHAs and LOAs included provisions to minimize the possibility that marine mammals might occur close

to the continuous sound sources generated by exploratory drilling and be exposed to levels of sound high enough to cause hearing damage or other injuries, and to reduce behavioral disturbances that might be considered as "take by harassment" under the MMPA. A mitigation program was conducted to avoid or minimize potential effects of Shell's marine surveys on marine mammals and subsistence hunting, and to ensure that Shell was in compliance with the provisions of the IHAs and LOAs. This program required PSOs onboard all of the project vessels to detect and monitor marine mammals and their responses to industry activities, and to initiate mitigation measures if necessary. The primary objectives of the monitoring and mitigation program were to: 1) provide real–time sighting data needed to implement the mitigation requirements; 2) estimate the numbers of marine mammals potentially exposed to low-level continuous sounds generated by the drilling operations and support activities near well sites; and 3) determine the reactions (if any) of marine mammals potentially exposed to exploratory drilling sounds and related activities. Herein is the 90-day report, which described the methods and results for the monitoring work specifically required to meet the above primary objectives. The following sightings data were from the Beaufort Sea vessel monitoring program: 160 sightings of 295 cetaceans, 593 sightings of 878 seals, 14 sightings of 24 Pacific walruses, and 13 sightings of 39 polar bears were recorded during Shell's 2010 Beaufort Sea marine surveys. Bowhead whale was the most commonly identified cetacean species, and it is likely that many unidentified mysticete whales were also bowheads. Ringed seal was the most abundant seal species identified followed by bearded and spotted seals, respectively. Estimates of the number of marine mammals exposed to sound levels greater than 120 dB was reported. In the Chukchi Sea aerial survey monitoring program the following marine mammal sightings were reported: 1) seventeen cetacean sightings of an estimated 22 individuals were recorded during nearshore surveys within the Chukchi Sea. Gray whale was the most commonly identified cetacean (10 sightings of 13 individuals) followed by five sightings of bowhead whales (five individuals). In the offshore area, 37 cetacean sightings of an estimated 43 individuals were sighted on the photographs. Bowhead whale was the most commonly identified cetacean (13 sightings of 15 individuals), followed by 11 sightings of beluga whales (14 individuals), and 2) sixty-one pinniped sightings of an estimated 73 individuals were recorded during nearshore surveys within the Chukchi Sea. Unknown seal was the most commonly identified pinniped (33 sightings of 43 individuals) followed by 25 sightings of bearded seals (26 individuals). In the offshore area, 329 pinniped sightings of an estimated 1558 individuals were sighted on the photographs. Walrus was the most commonly identified pinniped (163 sightings of 1334 individuals) in the offshore area, followed by 161 sightings of unknown pinnipeds (219 individuals). Results of marine mammal sightings from aerial surveys in the Beaufort Sea were also reported. An apparent near-shore shift in the bowhead migration occurred in late-Sept. coinciding with the start of drilling activities. In addition to the observed distribution of sightings being more near-shore during late Sept. and Oct., bowhead whales were also observed to have been moving more slowly and with more variable headings than during the peak of the migration. Two alternative hypotheses were possible explanations for this shift: 1) a possible reaction to drilling activities and, 2) natural variability in the migration, perhaps driven by an increase in near-shore foraging activity later in the season.

BP Exploration Inc. (2012). 14th(+) Open Water Meeting Report on Marine Mammal and Acoustic Monitoring of the Northstar Offshore Production Facility. Institution. 24 pp.

This document is a slide deck used by the author to present information contained in a report to the 14th NMFS open water meeting in Anchorage, Alaska regarding monitoring and evaluating impacts of the Northstar offshore production facility. The author noted that peak oil production at the facility was approximately 80,000 barrels per day (bpd) in 2003 and 2004, whereas production in 2012 was 11,600 bpd. Regarding wildlife monitoring, it was noted that seal counts and bowhead call rates were highly

variable interannually. Therefore, from a statistical power perspective detecting trends using monitoring data would be low.

Emmerson, C. and Lahn, G. (2012). Arctic Opening: Opportunity and Risk in the High North. Lloyd's, ClimateWise, Chatham House. 60 pp.

The primary premise of the author was that the combined effects of global resource depletion, climate change and technological progress mean that the natural resource base of the Arctic is now increasingly significant and commercially viable. Further, comprehensive and rigorous risk management was noted as being essential for companies seeking to invest in the Arctic. The author reported on and discussed the following key points: 1) rapid and disruptive change in the Arctic environment presents uneven prospects for investment and economic development, 2) the Arctic is likely to attract substantial investment over the coming decade, potentially reaching $100 billon or more, 3) significant knowledge gaps across the Arctic need to be closed urgently, 4) Arctic conditions will remain challenging and often unpredictable, 5) the environmental consequences of disasters in the Arctic are likely to be worse than in other regions, 6) the politics of Arctic economic development are controversial and fluid, 7) governance frameworks in the Arctic should continue to develop in their current direction and be reinforced, where possible, and 8) risk management is fundamental for companies to work safely, sustainably, and successfully in the Arctic. The balance of risk and opportunity for major Arctic development projects depends on a range of further factors. For example, for oil and gas developments, there is a key distinction between onshore and offshore developments, between shallow water offshore and deep water offshore, and between developments close to existing pipelines and transport infrastructure and those that would require the construction of entirely new pipelines and infrastructure. Additionally, for Arctic shipping, the widely varying quality of seabed mapping in different parts of the Arctic, and disparities in port infrastructure, surveillance and search and rescue capability, create an uneven matrix of risk and opportunity. In addition, the author noted the global consequences of Arctic environmental change related to warming, loss of sea ice and glacial ice, and thinning of sea ice. The following four economic sectors were identified as having growing interest in the Arctic, especially in the Barents Sea and northern Alaska: 1) mineral resources, 2) fisheries, 3) shipping and other logistical enterprise, and 4) tourism. Increased interest in military preparedness and operations could also become significant. Key environmental risks (e.g., coldness, darkness, ice movement, etc.) were discussed in detail in Chapter 3. The author concluded that major investment in infrastructure and surveillance was required to enable safe and sustainable economic activity. Further, industry would have to commit to a development approach that was safe for the environment and local residents, and sustainable.

Gadd, P.E., Leidersdorf, C.B., Hearon, G.E. and McDougal, W.G. (2012). The History of Artificial Islands for Oil Exploration and Development in the Alaskan Arctic. Offshore Technology Conference. December 3-5, 2012. 16 pp.

The authors in this paper provides an overview of the history, design evolution, construction and performance of the 18 artificial (i.e., man-made) islands constructed in the Alaskan Arctic. Locations were presented in Fig. 1. The islands were built to support oil and gas exploration and production. The authors noted that the use of artificial islands to support oil and gas activities first took place in Canada in the early 1970s, and then in the US in the late 1970s. The maximum water depth for such structures was reported as 14-15m. A summary of water depths for each artificial island was presented in Fig 2. In Alaska, four islands continue to produce oil and gas (at least as of 2012). The authors noted that the key requirement in the design of coastal and nearshore facilities was the selection of a side slope profile and armor material to provide protection against waves. In the Arctic, protection also must be provided against ice. The resulting armored slope must protect the slopes from wave erosion, ice

damage, and the combination of waves and ice. A summary of slope protection measures used in Alaska was presented in Table 1. Details for each artificial island constructed in the Alaskan Arctic was presented, and serves as an excellent overview of the different designs, construction methods, and uses of such structures.

MMOA (2012). Position Statements: The Key Issues That Should Be Addressed When Developing Mitigation Plans To Minimise The Effects of Anthropogenic Sound On Species Of Concern. Marine Mammal Observer Association. September 10, 2012. 36 pp.

The authors recommended the following policy positions: 1) A thorough Environmental Impact Assessment is required prior to all projects to provide the information necessary to formulate a Mitigation Plan, 2) mitigation plans should be site, species and source specific, 3) mitigation measures incorporated in mitigation plans should be based on scientific principles, in the absence of which a precautionary approach should be adopted, 4) the limitations of Passive Acoustic Monitoring (PAM) should be realized in order to mitigate effectively during times when visual monitoring is compromised, 5) only suitably qualified, experienced and dedicated personnel should be hired as PSOs[1] and PAM Operators, 6) PSO/PAM mitigation training certificates should not be the only requirement to qualify a person as a PSO or PAM Operator, 7) PSO/PAM Mitigation Training Providers should not advertise their courses to be the only qualification needed to qualify a person as an PSO or PAM Operator nor should Regulators, Clients or PSO/PAM Operator Provider Companies consider certificates to be such, 8) PSO data that are to be scientifically analyzed must be collected and analyzed by suitably qualified personnel, 9) PSO data collection should be standardized globally to create a stronger dataset, and 10) the publication of individual PSO data by suitably qualified PSOs should be encouraged given that permission has been granted from the Client. Details and support for each policy recommendation were reported.

[1]The report uses the outdated MMO terminology which we have changed to PSO for simplicity.

Normandeau Associates Inc. (2012). Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. Workshop Report. Bureau of Ocean Energy Management. Contract M11PC00031, December 2012. 361 pp.

In order to further their understanding of the issues surrounding the analysis of the effects of man-made sounds on fishes, fisheries and invertebrates, BOEM funded a three-phase project that consisted of: 1) a synthesis of available literature on the subject; 2) a Workshop of experts convened to discuss the state of knowledge (http://www.boemsoundworkshop.com/); and 3) an analysis of the information that is needed to improve BOEM's understanding of the issues. The regional focus was the US Arctic and US east coast. The Literature Synthesis was prepared in advance of the Workshop and was appended to this report (Appendix E). The Workshop was convened in March 2012; discussions were summarized in this report. Participants agreed that the cumulative sound exposure level was the most appropriate methodology for characterizing the accumulation of sound energy in the marine environment. Further, it was agreed that monitoring for dead or injured fish would improve the understanding of the effects of exposure to anthropogenic noise. Recommendations and findings were presented in Session 5 (p. 36), as well as in associated appendices. One of the primary conclusions was that there is a large gap in our knowledge as to how anthropogenic sound affects fishes and invertebrates. Prioritized research needs were presented in Section 3.2 (p. 65), and included: 1) development of a library of sounds produced by fishes and invertebrates, 2) development of a long-term monitoring program of soundscapes in both regions, 3) a description and full evaluation of the effects of the sound fields (nearfield and far-field) produced by explosions, seismic airguns, pile driving, dredging, wind f arm operation, vessel noise, fishing activities, and sonar systems on fishes and invertebrates, 4) assessment of effects has to include both cumulative and aggregate effects of sound

exposure, 5) more extensive and detailed knowledge of the hearing abilities of fishes and invertebrates, 6) the susceptibility of animal hearing to masking by man-made sounds, 7) the effects of man-made sounds on the distribution of fishes and their capture by different fishing gears, and 8) the efficacy of ramp-up, soft-start and other aversive techniques. That is, can fishes and invertebrates be induced to move away from an area by using ramp up in order to allow potentially damaging sounds to be produced subsequently.

SAExploration (2012). Apache Cook Inlet 3D Seismic Protected Species Monitoring Program. July 5, 2012. 20 pp.

The authors reported on the marine mammal monitoring program during a 3D seismic survey in Cook Inlet, Alaska. Observations were made from 4 vessels, land observations, daily aerial overflights, and vessel-based acoustic monitoring. Operations generally took place in the Trading Bay area on the west side of Cook Inlet (although the authors referred to the study as being on the east side of Cook Inlet). The monitoring program was designed to document the following: species and number of marine mammals within the 160dB safety zone (9.5 m), number of seismic survey shutdowns due to marine mammals approaching or within the safety zone, and the number of marine mammals observed in the project area. Marine mammal sightings were summarized in Table 1. Seventy-five percent of sightings were harbor seals (n=2627), while 660 beluga whales were sighted. Details for each marine mammal sighting was presented in Appendix A. Mitigation measures included 42 shut downs, 16 power downs and 68 clearing safety zone delays. There were 165 sightings that did not require mitigation measures. Shut downs were implemented for sightings of beluga whales (1), gray whales (2), harbor porpoise (6), harbor seals (32) and one unidentified pinniped. In addition, on June 9th there were Level B takes reported for a harbor seal that was observed 8.3 and 8.5 km from the source vessels.

Smultea, M.A., Fertl, D., Rugh, D.J. and Bacon, C.E. (2012). Summary of Systematic Bowhead Surveys Conducted in the U.S. Beaufort and Chukchi Seas, 1975-2009. National Marine Fisheries Service. June 2012. 57 pp.

As background, NMFS initiated a 5-year study of bowhead whale (*Balaena mysticetus*) feeding ecology (referred to as BOWFEST). Field operations for BOWFEST were conducted from 2007 to 2011 and involved a partnership of 17 scientists from 7 research institutions across the United States. As a part of the BOWFEST, a comprehensive review was conducted of all prominent scientific surveys that systematically recorded bowhead whales in the U.S. Beaufort and Chukchi seas from 1975 to 2008 (and some from early 2009). In this review, the authors summarized available information on bowheads, which has been used to support environmental risk assessments, environmental impact assessments, and other pre-and post-leasing decision documents for potential gas and oil leasing in BOEM's Beaufort and Chukchi Sea planning areas. The stated goals of the authors were to provide: 1) a summary for historical comparisons; 2) a format to integrate and track the studies; and 3) a publicly available starting point to identify data of relevance to ongoing work. The authors noted that at least 189 systematic studies involving bowhead whales were conducted in the U.S. Beaufort and Chukchi seas from 1975 to 2008, including some from 2009. Most (67 %) of these studies were associated with monitoring and mitigation relative to offshore oil and gas exploration and development. The focus of these studies included aerial surveys, photogrammetry, ice and shore-based census operations, tagging, and monitoring. The primary contribution of this review is a large table that lists all of the scientific studies and associated publications by year. A short description of each study in part of Table 1.

ACCOBAMS Permanent Secretariat (2013). Guidelines to Address the Impact of Anthropogenic Noise on Cetaceans in the ACCOBAMS Area. 2013. 9 pp.
The authors of this report provided both general and specific guidelines to mitigate potential adverse impacts of anthropogenic noise on cetaceans in the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS) region). Recommended mitigation procedures included: measures are to be practical, account for various operating conditions and constraints, and minimize disruption of operations while maximizing environmental protection. Further, the following guidelines were to be taken into account inter alia: 1) avoid cetacean key habitats and marine protected areas, 2) model the generated sound field in relation with oceanographic features, 3) determine thresholds for safe and harmful exposure levels for various species, age classes, contexts, etc., 4) there should be a scientific and precautionary basis for the area that encompasses an exclusion zone, 5) mitigation guidelines should be adopted by all operators (e.g., military, industrial, academic), 6) during operations, stranding networks should be alerted, and 7) trained and approved cetacean observers should be employed for monitoring. In addition to general guidelines, guidelines specific to the following activities were included: 1) high power sonar (military and civil applications), 2) seismic surveys and airgun operations, 3) coastal and offshore construction activities, 4) operations on offshore platforms, 5) playback and sound exposure experiments, 6) shipping, and 7) other (e.g., tourism, whale watching, explosive disposal of war weapons or decommissioning of structures, and use of underwater acoustically active devices).

Aerts, L.A.M., Hetrick, W., Sitkiewicz, S., Schudel, C.S., Snyder, D. and Gumtow, R. (2013). Marine Mammal Distribution and Abundance in the Northeastern Chukchi Sea During Summer and Early Fall, 2008-2012. ConocoPhillips Company, Shell Exploration & Production Company, Statoil USA E & P Inc. October 13, 2012. 76 pp.
The authors reported on the results of a marine mammal abundance survey in the Chukchi Sea in 2012 and compare the results with similar data collected between 2008-2011. Abundance and density were reported for the bowhead whale, gray whale, ringed seal, bearded seal, and walrus. Polar bear sightings were noted, but there were too few sightings to estimate density (see Table 1.3). The following conclusions were reported: 1) point estimates of density for bowhead whales in 2012 was higher than previous years (although this conclusion was not tested statistically), 2) similarly, the point estimate for gray whale encounter rate in 2012 was higher than those reported for 2008-2011, 3) the distribution of sighted whales was presented in Attachment A, Chapter 2, 4) the point estimates for ringed/spotted seal density and bearded seal density in 2012 appeared similar to prior years (no statistical tests were performed), 5) the highest encounter rate in a given year was reported for 2012 (statistical significance was not reported), and 6) the highest observed walrus densities were in the Burger study area.

Baker, K., Epperson, D., Gitschlag, G., Goldstein, H., Lewandowski, J., Skupry, K., Smith, B. and Turk, T. (2013). National Standards for a Protected Species Observer and Data Management Program: A Model Using Geological and Geophysical Surveys. U.S. Department of Commerce National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-OPR-49, November 2013. 81 pp.
The authors of this reported provided recommendations from a Working Group on the development of a national Protected Species Observer and Data Management program. Recommendations herein were based on the output from a workshop, which was convened with members of the Working Group 19 June 2008 in St. Petersburg, Fl. The recommendations from the Working Group for NMFS included: 1) national standards for training PSOs should be established, 2) develop a policy for national PSO qualifications and eligibility, and establish criteria by which individual PSO qualifications and experience

can be evaluated, 3) ensure that the PSO standards developed were consistent with existing Federal statutes, regulations and policies, 4) develop standardized data collection and reporting requirements, and 5) develop a protocol for a data quality assurance standard, 6) develop PSO communication and outreach materials. Recommendations for BOEM/BSEE included: 1) develop a reimbursable agreement with NMFS to develop, implement, and manage the PSO training and data program, 2) consider assessing permit fees to financially support the PSO program needed for industry activities, 3) implement standardization protocol for all aspects of the program, 4) establish a process to advertise for and approve PSO procedures, 5) convene a stakeholder workshop to discuss new PSO procedures, and 6) develop a debriefing and evaluation system for observers. Only marine mammals under NMFS jurisdiction were considered in this report. In addition, the authors noted that the primary purpose of a PSO was to reduce the potential for injury or harassment to protected species. One of the primary purposes of this report was to address regional inconsistencies in the training, performance and reporting requirements for PSO in US waters. The roles of the four main groups implementing PSO training programs was reported in Table 1. Recommendations were summarized in Section 10 of the report.

HDR Alaska Inc. (2013). NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during BPXA Simpson Lagoon OBC Seismic Survey, Beaufort Sea, Alaska July to September 2012. BP Exploration Alaska Inc. March 2013. 149 pp.

This 90-day report summarizes the seismic survey and marine mammal monitoring data recorded between July 26 and September 7, 2013 as required by the NMFS and USFWS IHAs issued to BPXA. The project was completely demobilized on September 18, 2013. About 109 km^2 (50.1 percent) of the project area was located inside the barrier islands of Simpson Lagoon with water depths between 0 and 2.7 m, while 72.5 km^2 was outside the barrier islands where water depths ranged between 1 and 13.7 m the remaining 33.7 km^2 was on land. For operational reasons, the 640 in^3 array only operated outside the barrier islands while a 320 in^3 array was used inside the islands. Table 2.2 of the report provides detailed information on the three source and eleven support vessels used in the survey. Table 4.1 provides the modeled safety radii based on the airgun sizes and supporting data while Table 4.2 shows measured safety radii based on sound source verification. The vessel-based monitoring program implemented safety zones described in Table 4.2. In accordance with the CAA between BPXA and the whaling communities, no airgun activity occurred after August 25th. However, PSO monitoring did occur on August 29th and September 1st and 5th to monitor for bowhead whales outside the barrier islands. Monitoring procedures for the project are described in Section 4.3. A total of 35 ringed, spotted and bearded seals were observed during active seismic vessel activity as summarized in Table 5.3. Sighting locations both inside and outside the barrier islands are shown in Figures 5.6 – 5-8. Five shutdowns, three power downs and five delayed ramp ups were implemented due to pinniped sightings. No cetaceans were sighted but authors report that at least one cetacean may have been missed during the survey.

Lammers, M.O., Castellote, M., Small, R.J., Atkinson, S., Jenniges, J., Rosinski, A., Oswald, J.N. and Garner, C. (2013). Passive acoustic monitoring of Cook Inlet beluga whales (*Delphinapterus leucas*). *Journal of the Acoustical Society of America*, 134:2497-2504.

The authors reported on the results of a study designed to investigate the year-round occurrence and distribution of belugas and killer whales in Cook Inlet, Alaska. Beginning in June 2009, ten moorings were deployed throughout the Inlet and refurbished every two to eight months. The passive acoustic recording devices, the mooring system, and their placement were described in detail. Twenty-four mooring deployments were made, of which twenty were recovered. The results included: 1) beluga

and killer whale signals were detected at all locations, except North and South Eagle Bay, 2) beluga detections did not take place with regularity at any location, but rather occurred as multi-day episodes separated by long intervals of absence, 3) the distribution of belugas in the upper and middle inlet varied by season, 4) killer whale signals were mostly recorded in the vicinity of Homer Spit, but also one recording from the Beluga River mooring and one from the Tuxedni Bay mooring, and 5) there was no observed overlap based on the sites monitored between beluga and killer whale distributions. Of the sites monitored, the Beluga River mooring site had the most consistent recordings of beluga signals. Caveats regarding data interpretation were also discussed.

Streever, B. (2013). Case study: A look at the Simpson Lagoon seismic operation's estimated distance to 120dB re 1uPa. Alaska Marine Science Symposium. 5 pp.
This report summarized potential differences in estimates of the distance from a seismic source to the 120 dB re 1 uPa noise level, and factors to consider in evaluating "safe" operating distances regarding disturbances to marine mammals. The author noted a significant difference in noise levels associated with "endfire" (distance = 2528 m) versus "broadside" (distance = 16,598 m). The author also noted the following: 1) models produce irregularly shaped isopleths; whereas mitigation measures assume circular spreading adequately describes noise loss over distance, 2) models produce estimates of noise levels that vary by depth; whereas mitigation measures typically do not adjust for depth, 3) mitigation radii are typically based on 90th or 95th quantile estimates, 4) mitigation radii are typically based on a single transect at a single depth, and 5) "endfire" and "broadside" estimates of distance to 120 dB are often based on extrapolation beyond actual measurements (e.g., 180 dB re 1 uPa).

Zitterbart, D.P., Kindermann, L., Burkhardt, E. and Boebel, O. (2013). Automatic Round-the-Clock Detection of Whales for Mitigation from Underwater Noise Impacts. *PLoS One*, 8:e71217.
In this paper, the authors described an automated, ship-based thermographic whale detection system. The system detects cetacean presence via the detection of whale blows. The authors reported that this system outperforms alerted observers in terms of number of blows detected and whale encounters. Cetacean detection was uniform and omnidirectional out to a distance of 5 km. The infrared detection system used and its installation was described in detail (i.e., First-Navy). Comparisons with human observers were based on paired vessel transects conducted between Cape Town, South Africa and Antarctic waters over a 31 day period. Thermal imagery data was collected from seven cruises, where over 4500 blows were detected at distances out to 5500m. The thermal system was reported to detect 92% of the visually logged whale encounters on one cruise. Overall, the system detected approximately twice as many whale-cues as did the observers. Night and day time detection rates by the thermal system were comparable. System performance was affected by environmental conditions (e.g., wind, fog). Additional caveats of the detection system were discussed.

BOEM (2014). Quieting Technologies for Reducing Noise During Seismic Surveying and Pile Driving Workshop Summary Report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Headquarters. BOEM 2014-061, Herndon, VA. 306 pp.
The authors of this report summarize the findings and deliberations made during a workshop sponsored by BOEM on quieting technologies for reducing noise during seismic surveys and pile driving operations. Key findings included: 1) oil and gas industry, technology developers, non-government organization, and regulatory agencies must communicate effectively to optimally understand emerging technologies, 2) cooperation between oil and gas industry and the regulatory agencies has significantly improved over the last decade, and 3) a key issue that needs to be addressed is a lack of consistent acoustic terminology and noise measurement protocols and standards. Quieting technologies were focuses on three primary noise sources: airguns, pile driving, and vessels (used to support seismic

surveys and pile driving). The authors noted that marine vibroseis technology was not to a point of replacing the use of airguns. They further noted that commercially available alternatives to pile driving currently don't exist. Finally, mitigation of vessel noise was most likely to be achieved by addressing noise produced from propeller cavitation and diesel engines; however, it was recognized that reduction of noise from vessels, especially older vessels, was expensive and that no standards for vessel noise currently existed. Workshop participants identified data gaps that need to be addressed, as well as the need for regulatory agencies to provide incentives to implement measures to mitigate the potential impact of noise associated with seismic surveys and pile driving. Abstracts for presentations by workshop participants were provided in the body of the report. A synthesis of literature searches related to the workshop objectives was provided in the appendix, including an extensive list of literature.

Hemmera Envirochem Inc., SMRU Canada Ltd. and JASCO Applied Sciences (Canada) Ltd. (2014). Roberts Bank Terminal 2 Technical Data Report Underwater Noise Ship Sound Signature Analysis Study. Port Metro Vancouver. 154 pp.

This report summarizes underwater noise studies related to the Roberts Bank Terminal 2 project. The studies were designed to transmission loss (TL) and source levels (SL) of vessels in the vicinity of the construction project. Sound measurement and analyses methods were described in detail. Sounds measurements were reported for large container ships (at 20 kts - 206.0, 203.9, and 200.5 dB re 1 µPa at 1 m versus at 10 knots - 198.2, 191.9, 187.9 dB re 1 µPa at 1 m). In comparison, transiting fishing vessels and tugs had SLs with means of 177.6 and 179.3 dB re 1µPa at 1m, respectively. In general, sound levels of vessels increased with increasing speed and increasing vessel width. Sound levels for 5,993 vessels in Haro Strait were also reported. The results of this study will be integrated in on-going cumulative noise studies inter alia to determine the impacts of the Roberts Bank Terminal project on southern resident killer whales.

LGL Alaska Research Associates Inc., JASCO Applied Sciences Inc. and Greeneridge Sciences Inc. (2014). Joint Monitoring Program in the Chukchi and Beaufort Seas, 2012. LGL Alaska Final Report P1272-2 for Shell Offshore, Inc. ION Geophysical, Inc., and Other Industry Contributors. LGL Final Report P1272-2, September 3, 2014. 354 pp.

This comprehensive document provides detail on the large-scale joint monitoring program undertaken by Shell (as supported by ION) for offshore exploration during the open water seasons 2006 – 2012. From 2006–2011 activities included 2D and 3D seismic programs, shallow hazards and site clearance surveys, and related geophysical and geotechnical activities. Offshore exploratory drilling in both the Chukchi and Beaufort seas was conducted in 2012 and marked the first offshore exploratory drilling since 1991 in the Chukchi Sea and 2003 in the Beaufort Sea. Marine mammal monitoring results are reported for vessel-based PSOs, aerial surveys and acoustic monitoring. The acoustic monitoring program was conducted jointly by Shell, CPAI)and Statoil in 2009–2012, by Shell and CPAI in 2007, 2008, and by Shell, CPAI and GX Technology (GXT) in 2006. To minimize redundancy and integrate results from different data streams, each species or species group has a dedicated results chapter. There are 10 report chapters plus appendices. In addition to describing marine mammal species that occur in the project area, the introduction also dedicates brief descriptions on physical oceanography, sea ice in the Arctic, climate change, the acoustic environment and other recent offshore oil and gas activities. A comparison of digital imagery versus aerial surveyor marine mammal sighting data is provided in Chapter 5 concluding that reviewers of video imagery did not detect as many marine mammals as PSOs in real time and were not able to identify as many sightings to species. Factors contributing to this finding are described. Each chapter ends with a conclusion-type section(s), summarizing the data which are useful for a quick understanding of the multi-year program findings.

NMFS (2014). NMFS Whale Deterrence Workshop: Assessment Report. NMFS Whale Deterrence Workshop. Anchorage, AK. January 20, 2014. 9 pp.
The purpose of the workshop was to address bowhead and beluga deterrent techniques for oil spill response mitigation in Alaska. Approximately 30 people participated in the workshop, which NMFS convened in Anchorage, Alaska. The authors noted that NMFS did not currently have an official protocol for deterring bowhead whales and belugas from spilled oil to avoid exposure. The following deterrents were discussed: 1) use of airgun noise, 2) use of pingers, 3) olfactory deterrents, and 4) use of sounds that attract sperm whales to commercial fishing vessels. Previous unsuccessful attempts to deter whales from the *Exxon Valdez* Oil Spill (EVOS) were discussed (e.g., driving small boats at pods of killer whales). Existing literature on the topic was identified and discussed. Finally, traditional knowledge was also used to identify noises that would either attract or deter bowhead whales or belugas. The recommendations and findings from this workshop were to be used by NMFS in drafting the Arctic Marine Mammal Disaster Response Plan. NMFS recognized that any methods under consideration will need to be field-tested before any pre-approval would be granted for specific deterrence techniques. Note – the final Response Plan can be found at NMFS website: https://www.fisheries.noaa.gov/resource/document/arctic-marine-mammal-disaster-response-guidelines-technical-memo-and-appendices

Shell Gulf of Mexico Inc. (2014). Marine Mammal Monitoring and Mitigation Plan Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea. August 2014. 30 pp.
This 4MP)Program outlined a vessel-based, acoustic and aerial photograph monitoring program during Shell Chukchi Sea exploratory drilling activities in the Burger Prospect. Exposure areas and the associated monitoring zones were based on measurements collected during the 2012 drilling program or modeled by JASCO Applied Sciences. The 2012 measurement of the distance to the 120 dB (rms) threshold for normal drilling activity by the *Discoverer* was 1.5 km while the distance of the ≥120 dB (rms) radius during construction was 8.2 km. Measured sound levels for the *Polar Pioneer* were not available. The modeled threshold to 120 dB was 0.35 km. Source levels for exploration drilling were not high enough to cause temporary reduction in hearing sensitivity or permanent hearing damage to marine mammals. Consequently, mitigation during ramp ups, power downs, and shutdowns was not expected to be necessary. However, Shell planned to use PSOs onboard the drilling units, ice management, and anchor handling vessels to monitor marine mammals and their responses to industry activities. Two airgun arrays were planned (three 150 in^3 and two 250 in^3) during Shell's ZVSP survey (i.e., the energy source is positioned directly above the receivers, typically very close to the wellbore)(see Table 2 for sound source specifications). Estimated distances to NMFS regulatory thresholds (i.e., >190 dB, 180 dB, and 160 dB) are presented in Table 1 and range from 0.255 to 11.96 km, respectively. The vessel-based PSO program describes standard protocol recommended by NMFS. The acoustic monitoring program planned to deploy five Autonomous Multichannel Acoustic Recorders (AMAR) at radial distances ranging from 0.5 – 8 km from each drilling unit. One somewhat unique aspect to the monitoring program was the inclusion of aerial photographic monitoring to obtain marine mammal distribution data in the offshore Chukchi Sea and offer a safer option to manned aerial surveys by reducing the number of people onboard an aircraft from six to two (pilot and copilot). This was planned to serve as a pilot study for future UAS to determine if photographic images captured using UAS are comparable to manned aerial surveys. Details on camera specifications, survey timing and frequency, survey pattern and data analyses are described.

Smultea, M.A., Lomac-MacNair, K.S. and Bacon, C. (2014). NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during BPXA's Liberty Shallow Geohazard Seismic and Seabed Mapping Survey Beaufort Sea, Alaska. BP Exploration Inc. November 25, 2014. 152 pp.
This report satisfies the notification requirements for BPXA's Liberty shallow geohazard seismic and seabed mapping survey, regarding potential and actual takes of marine mammals in the region surrounding the project area. Three species of marine mammals were anticipated in the study area during the survey (i.e., 16 July – 5 August, 2014), which was conducted in waters less than 10 m in depth: ringed seal, bearded seal and spotted seal. NMFS approved observers were present aboard the source vessels in compliance with the NMFS IHA and the USFWS LOA. Some observers also served as Inupiat Communicators, where the goal was to avoid mitigatable impacts to subsistence hunters and to communicate operational details with local community members. Details of the survey area and survey methodology and equipment used was reported. The safety and disturbance "radii" were reported in Table 5. General mitigation measures and mitigation measures specific to seismic operations were discussed. Night vision devices were not used during the survey, as they were not considered useful at this time of year. No bowhead whales or polar bears were observed during the survey. Marine mammal behavioral responses to the vessel were tallied as: swim away, swim towards, swim parallel, no movement and unknown. 197 sightings of 213 individual marine mammals were observed (Table 10). Four species were observed: beluga, ringed seal, bearded seal and spotted seal. Spotted seals were the most common marine mammal species sighted. Re-sighting of animals was considered likely by the authors. Sighting rates of marine mammals were reported specific to a number of factors (i.e., date, with or without seismic operation, environmental conditions related to sighting). Statistical comparisons of sighting rates by species by factor were not reported. Behavioral responses were reported separately for cetaceans and pinnipeds. In terms of mitigation during the survey period, two shutdowns and one power down were reported. The minimum number of belugas and pinnipeds taken were 0 and 5, respectively. The maximum number of belugas and pinnipeds exposed taken were 10 and 86, respectively (Table 17). Both estimates of take were below the authorized levels in the IHA. There was no indication that any of the Liberty survey activities resulted in an impact to the subsistence resources of the local community.

Azzara, A., Wang, H. and Rutherford, D. (2015). A 10-Year Projection Of Maritime Activity in the U.S. Arctic Region. The International Council on Clean Transportation. Washington, DC. January 1, 2015. 73 pp.
This report directly supports the priorities outlined in the U.S. National Strategy for the Arctic Region (NSAR). On September 16, 2012, Arctic sea ice reached its lowest coverage extent ever recorded, creating the longest Arctic navigation season on record. While this may increase the season available for navigation in the Arctic, it may also intensify the risks. This study consists of a number of different elements; each element is designed to frame and inform vessel activity projections for the U.S. Arctic in 2025. The baseline analysis consists of vessel traffic and climate modeling represented by ice extent models. The vessel traffic projection scenarios are based on a combination of the baseline vessel analysis, and the analysis of growth components. While the report has interesting information on increased vessel traffic in the arctic, it does not consider or mention marine mammals.

Cate, J.R., Blees, M., Larson, M., Simpson, S., Mills, R. and Cooper, R. (2015). Marine Mammal Monitoring 90-Day Report: Shallow geohazard survey Hilcorp in Foggy Island Bay, Alaska, July 2015. Hilcorp Alaska, LLC. AES Document No. 15471-05 15-131, October 20, 2015. 122 pp.
In 2015, Hilcorp Alaska, LLC (Hilcorp) conducted a vessel based shallow geohazard and strudel scour survey with a transition zone component in federal and state waters of the Beaufort Sea. The purpose of this 90-day report is to describe Hilcorp's 2015 survey activities in the Beaufort Sea; the marine

mammal monitoring and mitigation methods implemented and their results; and provide an estimated number of marine mammals potentially exposed to harmful levels of sound generated by the survey activity. The 4MP required Hilcorp to employ Iñupiat and scientific PSOs on the project vessel for visual based monitoring and to implement mitigation. In conjunction with the survey, passive acoustic monitoring data were collected. Total observer effort of the survey was 1,187 km (126 hours). There were 27 sightings of 30 individual animals; five were beluga whales and the rest were pinnipeds. All mammals were identified to at least cetacean or pinniped classification. 63 percent of the 27 sightings exhibited no reaction to the vessel, regardless of survey activity. The only behavioral reaction (looking) was by pinnipeds; all cetacean sightings exhibited no reaction. Three mitigation events (shutdowns) were implemented due to marine mammals within or approaching the applicable Zone of Influence (ZOI). The estimated number of marine mammals which may have been taken by harassment through exposure to received levels of sub-bottom profiler sounds ≥160 dB re 1 µPa (rms) were 20 cetaceans and 80 pinnipeds. These numbers were below authorized takes of 57 and 514, respectively.

Frouin-Mouy, H., Zeddies, D. and Austin., M. (2015). Passive Acoustic Monitoring Study: Hilcorp's 2015 Geohazard Survey in Foggy Island Bay, AK. JASCO Applied Sciences (Alaska). (Alaska), J.A.S. P001275-Document 01114, Anchorage, AK. December 28, 2015. 56 pp.

This report provides results from an acoustic monitoring program concurrent with Hilcorp's shallow geohazard and strudel scour survey in Foggy island Bay. The program was designed to address ambient sound levels and the presence, distribution, and migration paths of marine mammal species occurring near the Liberty field. Three months of autonomous passive acoustic data were collected using two AMARs. The data were processed to characterize the ambient sound levels and the presence of marine mammals including bowheads, belugas, and seals. The only manually and automated detected odontocete species was beluga whale. Beluga calls (whistles, buzzes, clicks and other high-frequency sounds) were detected on 5 days at AMAR 1 (14 Jul, and 3, 4, 8, and 13 Aug) and 4 days at AMAR 2 (3, 4, 9, and 13 Aug). Bearded seal calls (trills) were identified once at AMAR 1 on 3 Aug 2015 and once at AMAR 2 on 15 Aug 2015. Unidentified pinniped vocalizations were frequently detected at both stations. Vessels were detected at both locations. Vessel traffic was relatively light with an average of ~1 hour per day in which vessels traffic was detected. Statistical distribution of the ambient sound levels with frequency generally followed the expected trends for weather-driven ambient sound conditions with occasional influence from vessel noise. Sound levels recorded during Hilcorp's geohazard survey were no louder than those recorded after the survey was complete. Vessel noise and noise from the sub-bottom profiler were detectable during the survey; however these sources did not result in sound levels in excess of the measured variability of ambient noise due to weather events or unrelated vessels.

Olgoonik Fairweather LLC (2015). Arctic Nearshore Impact Monitoring in Development Area – III (ANIMIDA III): 2015 Field Report. U.S. Dept. of the Interior, Bureau of Safety and Environmental Enforcement and Bureau of Ocean Energy Management. October 21, 2015. 32 pp.

Olgoonik Fairweather, in conjunction with a team of sub-contractors, conducted a 7-day sampling cruise in the Beaufort Sea during August 2015. Forty-seven (47) stations were originally slated for sampling as per the ANIMIDA sampling plan. Thirty four (34) stations were sampled. Due to ice, many of the planned stations were unreachable. The sampling focused on physical oceanography trace metal chemistry, benthic invertebrates, fish, sediment biogeochemical and processes. While epibenthic invertebrates and fish are prey for marine mammals, the study did not collect information on marine mammals themselves.

Smith, C.E., Sykora-Bodie, S.T., Bloodworth, B., Pack, S.M., Spradlin, T.R. and LeBoeuf, N.R. (2015). Assessment of known impacts of unmanned aerial systems (UAS) on marine mammals: data gaps and recommendations for researchers in the United States. *Journal of Unmanned Vehicle Systems*, Subnitted:39 pp.

UAS have become more accessible to civilian operators and are quickly being integrated into existing research to replace manned aircraft. The lack of available information on the effects of UAS operations on marine mammals and other protected species has made it difficult to evaluate and mitigate potential impacts. This paper presents a synthesis of the current state of scientific understanding of the impacts of UAS near marine mammals. It also identifies key data gaps that are currently limiting the ability of marine resource managers to develop appropriate guidelines, policies or regulations for safe and responsible operation of UAS near marine mammals. The authors recommend that researchers prioritize collecting, analyzing, and disseminating data on marine mammal responses to UAS when using the devices to better inform the scientific community, regulators and hobbyists about potential effects and assist with the development of appropriate mitigation measures.

Angliss, R., Ferguson, M. and Kennedy, A. (2016). Manned vs unmanned aerial surveys of cetaceans in the Arctic: Operations and preliminary results. National Marine Fisheries Service. Marine Mammal Laboratory. 14 pp.

This is a PowerPoint presentation that describes the use if aerial surveys and states that they may be the only way to collect data in some areas and that they are less expensive and restrictive and create less disturbance. It describes a collaboration experiment that includ d observers in aircraft, digital photos taken from a manned aircraft and comparison to digital photos from the UAS. The authors found that conducting UAS and manned fights safely in close proximity at the same altitude was challenging. They concluded that the image resolution achieved was sufficient for distinguishing bowhead and gray whales at 305 maltitude, but better resolution was needed for areas with higher species diversity or smaller target animals. Post field data processing was a significant challenge and manual analysis of every image was not possible. Overall human observers were able to view more area and saw more whales than either imagery data set. Next steps include investigating automatic image analysis and deriving model-based estimates density and associated uncertainty.

Bishop, S.C. and Streever, B. (2016). Long-Term Ecological Monitoring in BP's North Slope Oil Fields Through 2014. BP Exploration (Alaska) Inc. Anchorage, AK. 112 pp.

This report summarizes long-term data on a number of topics with the intent of identifying trends. Of interest to BOEM are chapters on weather and climate (Chap 1), polar bear sightings (Chap 8), maternal polar bear dens (Chap 9), underwater sound near Northstar (Chap 11), whale calls near Northstar (Chap 12), and seal counts at Northstar island (Chap 13). The report is useful in that it provides historic information for comparison to more recent data. The authors note that the number of polar bear sightings on land has increased over time, which may reflect recent declines in sea ice (Chap 8). From 2002–2014, researchers using hand-held FLIR units confirmed the presence of 32 dens (Chap 9). A typical maternal den is 2 m in diameter, 1 m high, and lies under 0.5 m of snow. Some dens are much larger; one measured approximately 11 meters in length and had three separate living chambers. On average, two to four maternal den sites are monitored annually, and reproductive success of those bears has ranged from one to three cubs. In all years, sound levels recorded 450 m north of Northstar ranged from about 81 dB–141 dB re 1 µPa (Chap 11). The numerous spikes seen in sound levels each year are mainly produced by vessel traffic. Minimum sound levels vary widely from day to day as a function of wind speed. Baseline sound levels in 2014 were within the typical ranges observed in previous years. Analysis showed that the relative abundances of different whale call types varied from year to year (Chap 12). In 9 of the 14 study years, simple calls comprised roughly 80– 90% of calls, while

10–20% of calls were complex. No clear trend in seal abundance near Northstar was detected between 2005 and 2014 (Chap 13). Rather, the data indicate wide variability in seal counts both among years, and among days within most years.

CH2M Engineers Inc. (2016). Anchorage Port Modernization Program Test Pile Program Report of Findings. Municipality of Anchorage/Port of Anchorage. Anchorage, AK. 68 pp.
This program involved a geotechnical investigation and the installation of 10 48-inch indicator pipe piles. Two attenuation systems were tested, a confined air bubble curtain and a resonator system. Monitoring for marine mammals was conducted from three locations, the southern and northern ends of Port of Anchorage (POA)property and from a single mobile observer (rover) stationed on the shore near pile installation. Forty-four marine mammal sightings were documented: 10 beluga whales, 6 Steller sea lions, and 28 harbor seals. There were nine Level B takes, including one beluga whale, one Steller sea lion, and seven harbor seals. A single shut-down was recommended by the PSOs and implemented by the Contractor due to poor weather conditions and reduced visibility. Numbers of beluga whales were low in May, and beluga whales were not observed in June. This is consistent with other years of marine mammal observations. Harbor seals numbers increased during the program and were present in low but consistent numbers in June. Their movements were concentrated around the mouth of Ship Creek. On average, the air bubble curtain reduced near-source levels more than the passive resonator; this trend was observed most strongly for the hydraulic impact hammer. Results indicate that a confined air bubble curtain system should be utilized for future construction phases. The performance of the bubble curtain should be improved to match the documented performance of bubble curtain systems used for other pile installation projects.

Cooley, H., Crokus, B., Miller, S., Perham, C., Regehr, E. and Wilson, R. (2016). Polar Bear Program Annual Report. U.S. Fish and Wildlife Service. Marine Mammals Management. Anchorage, AK. 22 pp.
In 2016, 33 polar bear mortalities were reported. 29 bears were killed for subsistence from eight communities, and four polar bears were killed in defense of life. Over the last ten years (2007-2016), 453 bears were reported as removed, 270 male, and 98 female The sex was reported as unknown or was not reported for 85 bears, The majority of mortalities occurred in spring (March, April, and May. In addition to the 453 reported bear mortalities from human causes, six bears were reported with unknown causes of death; three were reported in 2012, two in 2013, and one in 2014. Nine bears were reported as having died from natural causes from 2007 to 2016. Reported annual polar bear harvest by Alaska Natives averaged 39 bears for the period from 2007 to 2016, and ranged from 13 bears (in 2015) to 74 bears (in 2012). Since 2014 the USFWS has analyzed observation data to estimate the weekly number of polar bears on shore in fall; identify annual trends, if any, in the number of bears on shore; and determine which factors influence the number and distribution of bears along the coast. The mean annual number of polar bears onshore during the study was 140. The number of polar bears on shore each week was strongly related to sea ice conditions; with more bears on shore when ice return dates were later. Distribution of polar bears on shore was affected by sea ice conditions, presence of barrier islands, and presence of subsistence-harvested whale carcasses. Polar bears tended to occur in greater numbers in areas with whale remains, more barrier island habitat, and earlier dates of sea ice return in fall. The Service concluded that the polar bear continues to meet the definition of threatened and recommends no status change at this time.

Denes, S.L., Warner, G.A., Austin, M.E. and MacGillivray, A.O. (2016). Hydroacoustic Pile Driving Noise Study – Comprehensive Report. Alaska Department of Transportation & Public Facilities and Federal Highway Administration. Juneau, AK. 238 pp.

Underwater sound pressure levels were recorded at four sites while hollow steel piles were installed by vibratory and impact pile driving for modernization of the Alaska Marine Highway System ferry terminals at Kake, Auke Bay, Kodiak, and Ketchikan. Autonomous sound recorders were placed at distances of 10 m and 1 km from each pile. A mobile hydrophone recording system drifted during measurements and collected underwater recordings of noise generated by vibratory pile driving, followed by impact pile driving at Kake, Auke Bay, and Ketchikan, and socket hole drilling followed by vibratory setting at Kodiak. An impact hammer was used for no more than five proofing strikes at Kodiak. The goal of the sound measurements was to quantify the underwater SPLs during pile driving events. From these data, the sound transmission loss was characterized and distances to marine mammal injury and disturbance thresholds were calculated. Computed TL)coefficients, varied between sites, ranging from 14.6 to 20.3 for impact pile driving and from 12.0 to 21.9 for vibratory pile driving. Distances to marine mammal disturbance thresholds were derived from regressions of unweighted SPL versus range and weighted SEL versus range. Ketchikan had the greatest computed range (mean levels) to the impact hammering disturbance threshold of 160 dB re 1 µPa at 2703 m. Source levels estimated in this study could apply to other pile driving activities that are similar in terms of hammer specifications, pile size, and sediment properties, but the TL coefficients are less applicable to other locations.

Durner, G.M., Laidre, K.L. and York, G.S. (2016). Proceedings of the18th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 7–11 June 2016, Anchorage, Alaska. IUCN/SSC Polar Bear Specialist Group. Anchorage, AK. 242 pp.

These Proceedings represent a summary for 2009–2016 on the state of knowledge and conservation concerns for polar bears throughout their range. Of the 19 polar bear subpopulations recognized by the Polar Bear Specialist Group (PBSG), population estimates were available for 14. Of the 19 subpopulations, 5 appeared to be stable, 1 may be increasing, 2 were decreasing, and 11 had insufficient data to estimate a trend. Since satellite imagery of sea ice extent began in 1978, the summertime extent of sea ice has declined from 2.3–20.5 % per decade, depending on the subpopulation. Empirical data collected from field efforts is revealing the mechanisms that climate warming driven sea ice loss is having on polar bears. The nature and timing of these mechanisms is not uniform across their pan-Arctic range. Neighboring subpopulations experiencing similar sea ice declines have responded differently, likely due to regional variation in productivity of the underlying biological oceanography, the energetic costs for occupying drifting sea ice, and sub-optimal habitats. Regardless, unabated sea ice declines as projected through the 21st century, are expected to negatively impact all polar bear subpopulations over the long-term. Polar bears continue to be an important species for indigenous peoples of Greenland, Canada, the Russian Federation, and the United States. Humans and polar bears are being brought into closer proximity the potential for negative interactions is increasing. Pollutants from southern latitudes affect the health of polar bears through atmospheric and oceanic transport of contaminants into their environment. Changing sea ice has also altered the behavior and distribution of bears, bringing them into increased contact with humans, terrestrial wildlife, and novel diseases. Co-management is now more than ever an integral part of polar bear conservation.

Gailey, G., Sychenko, O., McDonald, T., Racca, R., Rutenko, A. and Bröker, K. (2016). Behavioural responses of western gray whales to a 4-D seismic survey off northeastern Sakhalin Island, Russia. *Endangered Species Research*, 30:53-71.

A seismic survey conducted off the northeastern coast of Sakhalin Island, Russia in 2010 was located adjacent to the only known near-shore feeding ground of the Critically Endangered population of western gray whales *Eschrichtius robustus* in the western Pacific south of the Aleutian Islands. This study examined the effectiveness of efforts to minimize the behavioral responses of the whales to vessel proximity and sound during the survey. Two shore-based behavioral observation teams monitored whale movements and respirations pre-, during and post-seismic survey. Theodolite tracking and focal-animal follow methods were used to collect behavioral data. Mixed linear models were used to examine deviations from 'normal' patterns in movement and respiration in relation to vessel proximity, vessel/whale relative orientations and received sound metrics to examine if seismic survey sound and/or vessel activity influenced the whales' behavior. Behavioral state and water depth were the best 'natural' predictors of whale movements and respiration. After considering natural variation, none of the behavioral response variables were significantly associated with seismic survey or vessel sounds. A whale's distance from shore and its orientation relative to the closest vessel were found to be significantly influenced by vessel proximity, which suggested non-sound related disturbance. The lack of evidence that the whales responded to seismic survey sound and vessel traffic by changing either their movement or respiration patterns could indicate that the current mitigation strategy is effective.

Ireland, D.S., Bisson, L., Blackwell, S.B., Austin, M., Hannay, D.E., Bröker, K. and Macrander, A.M. (2016). Comprehensive Report of Marine Mammal Monitoring and Mitigation in the Chukchi and Beaufort Seas, 2006–2015. National Marine Fisheries Service and U.S. Fish and Wildlife Service. LGL Draft Report P1363-E August 2016. 558 pp + appendices.

This report is an overview of Shell's marine mammal monitoring results during offshore exploration activities in the Alaskan Chukchi Sea during the 2015 Arctic open-water season. Shell's exploration drilling program was the only such activity in offshore waters of the Chukchi Sea in 2015. Nearshore oil and gas-related industry activities were also conducted in the Beaufort Sea by Eni, Caleus, ExxonMobil and various vessel operators in 2015. Various aircraft were used in support of both marine mammal monitoring and the 2015 exploratory drilling program in the Chukchi Sea. PSOs were stationed aboard the two drilling units and 17 support vessels to conduct visual watches for marine mammals to serve as the basis for implementation of mitigation measures. The acoustic monitoring program consisted of two key components: sound source verification and characterization measurements, conducted to characterize the source levels and range-dependence of sounds emitted by individual vessels during discrete activities; and regional acoustic monitoring, conducted to characterize long-range propagation of sounds from the drilling program and to perform marine mammal vocalization detection and classification. Vessel-based monitoring effort and observations of bowhead whales in the Chukchi Sea from years when seismic or shallow-hazards surveys occurred were pooled and sighting rates within received sound level bins calculated. The combined sighting rate from both source and monitoring vessels was very similar in areas where received sound levels were ≥160 dB re 1 µPa rms SPL and ≤120 dB re 1 µPa rms SPL. This shows that whales did not completely avoid areas with higher received sound levels from seismic airguns. Overall, monitoring results cannot rule out that bowheads may have responded to or avoided exploration drilling activities at relatively short distances (<10-15 km), but they do not show that large-scale disruptions to the bowhead migration timing or use of the Chukchi Sea occurred. Vessel-based sightings data do not show clear evidence of bowhead avoidance of drilling activities in the Beaufort Sea. Additionally, mitigation measures applied during these activities appear

to have been effective in limiting impacts from offshore seismic operations in the Beaufort Sea to bowhead whales and to the subsistence bowhead hunts in Barrow, Kaktovik, and Nuiqsut.

McPherson, C., Kowarski, K., Delarue, J., Whitt, C., MacDonnell, J. and Martin, B. (2016). Passive Acoustic Monitoring of Ambient Noise and Marine Mammals—Barossa Field. JASCO Applied Sciences (Australia) Pty Ltd. Capalaba, Queensland, Australia. 99 pp.

From July 2014 to July 2015, JASCO conducted a twelve month baseline acoustic environment characterization program at and surrounding the Barossa field. Three AMARs were deployed close to the seabed at three stations. The AMARs captured data that were analyzed to quantify ambient sound levels, the presence of sounds related to anthropogenic activity, and the acoustic presence of marine mammals and fish. The minimum levels of ambient sound were consistent across all stations. Ambient data showed low levels of diel variations in sound levels attributable to biological events such as fish chorusing, but were otherwise primarily affected by weather events such as wind, at times producing a noticeable diel variation in sound levels, with levels increasing during the day and decreasing at night. Shipping was a minor contributor to the soundscape. Automated analysis techniques, including manually validated automated detectors, were used to determine the presence of vocalizing marine life. Omura's whales were detected consistently from April to September inclusive, with a peak in June and July. Pygmy blue whales were detected during their northward migration. No detections were logged from the south-bound migration, suggesting a different migration path. The highest calling rates of the three monitoring station occurred at the Barossa field, which may reflect its greater depth and proximity to the trench. Bryde's whales were present in the region from January to October. They appear to move into the area in a south to north direction during summer and autumn, then utilize the region with a preference for the shallower sections over the Barossa field region. They then leave the area in a north – south direction, with the last detections in early October. Odontocetes were extremely common. Many species were detected on a daily basis, with a primarily nocturnal diel cycle. Fish chorused at dawn and dusk over the entire deployment period at all three stations. Their chorusing varied in intensity over the deployment period, but was consistent in diel pattern.

NMFS (2016). Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts. National Marine Fisheries Service. Office of Protected Resources. NOAA Technical Memorandum. NMFS-OPR-55, Silver Spring, MD. July 2016. 178 pp.

This document provides technical guidance for assessing the effects of underwater anthropogenic (human-made) sound on the hearing of marine mammal species under the jurisdiction of NMFS and was completed in collaboration with the National Ocean Service, Office of National Marine Sanctuaries. Specifically, it identifies the received levels, or acoustic thresholds, at which individual marine mammals are predicted to experience changes in their hearing sensitivity (either temporary or permanent) for acute, incidental exposure to underwater anthropogenic sound sources. NMFS has compiled, interpreted, and synthesized the scientific literature to produce acoustic thresholds for onset TTS and PTS that update those currently in use by NMFS. Updates include a protocol for estimating PTS onset acoustic thresholds for impulsive and non-impulsive sound sources, the formation of marine mammal hearing groups (low- (LF), mid- (MF), and high- (HF) frequency cetaceans, and otariid (OW) and phocid (PW) pinnipeds; and the incorporation of marine mammal auditory weighting functions into the derivation of PTS acoustic thresholds. These acoustic thresholds are presented using dual metrics of cumulative sound exposure level (SEL_{cum}) and peak sound level (PK) for impulsive sounds and SEL_{cum} for non-impulsive sounds. These updated PTS acoustic thresholds do not represent the entirety of a comprehensive analysis of the effects of a proposed action, but rather serve as one tool (along with, e.g., behavioral impact thresholds, auditory masking assessments, evaluations to help understand the

ultimate effects of any particular type of impact on an individual's fitness, population assessments, etc.) to help evaluate the effects of a proposed action and make the relevant findings required by various statutes.

Olgoonik Fairweather LLC (2016). Walrus Disturbance Workshop Notes. Alaska Marine Science Symposium Walrus Disturbance Workshop. Anchorage, AK. 40 pp.
The PowerPoint presentation summarizes the USFWS regulatory program for walrus, walrus disturbance, NSB walrus subsistence; noise considerations, and data management. Under MMPA, AOGA requested regulations with a 5 year lifespan (2013-2018). Regulations are over 100 pages long and outline each specified activity to occur within a specified region. Mitigation measures included general mitigation for: operational and support vessels, aircraft, offshore and onshore exploration activities, offshore seismic surveys, onshore exploration activities, and subsistence. Specific mitigation measures implemented in these regulations for high density walrus use areas such as Hanna Shoal include specific measures and stipulations required for use of delineated areas from June-September. Comments from NSB included: "1) Mitigation measures aren't typically based on science; they are based on common sense or what people think makes sense. They seem reasonable, but there isn't justifiable science to support them. The 15 mile separation is intended to help with the subsistence hunt, and that's good, but not based on science.; 2) We need more quantifiable information to justify development and mitigations that are being made for disturbance on ice, land and foraging within the Hannah Shoals." One of the key things that stemmed this conversation was that Shell was not able to get into the Hanna Shoal Walrus Use Area (HSWUA) to deploy hydrophones. NSB is a proponent of using the hydrophones to monitor marine mammals. Shell wasn't able to get into this area but other scientific research vessels were able to get into HSWUA; ships were traveling through the area without any oversight.

USFWS (2016). Endangered and Threatened Wildlife and Plants; Endangered Species Act Compensatory Mitigation Policy. *Federal Register*, 81:61032-61065.
This draft policy is the first comprehensive treatment of compensatory mitigation under authority of the ESA to be issued by the Service. Section 5 of this policy addresses sections of the ESA under which the Service has authority to recommend or require compensatory mitigation for species or their habitat. Specific regulatory requirements exist for marine mammals under the MMPA, whether or not they are also listed or proposed for listing under the ESA, and allows for the authorization of incidental, but not intentional, take of small numbers of marine mammals, provided certain findings are made. The USFWS may issue an LOA for potential incidental take. The LOA will specify monitoring and reporting requirements to evaluate the level and impact of any taking. Depending on the nature, location, and timing of a proposed activity, the Service may require applicants to consult with potentially affected subsistence communities in Alaska and develop additional mitigation measures to address potential impacts to subsistence users. The USFWS shall recommend mitigation for impacts to species covered by the MMPA that are under our jurisdiction consistent with the guidance of this policy. Proponents may adopt these recommendations as components of proposed actions. However, such adoption itself does not constitute full compliance with the MMPA.

BOEM (2017). Alaska Annual Studies Plan: 2017. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. Anchorage, AK October 11, 2016. 233 pp.
The Alaska Annual Studies Plan FY 2017 complements and reinforces the goals of the Environmental Studies Program including: Monitoring Marine Environments; Conducting Oil-Spill Fate and Effects Research; Minimizing Impacts to Marine Mammals and Other Biota; Understanding Social and Economic Impacts; Maintaining Efficient and Effective Information Management; and Integrating

Scientific Results with Local and Traditional Ecological Knowledge. Current Keystone Studies include integrated multidisciplinary studies and studies specifically focused on marine mammals such as: Field Evaluation of a UAS for Studying Whales in the Arctic; Village-based Satellite Tracking of Ringed and Bearded Seals; Satellite Tracking of Bowhead Whales; Abundance and Demographic Rates of Pacific Walruses; and Distribution and Relative Abundance of Marine Mammals in the Chukchi Sea and the Fall Migration of Bowhead Whales in the Beaufort Sea. The plan also presents a general forecast of significant topical issues and concerns to be addressed by studies for FY 2019 and beyond.

Greeneridge Sciences Inc. (2017). Northstar Near-island Sound Levels, 2001–2016. Hilcorp Alaska LLC. 6 pp.

This memorandum summarizes underwater sound levels recorded near Northstar from 2001–2016. This period covers much of the construction of the island, the drilling of the wells, and the transition to a production operation. Acoustic instruments were deployed in late August and retrieved in late September or early October, as well as additional time periods in the early years of the monitoring program. The three most prominent features of the sound pressure time series (SPTS) were wind, vessels, and "pops". For the 16 years of the Northstar monitoring program, the near-island Northstar acoustic data confirmed that ambient underwater sound levels were strongly related to wind speed. Vertical "spikes" in the SPTS are short-duration increases in the received levels of sound usually caused by vessels arriving at or departing from the island. In many years of the 16-year Northstar monitoring program, vessels were the only sound source resulting in received sound levels greater than 120 dB re 1 µPa. In 2008 and 2009, an unidentified popping sound was prominent and frequent on the near-island recorders. These pops were impulsive and short duration (~0.05 s). Data from 2008, 2009, and 2013 suggested that the pops were likely generated near or slightly offshore of the northeast corner of Northstar. The specific source for the pops has not been identified, but available evidence suggests that it may be an object or structure underwater near Northstar that moves as a function of waves or current.

Kasper, J., Dunton, K.E., Schonberg, S.V., Trefry, J., Bluhm, B. and Durell, G. (2017). Arctic Nearshore Impact Monitoring in Development Area III (ANIMIDA): Contaminants, Sources, and Bioaccumulation. U.S. Dept of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2017-032, Contract No. M13PC00019 by Olgoonik Fairweather, LLC, Anchorage, AK. 273 pp.

The Arctic Nearshore Impact Monitoring in Development Area III (ANIMIDA III) Project was designed to update previous evaluations of impacts that may have resulted from offshore oil and gas exploration and production in the coastal Beaufort Sea. This report summarizes sampling efforts during the open-water periods in 2014 and 2015 (late July through early August in both years) and during the 2015 spring-freshet. This report describes observations of (1) physical oceanography, (2) the distributions of trace metals in bottom sediments, suspended sediments, and biota, (3) the characteristics of petroleum hydrocarbons in the sediments and benthic organisms, (4) benthic infauna, carbon resources, and trophic structure, and (5) epibenthic communities and demersal fish communities in the central portion of the U.S. Beaufort Sea. Regarding contamination, most of the metals and hydrocarbons found in sediments and biota from the ANIMIDA III study have been found to be introduced naturally by river runoff and coastal erosion. Very few instances of metal or hydrocarbon contamination have been identified in the coastal Beaufort Sea When limited instances of contamination have been identified, sources include the following: (1) discharged drilling mud and cuttings within 25-100 m of exploratory drilling sites (~30 Federal or Federal/State lease sites in the ANIMIDA III study area), (2) activities at coastal locations including West Dock, Endicott, Kaktovik, Northstar, and Liberty, and (3) a few other unidentified sources.

MacCracken, J.G., Beatty, W.S., Garlich-Miller, J.L., Kissling, M.L. and Snyder, J.A. (2017). Final Species Status Assessment for the Pacific Walrus (*Odobenus rosmarus divergens*). U.S. Dept. of the Interior, U.S. Fish and Wildlife Service. Marine Mammals Management. Anchorage, AK. May 2017. 298 pp.
In 2011 a12-month finding placed Pacific walrus the on the ESA candidate list. This Species Status Assessment considers the needs of Pacific walrus, the current conditions that allow it to meet those needs, and the effects of future conditions on the ability of walruses to meet those needs. The Service found that environmental changes over the last several years such as sea ice loss and associated stressors are impacting Pacific walruses, but that other stressors that were identified in 2011 have declined in magnitude. Despite the current ice-free period of about 2 months in the summer/fall, the study found that the population is currently under low levels of stress and recovering from a population decline that started about 1980 when the population was likely near the carrying capacity of the environment. Population modeling indicated that the current growth rate suggests stability within the Pacific walrus population. The Pacific walrus population has persisted through past climate change events; however, the ability of population to adapt to increasing stress is uncertain. The increasing trend in identified stressors closely follows the projected trend of decreasing sea ice. Although Pacific walruses are adapted to living in a dynamic environment and have demonstrated the ability to adjust their distribution and habitat use patterns in response to recent shifting patterns of sea ice, the increasing abundance stressors will negatively affect the population but to an unknown extent. Overall, this will likely result in a population decline and a reduction in resiliency and redundancy but not representation of the population.

NMFS (2017). National Marine Fisheries Service (NMFS) Alaska Region Statewide Marine Mammal Spill Preparedness and Response Structure; Expectations for Responsible Parties. National Marine Fisheries Service. 8 pp.
To assist with emergency response preparedness for marine mammals under NMFS jurisdiction in Alaska, the NMFS Alaska Region Protected Resources Division has developed the following general guidelines and standards for response capacity by responsible parties. The guidelines address sampling and necropsy: prepare to sample 50 live or dead pinnipeds the first week and perform necropsies on 50 dead pinnipeds or cetaceans. The guidelines also address cleaning and rehabilitation of live animals (maintain level of readiness for 25 live pinnipeds and two small cetaceans, and maintain the readiness for up to 1 year post spill). The guidelines restate NMFS authority and discusses increasing capacity of the Alaska Marine Mammal Stranding Network in the Kodiak and Cook Inlet regions.

Exxon Neftegas Ltd. and Sakhalin Energy Investment Company Ltd. (2018). Report on Gray Whale Monitoring Program off Northeast Sakhalin Island in 2017. Exxon Neftegas Limited. 50 pp.
Citation only. Out of geographic scope.

Fairweather Science LLC (2018). CIPL Extension Project: Marine Mammal Monitoring and Mitigation Plan (Revised). Harvest Alaska LLC. Revised March 2018. 15 pp.
Objectives of this 4 MP included: establish real-time mitigation procedures as required by the IHA; collect information needed to estimate the number of exposures of marine mammals to sound levels that may result in harassment, which must be reported to NMFS; collect data on occurrence and activities of marine mammals in the area and timing of the Project activities; provide an opportunity to collect information on behavioral responses of marine mammals to vessels; and provide a communication channel to coastal communities. It was not possible to safely place PSOs on vessels; one PSO was on the Tyonek platform and one was on land a Ladd Landing. The 4MP included shut down procedures and monitoring and clearing of a safety zone to protect marine mammals from injury

and disturbance. It also included recommendations for vessel speed or course alterations. UAS surveys were also planned to assist in safety zone monitoring.

Ferguson, M.C., Angliss, R.P., Kennedy, A., Lynch, B., Willoughby, A., Helker, V., Brower, A.A. and Clarke, J.T. (2018). Performance of Manned and Unmanned Aerial Surveys to Collect Visual Data and Imagery for Estimating Arctic Cetacean Density and Associated Uncertainty (DRAFT). ***Journal of Unmanned Vehicle Systems*****, 58 pp.**

Manned aerial surveys have been used successfully for decades to collect data to infer cetacean distribution, density, and abundance. UAS have potential to augment or replace some manned aerial surveys for cetaceans. We conducted a three way comparison among visual observations made by marine mammal observers aboard a Turbo Commander aircraft; imagery autonomously collected by a Nikon D810 camera system mounted to a belly port on the Turbo Commander; and imagery collected by a similar camera system on a remotely controlled ScanEagle® UAS operated by the U.S. Navy. Bowhead whale density estimates derived from the marine mammal observer data were higher than those from the Turbo Commander imagery; comparisons to the UAS imagery depended on survey sector and analytical method. Beluga density estimates derived from either dataset collected aboard the Turbo Commander were higher than estimates derived from the UAS imagery. Uncertainties in density estimates derived from the marine mammal observer data were lower than estimates derived from either imagery dataset due to the small sample sizes in the imagery. The visual line transect aerial survey conducted by marine mammal observers aboard the Turbo Commander was 68.5% of the cost of the photo strip transect survey aboard the same aircraft and 9.4% of the cost of the UAS survey.

Green, G.A., Blees, M., Cartier, P.G., Olson, L.R. and Leavitt, J.B. (2018). Quintillion 2017 Subsea Cable System Phase 1 Installation Program Marine Mammal Monitoring 90-Day Report. Quintillion Subsea Operations LLC. Anchorage, AK. January 2018. 35 pp + appendices.

Quintillion Subsea Operations, LLC (Quintillion), completed in October 2017 the installation phase of a subsea fiber-optic cable network along the northern and western coasts of Alaska. Ninety-six percent of the 1,904-km marine route was installed in 2016, with the remaining 76 km completed in summer and fall of 2017. As stipulated in the 2017 IHAs from both NMFS and USFWS, PSOs monitored for marine mammals from onboard the cable-lay. Within the Project Area, defined as all the cable and transit routes between Nome and Oliktok Point (or north of 64°N), PSOs recorded 187 groups of marine mammals composed of 248 individuals representing 10 species (bowhead whale, fin whale, humpback whale, minke whale, gray whale, bearded seal, ringed seal, spotted seal, Steller sea lion, and Pacific walrus). In addition, PSOs recorded 16 groups of 39 individual marine mammals during cable ship transit from Dutch Harbor to Nome. Four species (humpback whale, Dall's porpoise, harbor porpoise, and northern fur seal) were recorded during these transits across the Bering Sea. Four species typically defined as "subarctic" were recorded in the Project Area including fin whales (4 animals), humpback whales (14 animals), minke whales (3 animals), and Steller sea lions (2 animals). Thirty-three identified cetaceans and 88 identified pinnipeds (including one walrus) were potentially exposed to noise levels exceeding threshold. In no case did the number of potentially exposed animals come close to exceeding the authorized Level B take.

Sitkiewicz, S., Hetrick, W., Leonard, K. and Wisdom, S. (2018). 2018 Harvest Alaska Cook Inlet Pipeline Project Monitoring Program Marine Mammal Monitoring and Mitigation Report. Harvest Alaska LLC. November 26, 2018. 98 pp.

Harvest Alaska implemented the 4MP during their 2018 CIPL Cross Inlet Extension Project in Cook Inlet. Vessel activities occurred on the west side of middle Cook Inlet between Ladd Landing near Beluga, Alaska and the Tyonek Platform. Marine mammal observations began on May 9 and continued until

September 15, 2018. A total of 11 vessels operated over the duration of the CIPL project. The project utilized land and platform-based PSOs who monitored nearshore, middle, and offshore work zones between the two observation stations during daylight hours. A total of 493 sightings (i.e., groups) of approximately 1,184 individual marine mammals were observed from May 9-September 15, 2018. Harbor seals were the most frequently observed species with 313 sightings (~316 individuals), followed by beluga whales with 143 sightings (~814 individuals), and harbor porpoises with 29 sightings (~44 individuals). Also observed were 2 sightings (~3 individuals) of humpback whales, 1 sighting of ~1 Steller sea lion, 3 sightings of ~3 individual unidentified pinnipeds, 1 sighting of ~1 individual unidentified marine mammal. Mitigation measures identified in the IHA were incorporated into the PSO field protocol and implemented during the project. Prior to initiation of vessel activities, PSOs cleared the monitoring area for 30 minutes and requested additional time if marine mammals were present. A work shut-down was implemented if a marine mammal was observed within the safety zone (SZ) during vessel activities. During the CIPL project, 25 marine mammal sightings occurred while the SZ was being cleared and 1 sighting resulted in a work shut-down of vessel activities. A total of 18 marine mammals were observed within the Level B SZ during vessel activities, resulting in 18 Level B exposures. Marine mammals observed within the Level B SZ included 17 sightings of ~17 individual harbor seals and 1 sighting of a single humpback whale. There was one marine mammal carcass observed during the CIPL project which was recorded as a Level A sighting; the marine mammal's death was not due to CIPL project activities. The dead animal was unidentifiable, and all necessary notifications and reporting took place in a timely manner.

Verfuss, U.K., Gillespie, D., Gordon, J., Marques, T.A., Miller, B., Plunkett, R., Theriault, J.A., Tollit, D.J., Zitterbart, D.P., Hubert, P. and Thomas, L. (2018). Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys. *Marine Pollution Bulletin*, 126:1-18.

Loud sound emitted during offshore industrial activities can impact marine mammals. Regulations typically prescribe marine mammal monitoring before and/or during these activities to implement mitigation measures that minimise potential acoustic impacts. Using seismic surveys under low visibility conditions as a case study, we review which monitoring methods are suitable and compare their relative strengths and weaknesses. Passive acoustic monitoring has been implemented as either a complementary or alternative method to visual monitoring in low visibility conditions. Other methods such as RADAR, active sonar and thermal infrared have also been tested, but are rarely recommended by regulatory bodies. The efficiency of the monitoring method(s) will depend on the animal behaviour and environmental conditions, however, using a combination of complementary systems generally improves the overall detection performance. We recommend that the performance of monitoring systems, over a range of conditions, is explored in a modelling framework for a variety of species.

Alaska Fisheries Science Center (2019). ASAMM polar bear sightings, 16-30 September 2019. Email communication, 3 pp.

This is an email that summarizes polar bear sightings in the eastern Chukchi and western Beaufort seas over the period Sept. 16-30, 2019. A figure is included: 20 Sep – One polar bear was standing on a barrier island approximately 30 km east of Utqiaġvik. 24 Sep – Twenty-five polar bears, including 10 cubs/yearlings, were milling on Cross Island. One polar bear was swimming in open water approximately 22 km east of Cross Island. One polar bear was resting in open water approximately 50 km west of Kaktovik. A sow and cub were walking on a barrier island approximately 70 km east of Kaktovik. Five polar bears were on barrier islands or the beach near Kaktovik; one bear was swimming approximately 25 km northwest of Kaktovik. 25 Sep – 52 polar bears, including 11 cubs/yearlings, were distributed along the coastline from approximately 15 km east of Kaktovik to the western part of

Camden Bay. Two polar bears were swimming near the coast approximately 60 and 70 km southeast of Kaktovik. 27 Sep – One polar bear was walking along on the western edge of Smith Bay, one adult with a cub/yearling were standing on a barrier island approximately 25 km west of Cape Halkett, and one adult with a cub/yearling were resting on a barrier island approximately 40 km west of Cross Island. 28 Sep – One polar bear was standing on a barrier island approximately 25 km east of Utqiaġvik. Thirty polar bears with 8 cubs/yearlings were resting on Cross Island, and one bear was swimming in the water. Two polar bears were resting on a barrier island approximately 30 km southeast of Cross Island. One polar bear was swimming approximately 45 km east of Cross Island. One polar bear was sighted swimming in open water approximately 80 km east of Cross Island. One polar bear was swimming next to a bowhead whale carcass approximately 12 km east of Demarcation Bay. One polar bear was walking on a barrier island approximately 30 km northwest of Demarcation Bay. One polar bear adult and one cub/yearling were walking on a barrier island approximately 30 km east of Kaktovik. 29 Sep – 19 polar bears, including 4 cubs/yearlings polar bears were sighted on barrier islands near Kaktovik. 30 Sep – Two polar bears were resting on a barrier island approximately 75 km southeast of Kaktovik, and one polar bear was walking on a barrier island in Camden Bay.

Castellote, M. (2019). Harvest's Cook Inlet Pipeline (CIPL) Extension Project Acoustic Monitoring: Final Report. University of Washington, NOAA Fisheries, Joint Institute for the Study of the Atmosphere and Ocean. Seattle, WA. 33 pp.

Between May and September 2018, Harvest Alaska installed two subsea oil and gas pipelines within Cook Inlet beluga whale critical habitat. To characterize the underwater noise generated by these activities to inform management decisions in future projects, and reduce assumptions related to the potential acoustic disturbance to endangered marine mammal species, a passive acoustic mooring package was deployed 1 km north of the pipeline corridor for 128 days during construction. A total of 6 noise sources were identified and linked to the construction activities, plus an unknown source of mechanical machinery. Results demonstrate although winch noise and pipeline drag generated tonal and impulsive signals, broadband vessel noise was the primary source of acoustic disturbance. Instead of being concentrated in periods corresponding to operations along the closest section of pipeline path to the acoustic moorings, vessel noise was broadly distributed in time and space. Noise generated by the anchor buoy lines during periods of high currents provided the highest SPL with a median of 144.7 dB re 1 µPa for the frequency range of 20 Hz to 24 kHz. When considering the full construction period, the frequency range of highest disturbance was 20 Hz to 5400 Hz. Overall SPL ranged from 86 to 137 dB, and 31.1% of the sampled time SPLs exceeded the level B harassment threshold of 120 dB. These results demonstrate the IHA analysis was conservative most but not all of the time and potential harassment was adequately characterized. When concurrent acoustic and visual efforts were compared, all days with beluga whale sightings included acoustic detections except 3 (2.3 %), while 28 days (21.3%) with beluga acoustic detections did not include visual sightings. Maximum acoustic detection range from the mooring was estimated at 6.7 km for vocalizations and 2.4 km for echolocation.

Trefry, J.H. and Neff, J.M. (2019). Effects of offshore oil exploration and development in the Alaskan Beaufort Sea: A three-decade record for sediment metals. *Integrated Environmental Assessment and Management*, 15:209-223.

Impacts from oil exploration, development, and production in the Beaufort Sea, Alaska, USA are assessed using concentrations of metals in sediments collected during 2014 to 2015, combined with a large data set for 1985 to 2006. Concentrations of 7 (1980s) or 17 (1999-2015) metals in 423 surface sediments from 134 stations, plus 563 samples from 30 cores were highly variable, primarily as a function of sediment granulometry with naturally greater metals concentrations in fine-grained, Al-rich

sediment. Metals versus Al correlation plots were used to normalize metals concentrations and identify values significantly above background. Barium, Cr, Cu, Hg, and Pb concentrations were above background, but variable, within 250 m of some offshore sites where drilling occurred between 1981 and 2001; these areas totaled <6 km^2 of 11 000 km^2 in the total lease area. Random and fixed sampling along the coastal Beaufort Sea from 1985 to 2015 yielded 40 positive anomalies for metals in surface sediments (approximately 0.8% of 5082 data points). About 85% of the anomalies were from developed areas. Half the anomalies were for the 5 metals found enhanced near drilling sites. No metals concentrations, except As, exceeded accepted sediment quality criteria. Interannual shifts in metals values for surface sediments at inner shelf sites were common and linked to storm-induced transitions in granulometry; however, metal-to-Al ratios were uniform during these shifts. Sediment cores generally recorded centuries of background values, except for As, Fe, and Mn. These three metals were naturally enriched in sediments from deeper water (>100 m) via diagenetic remobilization at sediment depths of 5 to 15 cm, upward diffusion, and precipitation in surface oxic layers. Minimal evidence for anthropogenic inputs of metals, except near some exploratory drilling sites, is consistent with extraction of most oil from land or barrier islands in the Alaskan Arctic and restricted offshore activity to date.

Dunton, K.E., Bonsell, D.E., Iken, K., Konar, B., Muth, A.F. and Schonberg, S.V. (2020). ANIMIDA III Boulder Patch and Other Kelp Communities in Development Area III, Final Report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2019-053, Cooperative Agreement No. M12AC00007, January 15, 2020. 172 pp.

The objectives of this program in the Boulder Patch were to: 1) monitor physical parameters that define the spatial variability in annual kelp productivity and biomass; 2) characterize benthic community structure changes and 3) collect annual measurements of kelp growth to provide a nearly continuous record of kelp growth since 1977. The results show that the Boulder Patch remains a dynamic, productive, biologically diverse environment within Stefansson Sound. Seasonal environmental fluctuations in salinity and light levels influence the current spatial species distributions. Through long-term observations, benthic monitoring and experimental work, we can reach a better understanding of how environmental factors shape this ecosystem and how it may respond to changes associated with regional climate warming.

Bin 5 – Subsistence and Traditional Knowledge (TK)

Nielsen, J.B. (1988). Inupiat Whaling and Oil Industry in North Alaska. *Folk*, 30:57-71.
The article focuses on the ramifications of the pressures on Inupiat whaling and attempts to solve the problems, which led to the establishment of the 1986 Oil/ Whalers Working Group and a changed relationship between lnupiaq whalers and the oil industry. The fall whaling has special importance to Nuiqsut and Kaktovik. The proximity of oil industry activities has created the fear of impact on the fall whaling, and disturbance of the bowhead whale migration pattern. The article reveals how recent cooperation between the AEWC and the oil industry has tried to solve these problems, and describes in detail whaling celebrations in Barrow (Utqiagvik), the cultural aspects of whaling, and interactions and agreements between the AEWC and industry. However, another side of the problem remains. The Inupiat Community wants lnupiat rights to title and jurisdiction in areas of the Beaufort and Chukchi Seas. The AEWC seems to undermine these long term goals. The whaling issue is linked to the sovereignty issue, and the AEWC has obligations to think of the long term implications of this in its future activities and dealings with the oil industry.

Brower, H.K., Olemaun, T. and Hepa, R.T. (2000). North Slope Borough Subsistence Harvest Documentation Project; Data for Kaktovik, Alaska for the Period December 1, 1994 to November 30, 1995. North Slope Borough. Department of Wildlife Management. Barrow, AK. September 20, 2000. 81 pp.
The objectives of the study described in this report were to: 1) document the level of subsistence harvested animals required by the village of Kaktovik in the NSB to meet its nutritional and cultural needs, 2) obtain harvest and land use data for the purpose of allowing greater local participation in the management of wildlife resources within the NSB and to allow the NSB to better represent residents of Kaktovik in dealing with State and Federal regulatory agencies. Subsistence harvest data were obtained through interviews with members in the community from 1 December 1994 to 30 November 1995. Each of 73 households was assigned an identification number, which provided for data confidentiality in reporting. A standardized form was used to collect harvest data. Project leaders reported back to community members prior to finalizing the harvest report document. A summary of harvest levels for subsistence species other than fish and fish was provided in Figures 4 and 5, respectively. A summary of marine mammal harvest data was provided in Figure 12. The authors noted that 61% of the estimated harvest in edible pounds was from marine mammals. Further, the authors noted that sharing of the subsistence harvest among community members was a common practice.

Huntington, H.P. (2000). Traditional knowledge of the ecology of belugas, *Delphinapterus lecuas*, in Cook Inlet, Alaska. *Marine Fisheries Review*, 62:134-140.
This paper systematically documents the knowledge of hunters of Cook Inlet belugas (i.e., the life history of belugas in Cook Inlet, as well as their habitat use patterns). The author used a semi-directive interview protocol for collecting information from participants. The initial interviews were held between November 1998 and February 1999. Ten participants were involved in the study, who were identified as knowledgeable regarding Cook Inlet belugas by the Cook Inlet Marine Mammal Council and NMFS personnel. The author summarized information from the interviews in the following categories: 1) distribution, abundance and migration pattern, 2) natural history, and 3) related observations. Several participants noted that declines in the number of fish in Cook Inlet over the past few decades were a significant factor in changes in the distribution and number of belugas in Cook Inlet. Participants in this study added considerable detail to available information regarding belugas in Cook Inlet, including information on distribution, abundance and natural history from the 1930s to the present. Finally, the author noted that the participation of local hunters in studies related to Cook Inlet belugas was an important step in the conservation of this population.

MMS (2000). Proceedings of the Beaufort Sea Information Update Meeting. U.S. Dept. of the Interior, Minerals Management Service. Alaska OCS Region. 46 pp.
A Beaufort Sea information update meeting was held on 28 and 29 March 2000 in Barrow (Utqiagvik), Alaska for the purpose of updating the local community regarding BOEM OCS activities. The workshop was part of BOEM's Environmental Studies Program. Over 100 people participated in the meeting. Fifteen scientists presented talks at this meeting. Abstracts for each presentation make up the bulk of the meeting report. The following talks were presented: 1) update on scientific and traditional knowledge studies on feeding of bowhead whales, 2) impacts of an oil spill on bowhead whales, 3) bowhead whale migratory behavior, 4) acoustic monitoring of marine mammals, 5) distribution and abundance of ringed seals in northern Alaska, 6) an update on polar bear research in Alaska, 7) status of king and common eider, 8) status of Beaufort Sea waterfowl and marine birds, 9) the Alaska Marine Mammal Tissue archive, 10) studies to monitor the impact of nearshore oil and gas activities in the Beaufort Sea, 11) the Alaskan frozen tissue collection, 12) establishing a computer accessible Traditional Knowledge database, 13) subsistence economics and oil development, 14) reference manual for geospatial database of oil industry and human activities in the Beaufort Sea (1979-1998), and 15) fisheries for Arctic cisco in the mid-Beaufort Sea and Colville River areas.

BP Exploration Inc. (2001). BP Exploration Inc. Good Neighbor Policy: Northstar Project. BP Exploration Inc. 18 pp.
In this document, BPXA codifies that they understand the risks to the Alaska Native subsistence life style and culture posed by oil and gas exploration and were committed to efforts to mitigate the effects of a large offshore crude oil spill. BPXA noted they were committed to this policy until BPXA no longer produces crude oil at the Northstar facility and until Northstar has been fully decommissioned. The marine mammal resources of greatest importance to subsistence hunters and at risk due to an oil spill were identified as bowhead whale, beluga, ringed seal, bearded seal, walrus, and polar bears (as well as fish and water fowl). Mitigation measures were described which included: 1) hunting for subsistence resources at other locations, 2) trading quotas with other villages, 3) transporting the catch from other areas to areas impacted by the spill, and 4) hunting of alternative species for subsistence use. All of these measures would have cost implications to villages in the vicinity of Northstar. The elements of the policy described in this paper were: 1) a bond of $20 million was established by BPXA as a financial assurance instrument, 2) the intended purpose for mitigation funds in the advent of an oil spill was described, 3) establishment of a Trustee (i.e., Wells Fargo Bank), 4) the protocol for the disbursement of funds was described, 5) provisions for assistance for interim transportation were described, 6) provisions for interim alternate food supplies were described, 7) provisions for interim counseling and cultural assistance were described, and 8) provisions for interim IWC quota restoration were described. The policy also includes a dispute resolution mechanism. In attachment 1, village-specific mitigation efforts and associated costs are described, which were based on household survey results regarding subsistence use patterns.

Richardson, J.W. and Thomson, D.H. (2002). Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea - Update of Scientific and Traditional Information Vol 2. U.S. Dept. of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2002-12, LGL Report TA2196-7, Anchorage, AK. October 2002. 282 pp.
This is a compendium of several research papers on diet and regional occurrence of bowhead whale feeding. The first component sought to determine (1) what types of prey bowhead whales of the Bering-Chukchi-Beaufort (BCB) stock eat, and (2) what parts of their seasonal range provide the pre-dominant part of this food. The second study documents bowhead whale feeding in the Alaskan Beaufort Sea based on stomach contents of whales harvested by Alaska Natives. This study determined

that 105 bowheads taken in the Alaskan Beaufort Sea during September-October had been feeding and 32 had not. Copepods and euphausiids were the main bowhead prey items near Kaktovik. Other studies in the compendium induced research on fatty acids in bowhead whales to determine integrated diets, and tracking bowhead feeding by stable isotopes.

Galginaitis, M. and Funk, D.W. (2004). Annual Assessment of Subsistence Bowhead Whaling Near Cross Island, 2001 and 2002- ANIMIDA Task 4 Final Report. U.S. Dept. of the Interior, Minerals Management Service. Alaska OCS Region. MMS-2004-030, Anchorage, AK. April 2004. 55 pp.
The authors in this report summarized the subsistence whaling practices at Cross Island by residents of Nuiqsut for years 2001 and 2002. The report has companion reports that cover a total of 6 years of whaling at this location. The following information was collected routinely in all years: 1) Number of crews actively whaling (observation), 2) Size and composition of crews, and fluctuation over the whaling season (observation), 3) Number of whales harvested (observation, self-report), 4) Days spent whaling, and days prevented from whaling (observation, self-report), 5) Days suitable for whaling when whaling did not occur (observation, self-report), 6) Subsistence activities occurring other than whaling (self-report, observation), 7) Location of whale searching, whale sightings, and whale harvest (GPS, self-report), 8) Local weather and ice conditions (observation, self-report), 9) Bowhead whale behavior in the Cross Island area, and differences from past experience (self-report), 10) Changes in access or other issues related to the whale hunt, such as increased effort for the same (or reduced) harvest, increased risk, increased cost (self-report). The authors also summarized Nuiqsut whalers' observations and perceptions on how whale behavior in 2001 and 2002 was different from that of other years, and the implications of those differences for subsistence whaling. The report includes an excellent summary of contemporary and historical subsistence whaling practices. The figures in the report were helpful in understanding spatial relationships described by the hunters, and patterns of whaling effort and landings data.

Ice Seal Committee (2006). Agreement between the Ice Seal Committee (ISC) and the National Marine Fisheries Service (NMFS) for the Co-Management of Alaskan Ice Seal Populations. 7 pp.
This document codifies an agreement between the members of the Ice Seal Committee (ISC) and NMFS for the co-management of ice seals in Alaska. Further, it is noted that the purpose of the agreement is to set forth a structure for the conservation and management of ice seals, where the purpose of this management is to: 1) promote the sustained health of Alaskan ice seals in order to protect the culture and way of life of Alaska Natives who rely on the harvest of ice seals for subsistence uses; 2) advance co-management, research, and the use of traditional knowledge of Alaska Natives; and 3) provide information to subsistence hunters and the public at large. The agreement provides for full and equal participation of both parties in decisions affecting the subsistence management of four species of ice seals (ringed, bearded, ribbon and spotted seals). It was documented that decision making will be by consensus of the parties. Regarding operational considerations, it was noted that: 1) the Co-Management Committee will be comprised of 5 members from the 5 regional management areas and 3 NMFS employees, 2) the Committee is responsible for the development of a Management Plan, and 3) annual meetings will be held that are open to the public, although executive sessions are authorized. The Management Plan included: 1) population monitoring, 2) harvest monitoring, 3) education, 4) research recommendations, 5) management issues, 6) training, 7) traditional knowledge, and 8) other recommendations. The parties further agreed to consult regarding any stock listings under the MMPA or ESA, and any management implications associated with such listings. The agreement makes no party responsible for financial commitments.

Noongwook, G., The Native Village of Savoonga, The Native Village of Gambell, Huntington, H.P. and George, J.C. (2007). Traditional Knowledge of the Bowhead Whale (*Balaena Mysticetus*) around St. Lawrence Island, Alaska. *Arctic*, 60:47-54.
Relatively little research has been conducted on the bowhead whale (*Balaena mysticetus*) in the northern Bering Sea. This paper documents traditional knowledge of bowhead whales presented by Yupik whalers of St. Lawrence Island. Descriptions of the seasonal movements, distribution, and abundance of bowheads near St. Lawrence Island are provided. Based on the TK, the bowhead population appears to be increasing, as is the number of young whales seen. Changing environmental conditions are influencing distribution, leading to an earlier spring migration and a greater presence of whales near the island in winter. Hunters describe two bowhead migration paths near the island. It is unknown whether these two paths are used by two genetically different groups of whales, or whether the animals are simply responding differently to oceanographic conditions or geography. The findings are consistent with studies of this bowhead population conducted elsewhere and suggest that additional research is needed to determine possible migratory (or genetic) differences between the two migrations of whales seen at St. Lawrence Island [Abstract only]

EDAW Inc., Adams/Russel Consulting, Applied Sociocultural Research, Callaway, D.G., Circumpolar Research Associates and Northern Economics Inc. (2008). Quantitative Description of Potential Impacts of OCS Activities on Bowhead Whale Hunting Activities in the Beaufort Sea. U.S. Dept. of the Interior, Minerals Management Service. Alaska OCS Region. MMS-2007-062, Anchorage, AK. 289 pp.
The project provides comprehensive profiles of four communities: Barrow (Utqiagvik), Kaktovik, Nuiqsut, and Savoonga and then addresses results as to how communities evaluate OCS activities as an event in their environment and the overall risks and benefits associated with these activities. Data were collected via: 1) literature review, 2) structured questionnaires to community members, and 3) semi-structured and unstructured interviews. Key findings include: 1) industry activity is designated as the major factor in the disturbance of bowhead migration patterns during the fall whaling season, whereas changes in the spring bowhead migration pattern are largely attributed to climate change, and 2) 69% of the surveyed whaling captains in the NSB communities believe it is not possible to have oil development in offshore coastal areas and at the same time provide adequate safeguards to protect the environment and important cultural activities. Key information gaps or research needs include: 1) development of a comprehensive research plan, 2) design and implement a survey to better understand perception of community youth and students, and 3) an in-depth investigation of the dependence on subsistence foods in the four communities.

Hovelsrud, G.K., McKenna, M. and Huntington, H.P. (2008). Marine Mammal Harvests and Other Interactions with Humans. *Ecological Applications*, 18:S135-S147.
This paper has three parts: 1) an overview of marine mammal harvesting activities in the different circumpolar regions provide a snapshot of current practices and condition; 2) case studies of selected Arctic regions, indigenous groups, and species provide insight into the manner in which climate change is already impacting marine mammal harvesting activities in the Arctic; and 3) a description of how climate change is likely to affect shipping and oil and gas exploration and production activities in the Arctic the possible implications of these changes for the marine mammal populations is provided. The paper concludes that many of the consequences of climate change are likely to be negative for marine mammal hunters and for marine mammals. However, a lack of adequate baseline data makes it difficult to identify specific causal mechanisms and thus to develop appropriate conservation measures. Nonetheless, the future of Arctic marine mammals and human uses of them depends on addressing this challenge successfully

Braund, S.R. and Kruse, J. (2009). Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska. U.S. Dept. of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2009-006, Anchorage, AK. May 2009. 462 pp.
This report was funded by MMS to provide a synthesis of social research in Alaska from 1975 – 2004. The synthesis was intended to capture the key findings in over two hundred formal reports funded by the MMS Environmental Studies Program on the effects of offshore oil and gas development on the residents of Alaska, as well as over 2000 social science research publications. Findings to a large extent were reported for each of seven Petroleum Development Regions, including the Beaufort Sea region (but not the Chukchi Sea region). The following chapters by various authors include information pertinent to the impact of oil and gas development on marine mammals in the U.S. Arctic and Cook Inlet or on traditional knowledge related to marine mammals in these two regions: 1) history of petroleum exploration and production in Alaska (pp. 31-50), 2) coastal villages economy baseline studies (pp 88-99), 3) community effects- the North Slope: a case study (pp. 105-108), 3) subsistence harvest studies and traditional knowledge studies (pp. 142 – 162), 4) subsistence harvest patterns and oil development on Alaska's North Slope (pp. 193 – 244), 5) summary and conclusions (pp. 343-352). The authors concluded by noting that the focus of sociocultural studies in the future regarding the impacts of oil and gas activities should be a quantitative assessment of the cumulative effects of change in the regions most likely affected by offshore development for oil and gas.

Galginaitis, M. (2009). Annual Assessment of Subsistence Bowhead Whaling Near Cross Island, 2001-2007: Final Report. U.S. Dept. of the Interior, Minerals Management Service. alaska OCS Region. MMS-2009-038, Anchorage, AK. 110 pp.
This report is a synthesis of seven annual reports from 2001 – 2007 and describes subsistence whaling as currently conducted near Cross Island by residents of Nuiqsut. The purpose of this synthesis is to provide a baseline for basic parameters of Cross Island whaling, which can be compared with similar data collected and reported on in the future. Three primary methods of information collection were utilized: systematic observations, collection of daily vessel locations from handheld Global Positioning System (GPS) units, and whaler's self-reports and perceptions. In addition to reporting on baseline information regarding whaling operations, the author described in detail through text and figures the history of whaling, the culture of Nuiqsut whalers, and issues related to disturbance to whaling caused by oil and gas operations. For the seven seasons, the number of days at least one whaling crew occupied Cross Island ranged from 13-30 days, while the number of whaling crews varied from 3-5. The seasonal average for scouting trips ranged from 48 to 135 km (roundtrip) and from 4 hours 31 minutes to nine hours 43 minutes. The average seasonal strike distance from Cross Island ranged from 15 to 42 km. The annual quota for the Nuiqsut whalers was four strikes, or a potential for 28 whales landed over 7 years. A total of 22 whales were landed. In addition, there were 2 struck-and-lost whales. Whales were generally closer to Cross Island (13 to 24 km) in the seasons with poor weather and no or little ice. The author noted that Nuiqsut whalers for the most part use black powder explosive bombs in the harpoons rather than penthrite bombs. Two hypotheses were posed by the author indicating an expectation that oil and gas development at Northstar and Liberty disrupted whaling operations. However, the author was unable to reject or accept the hypotheses with the available data from this study period.

Huntington, H.P. (2009). A preliminary assessment of threats to Arctic marine mammals and their conservation in the coming decades. *Marine Policy*, 33:77-82.
In this paper, the author noted that Arctic marine mammals over the next several decades will face threats from: 1) climate change, 2) environmental contaminants, 3) offshore oil and gas activities, 4) shipping, 5) hunting, and 6) commercial fisheries. The author concluded that climate change, oil and

gas activities and commercial fishing pose the most serious threat to populations of Arctic marine mammals. Further, the author commented that addressing the impacts of all six factors would be necessary to avoid further declines in marine mammal abundance in the Arctic.

Huntington, H.P. and Quakenbush, L. (2009). Traditional Knowledge of Bowhead Whale Migratory Patterns near Kaktovik and Barrow, Alaska. Report to the Barrow and Kaktovik Whaling Captains Associations and the Alaska Eskimo Whaling Commission, October 2009. 13 pp.
This report was prepared for the Barrow (Utqiagvik) and Kaktovik Whaling Captains Associations and the AEWC. At the request of the AEWC, the Alaska Department of Fish and Game interviewed whaling captains and crew from Barrow (Utqiagvik) and Kaktovik to document traditional knowledge of bowhead whale movements and behavior near those villages. The study was funded by a grant from CPAI. A semi-directive interview protocol was followed. Interviews were conducted in February 2007 and conducted in English. Five interviews of whalers or whaling captains were conducted in Kaktovik, and six in Barrow (Utqiagvik). Information collected as part of these interviews was reported herein. Information on migratory phenology and behavior was reported separately for the two villages (see Figures 1-3). Concerns were raised by hunters from Kaktovik that noise from offshore oil activity in their traditional hunting area will cause animals to move offshore, making them more difficult to hunt. Hunters from Barrow (Utqiagvik) noted that changes in sea ice and increased noise from snowmachine travel on the fast ice have led to noticeable changes in the spring bowhead whale migration. In addition, the hunters commented that bowhead whales avoided an area offshore of Point Barrow when a test well in the area was being drilled, where the whales returned to the area after the drilling was completed.

Palmer, A.C. (2009). Under what conditions can oil and gas developments in the Arctic be acceptable, and to whom? *Polar Record*, 45:113-117.
The author in this paper has attempted to address a number of issues related to the question posed in the title. The author is an engineer (who is not from or does not currently live in the Arctic). In addressing the central question of this paper, the author noted the following both with case examples and references from the literature: 1) progress in technology has provided for a lessening of the impacts of oil and gas development in a given area, 2) the impacts of construction are land are greater than they are for offshore construction projects; however, the impact of an oil spill from an offshore site would be greater than the impact of a spill from an on land site, 3) a few places in the Arctic have such a high value to humanity that no development should be allowed; however, the number of such places is relatively low, and 4) it should be possible to provide adequate safeguards for the environment and local communities by industry when pursuing oil and gas development, but in these cases a long-term commitment from the industry for adequate resources and in a timely manner is required.

Stephen R. Braund & Associates (2009). Impacts and benefits of oil and gas development to Barrow, Nuiqsut, Wainwright, and Atqasuk harvesters. North Slope Borough Department of Wildlife Management. Barrow, AK. 377 pp.
In this study, the author noted four objectives: 1) document the impacts and benefits of oil and gas development as perceived by NSB residents of four communities: Nuiqsut, Barrow (Utqiagvik), Atqasuk, and Wainwright, where each of these four communities could be potentially affected by oil and gas development in the NPR-A, 2) document personal experiences of residents with impacts and benefits related to oil and gas development in their region, 3) identify ways in which impacts to community members or communities could be mitigated and benefits enhanced, and 4) place oil and gas impacts in the context of how the well-being of North Slope residents has changed over the past thirty years

and how it compares with the well-being of other arctic residents. Responses related to each objective based on interview results were provided. Conclusions of the study related to marine mammals included: 1) a consensus that oil and gas activities individually and through cumulative effects posed a threat to the subsistence lifestyle on the North Slope, 2) North Slope residents fear the consequences of an oil spill, primarily due to the industry's inability to clean up an oil spill in ice invested waters, 3) hunters have concerns that anthropogenic noise related to oil and gas activities will impact marine mammals and other wildlife species such that successful hunts of animals will be more expensive, take longer, and pose a greater risk, 4) climate change is linked to oil and gas development and together result in greater adverse cumulative effects, and 5) community members were aware of mitigation efforts on the part of the oil and gas industry. The document included specific quotes and suggestions from individual community members, which were informative.

Quakenbush, L. and Huntington, H. (2010). Traditional Knowledge Regarding Bowhead Whales in the Chukchi Sea near Wainwright, Alaska. U.S. Dept. of the Interior, Minerals Management Service and Coastal Marine Institute, University of Alaska, Fairbanks. MMS 2009-063, Fairbanks, AK. September 2010. 35 pp.

There is an extensive amount of traditional knowledge on bowhead whale migration patterns and behavior near subsistence whaling villages. This project collected TK from Inupiat hunters so that it could be combined with a BOEMRE-funded telemetry whale tracking study to document bowhead whale movements, important habitats and interactions with industrial activities. The TK summarized by this paper provided valuable information on the timing of migration and how close to shore the whales migrate. As expected routes change based on changes in sea ice. TK also helped in the planning of satellite tag deployments and interpretation of satellite data. The combination of the satellite data and TK is being incorporated into scientific studies.

Stephen R. Braund & Associates (2010). Literature Review of North Slope Marine Traditional Knowledge. U.S. Environmental Protection Agency. Region 10. June 4, 2010. 120 pp.

The authors noted that there are four sources of TK: 1) focused TK studies on the physical and biological environment, 2) public testimony, 3) subsistence mapping, and 4) harvest data studies. This information related to the marine environment of the Chukchi and Beaufort seas was the focus of this literature review. Six communities were included in the study – Barrow (Utqiagvik), Wainwright, Kaktovik, Nuiqsut, Point Hope, and Point Lay. Table 1 in this review summarized MMS EISs and EAs that include TK related to the environment of the Chukchi and Beaufort Seas. A large number of additional references were listed in the literature cited section of the review (i.e., over 10 pages). The review was organized by source of TK and within source category community. In many of the sections, direct quotes from community members were included in the text. The key points included: 1) the building of nearshore causeways affects the availability of fish for subsistence, 2) contamination from drilling mud of fish used for subsistence is a concern, 3) hunters have considerable local knowledge regarding the timing and distribution of marine mammals used for subsistence food, 4) noise associated with oil and gas development causes migrating marine mammals to deflect offshore or to avoid a specific area, which makes subsistence hunting more difficult, more hazardous, and more costly, 5) community members are very concerned that there is no plan to remove oil from ice-infested waters, and that persistent oil from a spill or unauthorized discharge will severely damage their "ocean garden", 6) loss of sea ice is occurring, which significantly shortens the period that hunters can use the ice as a safe platform for hunting marine mammals and fish, and 7) harvest data from each community demonstrate the importance of a variety of marine species for subsistence food, areas key to hunting success, and the time periods during which they are hunted. These data were mapped in detail in the review.

Stephen R. Braund & Associates (2010). Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. U.S. Dept. of the Interior, Minerals Management Service. Alaska OCS Region. MMS 2009-003, Anchorage, AK. April 2010. 439 pp.

The author described in this study efforts to gather data relevant to subsistence hunting in three North Slope Communities – Nuiqsut, Kaktovik and Barrow (Utqiagvik). The marine mammal species included in this report were the bowhead whale, ringed seal, bearded seal and walrus. Geographic Information System (GIS) technology was used to map the results of information collected from community members. Total participation by community members from the three communities was 146; interviews were conducted in 2004, 2005 and 2006. The time frame for questions to participants being interviewed was 10 years, last 12 months and most recent hunt (in the most recent season). The study was funded by the MMS. Results are presented first by community and within community by species used for subsistence. Detailed maps were used to provide data summaries. Quotes from participants were included under each section.

Suydam, R., George, C., Person, B., Hanns, C. and Sheffield, G. (2010). Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2010. SC63/BRG2, 7 pp.

This paper was submitted to the Scientific Committee of the IWC. Subsistence harvest data are provided to the IWC annually by the U.S. government in cooperation with the AEWC. The authors in this paper summarized the efforts by subsistence whalers in Alaska to harvest bowhead whales. All of the information reported herein were provided by the AEWC. In 2010, the authors noted that 71 bowhead whales were struck, of which 45 were landed. The average number of whales landed by the Alaska native subsistence hunters between 2000-2009 was 39. Details related to the efficiency of the hunt (i.e., the proportion of struck whales that were landed) were provided. Twenty three of the 43 animals where sex was determined were females; four of which were determined to be mature (i.e., by length). Information was summarized by village and by date (Tables 1 and 2).

Suydam, R., George, C., Rosa, C., Person, B., Hanns, C., Sheffield, G. and Bacon, J. (2010). Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaska Eskimos during 2006. SC/59/BRG4, 7 pp.

This report was submitted to the Scientific Committee of the IWC and is not a peer-reviewed publication. The authors described the subsistence harvest of bowhead whales in 2006, including the number of whales struck (n=39), the number of whales landed (n=31), the sex ratio of landed whales (21 of the landed whales were males), and the reproductive status of any landed female whales (one female was of such a length as to be mature, but was believed to be pregnant). The harvest was compared to landings over the previous 10-year period (mean = 41.8 whales). The authors noted possible reasons as to why the 2006 harvest was lower than the average harvest over the past 10 years (i.e., challenging sea ice and weather conditions in the spring disrupting hunting in villages that have a spring hunt, environmental conditions around St. Lawrence Island that prevented any whales from being landed). Hunting efficiency (i.e., whales landed/whales struck) was similar in 2006 to the long-term average. This information is provided to the IWC on an annual basis.

Alaska Eskimo Whaling Commission (2011). AEWC Conflict Avoidance Agreement 2011 Open Water Season Programmatic Conflict Avoidance Agreement. March 31, 2011. 51 pp.

This is the CAA for 2011 open water work between industry (Arctic Cable Co., BPXA, Eni, ExxonMobil, ION/GX, Pioneer, SOI and StatOil), and the AEWC and the six village whaling captains associations. It covered Beaufort and Chukchi Sea waters and terminated on completion of the fall bowhead whale hunts. Mitigation measures in the agreement were intended to minimize interference by oil and gas and barge and transit operations with the subsistence bowhead whale hunt of 2011. Included were provisions for emergency communications and emergency assistance for subsistence whale hunters.

Pre- and post-season village meetings were required. Mitigation measures stipulated included: use of PSOs on primary offshore vessels; reporting of positions by whaling captains; avoiding hunting crews and areas; staffing of call centers by Inupiat operators; providing and return of communication equipment; industry contact lists; requirements for sound source verification testing; requirements for individual monitoring plans; and reporting requirements. The CAA also called for a cumulative noise impacts study. Specific measures included: planning of vessel and aircraft routs; no aircraft below 457 m; vessel speeds less than 10 kts near feeding whales and 5 kts within 274 m of bowhead whales; steering around whales; and checking around waters to ensure that no whales would be injured when the propellers are engaged. Lastly the CAA limited geophysical activity in the Beaufort and Chukchi seas.

Alaska Eskimo Whaling Commission (2011). AEWC Comments Revised Draft SEIS Chukchi Lease Sale 193. July 11, 2011. 18 pp.

The AEWC strongly disagreed with the continued assumption in the revised SEIS that villages could sustain up to two years of a potentially serious reduction in food supply without experiencing a significant impact from development. Other comments were on the adequacy of the alternatives and analysis: the regulatory framework needs to include MMPA requirements in the analysis of significant impacts; the revised SEIS fails to develop distinct alternatives and new alternatives must result in substantially different environmental impacts to subsistence hunting and the bowhead whale; the SEIS needs to analyze impacts to the bowhead whale and subsistence hunting in light of the new information; and fall subsistence hunting in Wainwright, Point Lay and Point Hope were not included within the SEIS's analysis, nor was winter bowhead subsistence whaling at St. Lawrence Island. Regarding mitigation, the AEWC wanted specific mitigation measures to ensure protection of subsistence hunting. They also stated that the significance thresholds in the revised SEIS allow for violations of federal law, specifically the MMPA. They believed that the very large oil spill (VLOS) analysis of impacts to bowhead whales did not demonstrate appropriate recovery responses and provide an explanation of long- and short-term impacts, and that the VLOS analysis needed to address possible impacts to subsistence hunting in greater depth. The analysis of cumulative impacts must include reasonably foreseeable activity that may affect resources, including oil and gas exploration and production within the Canadian Beaufort and Eastern Russia, and actions must also be considered in the context of climate change and ocean acidification.

Cannon, C. (2011). Native Village Point Hope Comments Chukchi Lease Sale 193 Draft SEIS. July 11, 2011. 2 pp.

The Native Village of Point Hope is gravely concerned about the potential effects of oil and gas development on the Arctic Ocean. The analysis seems rushed and incomplete. We are encouraged that BOEMRE has now for the first time admitted that a very large oil spill is possible in the Chukchi Sea from oil drilling. But the analysis contained in the revised SEIS is confusing and does not give a clear picture of what an oil spill would look like or how it would affect our Ocean and coasts. For example, it does not tell us what the oil plume would look like, and it only gives big ranges of the amount of the coast that would be covered if there were an oil spill. We urge BOEMRE to complete an analysis that addresses these shortcomings and provides a clearer picture of the consequences of a large oil spill. We also urge BOEMRE to discuss more deeply the shortcomings of oil spill response in the Arctic Ocean, with its harsh and remote conditions.

Itta, E.S. (2011). North Slope Borough Comments on the Chukchi Lease Sale 193 Draft SEIS. July 11, 2011. 11 pp.
These comments are from the NSB mayor. The NSB continues to hold the position that leasing and oil and gas industry operations should not be permitted in the Chukchi Sea. As we outlined again in our November 2010 comments, this position is based on our longstanding beliefs that the risk of a significant oil spill cannot be eliminated, that the capability does not exist to effectively respond to such a spill in our remote and challenging environment, and that too little is known out the ecosystem. Additional comments included the following topics: significance thresholds for impacts are problematic; pollution control technologies undertaken elsewhere in the Arctic should be considered; and additional mitigation measures such as zero discharge technology, no Chukchi Sea transit until July 15 or the end of the beluga hunt, measure to avoid bird strikes; shutdowns to avoid the fall hunts, and making monitoring and environmental data public. Additional specific comments on missing information, VLOS analysis, the 74-exploratory duration, use of relief wells, and the need for more information on modeling are provided.

Kishigami, N. (2011). Climate change, oil and gas development, and Inupiat whaling in northwest Alaska. *Études/Inuit/Studies*, 34:91-107.
The author concludes that subsistence whaling is directly linked to the cultural security of the Inupiat. The underlying premise of the paper is that US economics and politics influence the whaling practices of subsistence hunters in northwest Alaska. The data for this research was collected between 2006 and 2009, presumably through in-person interviews. The author asserts the following: 1) hunters must go farther from their communities to kill whales because of loss of sea ice, 2) there is increased uncertainty in the timing of the whale migration because of ocean warming in the Arctic, and 3) the increase in open water periods have led to increased oil and gas activities, as well as increased tourism and transportation activities, that disturb the whales and make it harder to hunt. The author asserts that US government policies favor oil and gas development over subsistence hunting in this region. He further asserts that recent changes at the IWC and among the non-profit environmental organizations have reduced support for aboriginal whaling. No quantitative analyses are provided to support these assertions. The article is 9 years old, and given changes in oil prices and the policies of the IWC, the findings are out of date. Further, the author made a number of incorrect characterizations of US and international politics in the article.

Powers, C. (2011). Koniag Corporation Comments Chukchi Lease Sale 193 Revised Draft SEIS. July 11, 2011. 1 pp.
This letter is from the Vice President for Corporate Affairs of the Koniag Corporation. The commenter states that the SEIS provides sufficient information and analysis; Sale 193 is critical to Alaska's future economy; safety and environmental standards are sufficient and efforts will be guided by lease stipulations; mitigation measures such as seasonal operating restrictions will minimize effects; and many jobs would be created.

Rexford, D.J. (2011). Whaling crew lands Point Lay's second whale after decades- long shutout. *The Arctic Sounder*, 1-4.
This article was published in the Arctic Sounder on 13 May 2011. It reported on a bowhead whale being successfully landed at the village of Point Lay by Whaling Captain Julius Rexford Sr. and his crew. This successful harvest was only the second such harvest of a bowhead whale since 1937. Two years prior, the same crew landed a bowhead whale on 5 May 2009. The article provided a comprehensive description of the May 2009 event, as well as the politics regarding Point Lay getting a quota through the Alaska Eskimo Whaling Commission from the International Whaling Commission. One key point

made by the author was the importance of community support in the successful hunting of bowhead whales from the Point Lay community. The article was copyrighted in 2020 by the Arctic Sounder, which is a publication of the Anchorage Daily News.

Shell Gulf of Mexico Inc. (2011). Plan of Cooperation Addendum Revised Chukchi Sea Exploration Plan OCS Lease Sale 193 Chukchi Sea, Alaska. Anchorage, AK. May 2011, Revised August 2011. 178 pp.

This revised version of the PO) was revised in August 2011. The original version was published in May 2011. The authors noted that BOEM requires that all exploration operations be conducted in a manner that prevents unreasonable conflicts between oil and gas exploration activities and subsistence resources and activities. This stipulation also requires adherence USFWS and NMFS regulations, which require an operator to implement a POC to mitigate the potential for conflicts between the proposed activity and traditional subsistence activities. A POC was prepared and was submitted with the initial Chukchi Sea Exploration Plan (EP). The POC Addendum reported herein updates the POC with information regarding proposed changes in the proposed exploration drilling program, and documentation of meetings undertaken to inform the stakeholders of the revised exploration drilling program. The POC Addendum builds upon the previous POC. Subsistence mitigation measures in the revised POC included: 1) exploratory drilling activities were delayed until after 4 July 2011 in deference to the recommendations from the hunters, 2) transit of drilling vessel will not occur before 1 July 2011, 3) vessel routing will avoid the Bering Sea polynya, 4) Shell will finalize a Communication Plan that will include coordination with communication centers in villages potentially impacted by this activity, 5) Shell will employ local subsistence advisors to provide consultation and guidance regarding bowhead whale migration status, 6) aircraft in general will not operate below 457 m, 7) drilling muds will be recycled, 8) lighting on the drill ship be shaded, as described, 9) marine mamal observers will be required to support the transit and operations in the Chukchi Sea, and 10) Shell will implement manned aerial surveys and passive acoustic monitoring in the vicinity of the drill ship operations. Specific mitigation measures for polar bears and walrus were also described in detail (p. 10). The schedule of meetings with community leaders was summarized in Table 4.2.1.

Shell Offshore Inc. (2011). Plan of Cooperation Addendum Revised Outer Continental Shelf Lease Exploration Plan Camden Bay Beaufort Sea, Alaska. Anchorage, AK. May 2011. 216 pp.

The initial Camden Bay EP was deemed submitted by BOEM on 10 August 2009. BOEM subsequently prepared and distributed an EA of the proposed exploration drilling program as detailed in the Camden Bay EP, issued a Finding of No Significant Impact (FONSI), and approved the Camden Bay EP on 19 October 2009. Shell was not able to conduct the exploration drilling program in 2010 or 2011 since the exploration activities were postponed when BOEM suspended all exploration drilling activities in the Arctic following the Deepwater Horizon incident in the Gulf of Mexico. Pursuant to a revised Camden Bay EP, Shell plans to conduct an exploration drilling program starting in 2012. This revised Camden Bay EP is described in this document. It includes the Sivulliq N and Torpedo H locations plus two additional wells, Sivulliq G and Torpedo J. Shell is proposing to use either the *Discoverer* or the conical drilling unit *Kulluk* to execute this revised Camden Bay EP. Shell has also committed to collecting select waste streams rather than discharging these waste streams into the ocean. The POC also identifies the measures that Shell has developed in consultation with North Slope communities and subsistence user groups and will implement during its planned Camden Bay exploration drilling program to minimize any adverse effects on the availability of marine mammals for subsistence uses. In addition, the POC details Shell's communications and consultations with local communities concerning its proposed exploration drilling program beginning in the summer of 2012, potential conflicts with subsistence resources and hunting activities, and means of resolving any such conflicts.

Stephen R. Braund & Associates (2011). Chukchi and Beaufort Seas National Pollutant Discharge Elimination System Exploration General Permits Reissuance Report of Traditional Knowledge Workshops – Point Lay, Barrow, Nuiqsut, and Kaktovik. U.S. Environmental Protection Agency March 11, 2011. 201 pp.

The results this report were the end product of the TK workshops conducted in the study communities of Point Lay, Barrow (Utqiagvik), Nuiqsut, and Kaktovik. The results of the workshops summarized the TK information provided by participants as it relates to the physical environment (e.g., currents and ice conditions), biological environment (e.g., bowhead habitat areas), subsistence use area review, and knowledge, observations, and concerns about discharges from offshore oil and gas activities. After showing workshop participants the areas of exploration wells and seasonal discharge restrictions as well as the list of currently authorized discharges, the study team asked workshop participants to share experiences with discharges related to offshore oil and gas activities, concerns about discharges, and suggestions for monitoring or stipulations related to discharges. Prior to concluding each workshop, the study team also asked participants to share any additional questions, comments, or concerns they had regarding the discharge permits or the workshop. Results are presented for each community, and within community by species. Detailed maps provided an excellent overview related to the distribution of oil and gas activities, traditional hunting areas for key species, etc. Concerns from workshop participants regarding the potential impacts of pollution from discharge and the permitting process were presented by community. Suggestions regarding discharge monitoring and permit stipulations were presented by community. Finally, quotes from participants regarding their "take home message" uniquely summarized community opinions regarding the issues addressed in this report.

Whiting, A. and Naylor, N. (2011). Native Village Kotzebue Comments Chukchi Lease Sale 193 Revised Draft SEIS. June 28, 2011. 2 pp.

The comment letter is signed by the Native Village of Kotzebue's Environmental Specialist and the Executive Director. The Tribe has been undertaking and supporting continued research into the ecology of the Chukchi Sea and Kotzebue Sound. The Tribe participated in groundbreaking research with the National Marine Mammal Laboratory (NMML), it was shown that adult bearded seals feed in areas adjacent to the lease area for a few months during the period when there is open water and when development activities would be in high gear. the current level of baseline environmental information makes it very challenging, if not in the majority of cases impossible, to track changes in the environment, or harm to fish and wildlife, caused by industry during the exploration phase of the Lease 193 area. This makes it difficult to know what impacts actually occur, or may occur, or whether mitigation plans put in place are effective. While the Tribe concurs with the court that it is important to address the environmental impacts of natural gas development and a VLOS and the BOEM attempts to do this in the revised draft SEIS, without a sufficient level of understanding of the ecological processes in place it is unlikely that this NEPA process will be sufficient to inform sound mitigation strategies for the many and varied environmental impacts likely to occur. The Tribe is not confident that that exploration and development of the Lease 193 area can currently occur in a manner protective of the environment.

Whiting, S.M. (2011). Northwest Arctic Borough Comments on the Chukchi Lease Sale 193 Draft SEIS. July 6, 2011. 4 pp.
These comments are from the acting borough Mayor. They request BOEMRE to: analyze the environmental impact of natural gas development; determine whether missing information was essential or relevant under 40 CFR 1502.22; and determine as to whether the cost of obtaining missing information is exorbitant or means unknown. Specifically the process/document was lacking in: government to government consultation; local traditional knowledge; and geospatially explicit spill trajectory models.

Alaska Eskimo Whaling Commission (2012). AEWC Comments BOEM 2012-2017 5-Yr Lease Plan. February 8, 2012. 12 pp.
Comments were focused on five main areas: 1) compliance with MMPA provisions to protect subsistence activities including a complete revision of modeling performed for subsistence; 2) the environmental sensitivity analysis for the Arctic as it pertains to marine mammals and marine productivity must be updated; 3) areas in the Arctic need to be deferred and addition time is needed to identify specific deferral areas to protect subsistence; 4) ecosystem based planning must be done to address conflicts between oil and gas activities and subsistence; and 5) BOEM must work more closely with Alaska Native organizations. The five-year plan and accompanying modeling failed to demonstrate that unmitigable, adverse impacts to the availability of marine mammals for subsistence activities will not occur as a result of further offshore oil and gas leasing in the Chukchi and Beaufort Seas

BOEM (2012). Special Issue on Traditional Knowledge. *BOEM Ocean Science*, 9:3-15.
This quarterly issue of the BOEM's Ocean Science Journal was dedicated to the recognition and application of traditional knowledge (TK) in BOEM's pursuit of stewardship of the Arctic environment. Twelve separate articles are included in this issue, which cover a range of topics, including: 1) history of the integration of TK with on-going science programs, 2) collection of TK (e.g., Point Lay biographies), 3) subsistence use mapping to reveal TK (e.g., assessment of subsistence whaling near Cross Island), 4) integrating TK into biological resource studies (e.g., bowhead whales in the Chukchi Sea), 5) partners in conservation awards (e.g., bowhead whale tracking project), 6) TK and government to government consultation, 7) an interview with the Administrator of Kaktovik, Fenton Rexford, and 8) future efforts.

Edwardson, G. (2012). Inpuiat Community of the Arctic Slope (ICAS) Comments on BOEM 2012-2017 5-Yr Lease Plan. February 8, 2012. 23 pp.
This letter is from the Inupiat Community of the Arctic Slope (ICAS) president. ICAS urges BOEM to exclude the Beaufort and Chukchi Seas from the OCS leasing program for 2012-2017. The federal government is ill equipped to deal with the existing leases, which total millions of acres across both the Beaufort and Chukchi Sea. Now is not the time to expand the leasing program, but instead the federal government should focus on developing a comprehensive management plan for the Arctic OCS and on improving its oil spill response capabilities. ICAS reiterates its request that BOEM engage in meaningful and formal government-to--government consultations with our Board Members and Staff on the 2012-17 plan and EIS. Specifically the letter states that the plan did not adequately consider impacts to subsistence; oil spill prevention and clean up has to be proven before additional leasing is allowed; the plan does not acknowledge the sensitivity of the Arctic; and human health and environmental justice impacts must be analyzed.

Huntington, H.P., Nelson, M.W. and Quakenbush, L.T. (2012). Traditional Knowledge Regarding Walrus Near Point Lay and Wainwright, Alaska. Final report to the Eskimo Walrus Commission and the Bureau of Ocean Energy Management, 11 pp.

Walrus are an important species for subsistence harvests by Iñupiat hunters in northern Alaska. Increasing industrial activity in the Chukchi Sea is an additional potential stressor to walrus. This report summarizes information gathered from interviews with hunters and other knowledgeable residents in Point Lay and Wainwright, Alaska, in March 2011. The semi-directive interview method was used. Results are organized by village and provides historical details of observation of walrus and seals in the vicinity of these villages. Of note, Point Lay hunters stated that apart from the recent changes in haul-out locations and the number of animals hauling out, Point Lay residents have seen few if any changes in walrus abundance, distribution, and behavior. Walrus body condition appeared to be good, with no change over time. Since the walrus have been hauling out near Point Lay, fewer seals have been seen because seals avoid walrus. There appeared to be no interaction between the walrus and harbor porpoises, but beluga whales behave differently when there are walrus around, appearing more nervous and harder to herd and hunt. Wainwright hunters have had to pursue walrus in the water rather than on the ice. In about 2008, no walrus were seen at all, having migrated past the Wainwright area before the shorefast ice broke up and boating was possible. Hunting patterns have changed over the years, largely in response to larger boats and more powerful outboard motors. Hunters used to work together with several boats, but now it is common for boats to travel alone when hunting walrus in the ice. In 2011, hunters went 64 km offshore but did not see walrus. However, when caught walrus today are in good physical shape, healthy and good to eat. Ringed and bearded seals have thinner blubber now than they used to. The blubber is also a different color, more yellow than it used to be. The taste of the meat has also changed, and this is true of many subsistence species, including marine mammals and waterfowl. Hunters are concerned about the possible impacts of offshore activity, including ship traffic and oil drilling. The activity may displace walrus and other animals, moving them farther from their feeding grounds. If animals are harder to hunt, people's diets may change. There was also concern about the potential impacts of polar bears and other species being listed as threatened or endangered, and the potential for regulation of subsistence hunting and critical habitat designations. Wainwright hunters also noted that the ice is thinner. In the past, large floes of multi-year ice would arrive in fall and serve as "anchors" to the newly forming ice, creating a solid shorefast ice zone and allowing the ice to grow thick.

Whiting, A. (2012). Native Village Kotzebue Comments on BOEM 5-Yr Lease Plan 2012-2017. February 8, 2012. 4 pp.

Comments are from the Environmental Specialist for the Tribe. The Tribe preferred keeping the Chukchi Sea out of the last 5-year plan due to concerns about the infrastructure capabilities of industry and federal government to manage exploration plans in the Chukchi Sea responsibly, in addition to the insufficient environmental and social baseline information needed to inform effective mitigation measures to ensure unnecessary damage to the environment and natural resources. Consider narrowing the focus of lease areas based on known sensitive areas and important migratory corridors and important subsistence use areas, this should include larger deferral areas between leases and shore. More emphasis should be included on the real challenges of oil spill response along the coast of the Chukchi Sea and a more thorough discussion of impacts to coastal communities from a VLOS, including perceived impacts that are reasonable to postulate based on the real world impacts to communities and their relationship with marine food harvesting should be added. The climate change discussion needs to be improved.

Huntington, H.P. (2013). Traditional Knowledge Regarding Bowhead Whales and Camden Bay, Beaufort Sea, Alaska. 15 pp.
The report summarized information gathered from interviews with hunters in Kaktovik and Nuiqsut, Alaska, in January 2013, in an attempt to fill the information gap with regard to the ecological significance and sensitivity of Camden Bay in the face of pending oil and gas development. The author used a semi-directive interview protocol for this study. A draft report based on all of the interviews was sent to all of the participants prior to finalizing the report. Six people from Kaktovik were interviewed and seven people from Nuiqsut. Results were presented by village. Kaktovik participants reported the presence of a National Oceanic and Atmospheric Administration (NOAA) research vessel (August 2012) operating near Kaktovik and heading east just prior to the start of the whaling season. They noted that the whales that season were seen farther offshore and in groups of one or two animals. This report is consistent with concerns raised by hunters that noise from industrial or research vessels can interfere with subsistence hunting operations. A similar report from participants from Nuiqsut was reported where barge noise was believed to cause bowhead whales to temporarily abandon the Cross Island area. Further, it was noted that the construction of the Northstar facility caused bowhead whales to avoid the area in the vicinity of the facility. In the discussion, the author noted that whalers from both villages were very concerned regarding the impact industrial activity in Camden Bay would have on their subsistence hunting. It was recognized that while CCAs help mitigate impacts of human activities, not all vessel operators are part of CCAs. Participants recommended studies be conducted on the long term impact of industrial activity on the presence and use patterns of marine mammals in Camden Bay

Stephen R. Braund & Associates (2013). Aggregate Effects of Oil Industry Operations on Inupiaq Subsistence Activities, Nuiqsut, Alaska: A History And Analysis of Mitigation and Monitoring. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 213-212, Anchorage, AK. December 20, 2013. 314 pp.
Through its discussions with key informants, the study team found that a majority of mitigation measures were, in concept, considered to be effective. However, individual mitigation stipulations varied in effectiveness due to differences in how they were implemented by development companies. No measures were considered to be “ineffective” in their design, but rather in their implementation. In many cases, key informants provided recommendations for how a mitigation measure could be enhanced to improve its effectiveness. The study team found that in a number of cases local residents were unaware of the presence of a mitigation measure. In addition, local residents’ frustrations were often directed toward the mitigation process rather than the mitigation measures themselves, indicating that improved communication and consultation with local communities could improve local perceptions related to mitigation. Finally, the study team found that in most cases there is no official mechanism for monitoring mitigation measures after they have been implemented, or for measuring their effectiveness. This is particularly true for social mitigation measures aimed at reducing impacts on subsistence activities. Overall, this study provides a useful basis for agencies, developers, and local residents to increase collaboration in the development of new mitigation measures, enhance existing mitigation measures, and streamline the mitigation process.

Stephen R. Braund & Associates (2013). COMIDA: Impact Monitoring for Offshore Subsistence Hunting, Wainwright and Point Lay, Alaska. U.S. Dept. of Interior, Bureau of Ocean Energy Management. BOEM 2013-211, Anchorage, AK. December 31, 2013. 300 pp.
This is a contract report that 1) summarized baseline offshore subsistence data from Point Lay and Wainwright from 2010-2012, 2) characterized interannual variability in hunter success in the Chukchi Sea, and 3) evaluated whether offshore industrial activity for oil and gas development contributed to variability in hunter success. The authors focused on three marine mammal species for each

community (i.e., Wainwright – bearded seal, bowhead whale and walrus; Point Lay – bearded seal, walrus and beluga). Variability in hunting success was attributed to the following variables: ice, wind, aircraft and vessel traffic, and other factors such as resource health or equipment failures. The most persistent concern raised by hunters who participated in the study was absence of sea ice. The authors noted that three years of data collection using the protocols described in this report were insufficient to fully identify and evaluate all of the factors that contributed to interannual variability in hunter success. Further, whether offshore oil and gas activities impacted hunting success could not be evaluated at this time because of the limited number of oil and gas activities during the study period and the relatively large distance offshore of where on-going activities were sited.

Alaska Eskimo Whaling Commission (2014). AEWC Mini Convention Whaling Captains Meeting Minutes. February 10, 2014. 32 pp.
The mini convention addressed meeting with the IWC, a weapons improvement program, and, oil and gas activities, and increased Arctic shipping. Regarding oil and gas activities, the group is focused on zero discharge in the Beaufort Sea; the need for a deferral area around Cross Island; and the Camden Bay imitative to develop a TK database on the use of Camden Bay by bowhead whale. Vessel travel around Barrow (Utqiagvik) was also a concern.

Alaska Eskimo Whaling Commission (2014). AEWC and Harry Brower Comments Chukchi Lease Sale 193. December 3, 2014. 4 pp.
These comments stressed that the subsistence hunt of the bowhead whale is the most important subsistence activity for our people, both in terms of food security and for what it means culturally and spiritually to our communities. The AEWC strongly encourages BOEM to work with the commission and communities to build off of the CAA to develop site specific mitigation measures for exploration and development. An important step that BOEM could take right now is coordinating its review of site-specific projects to be consistent with the timing of the annual CAA process. Operators that are not already working with us must be encouraged to talk directly with our whaling captains through the CAA process. And BOEM should incorporate the mitigation measures from the CAA into its decisions.

Alaska Eskimo Whaling Commission (2014). AEWC Comments Chukchi Lease Sale 193 SEIS. December 17, 2014. 2 pp.
The AEWC has commented many times over the past 30 years that our communities support well-managed offshore oil and gas development, undertaken in a manner consistent with our subsistence bowhead whale harvest. AEWC villages support actions by our federal government to give offshore operators the chance to pursue work on the Lease Sale 193 prospects. However, we note that BOEM has identified, in the SEIS, the potential for impacts to our subsistence activities from work on those prospects, depending on the level of development. With this, the AEWC very strongly encourages BOEM to fully integrate the AEWC's CAA Process and relevant substantive CAA provisions into its decision making for lease sale stipulations and other matters related exploration and development planning and permitting under Lease Sale 193.

Awalin, M. (2014). Cully Corp Comments on Chukchi Lease Sale 193 Draft SEIS. December 22, 2014. 5 pp.
These comments are from the Chief Executive Officer (CEO) of the Cully Corporation. The Draft Second SEIS maintains an ambiguity regarding Lease Stipulation 7 that has existed since the leases were originally issued in 2008. That ambiguity is now adversely affecting Cully's ability to pursue opportunities on behalf of its shareholders. Cully was organized under the Alaska Native Claims Settlement Act and is the Alaska Native Corporation for the village of Point Lay. Cully wishes to provide

support services for CPAI, including an OSR program designed to protect the natural resources which the Point Lay community harvests and depends on. This opportunity presents both environmental and economic benefits for Point Lay. Cully's ability to pursue an OSR program has been limited because of uncertainty regarding the restrictions imposed by Stipulation No. 7 to the Chukchi Sea OCS leases sold in Lease Sale 193. Stipulation No. 7(A)(2)(b) prohibits "surface vessels associated with exploration and delineation operations" from entering the Ledyard Bay Critical Habitat Unit (LBCHU) during the open water season (July 1 through November 15) except for "emergencies or human/navigation safety, " in which case, vessel travel in the LBCHU must be reported to BOEM within 24 hours.3 The stipulation does not define the term "surface vessels associated with exploration and delineation operations, " and it is unclear whether BOEM would interpret the stipulation to prohibit vessels operated by a lessee's contractors from traveling through the LBCHU. Although BOEM is now on its third NEPA review of this lease sale, the voluminous NEPA documents that have been prepared fail to analyze the impact of Stipulation No. 7 on Point Lay. An OSR and support services program would benefit the people of Point Lay.

BP Exploration Inc., ENI US Operating Co. Inc., EXXONMOBIL Corporation, GX Technology Corporation, CAELUS Energy Alaska, SAExploration, Shell Offshore Inc. and TGS-NOPEC Geophysical Company (2014). 2014 Programmatic Conflict Avoidance Agreement Beaufort and Chukchi Seas, Alaska. June 2014. 55 pp.

The purpose of this agreement was to provide (or identify): 1) equipment and procedures for communication subsistence participants and industry participants, 2) mitigation measures to be followed by the industry participants working in or transiting the vicinity of active subsistence hunters, in areas where subsistence hunters anticipate hunting, or in areas in proximity to areas expected to be used by hunters, 3) measures to be taken in the event of an emergency occurring during the term of this agreement, and 4) dispute resolution procedures. In this agreement, the geographic region covered was defined. The agreement was intended to apply to all oil and gas operations and barge and transit vessel traffic during the 2014 Open Water Season in the Beaufort Sea or Chukchi Sea. Limitations on the agreement were also included in the agreement. Details related to communication protocols, funding responsibilities, staffing expectations, use of standardized log books by industry participants, and reporting responsibilities for subsistence whale hunting crews were included in the agreement.

Brower, C. (2014). NSB Comments Chukchi Lease Sale 193. December 22, 2014. 18 pp.

These comments are from the NSB Mayor. They include attachments detailing technical comments, air quality comments and comments on dispersants. This latest document specifically considers a larger potential amount of producible oil within the lease sale area than was evaluated in the initial EIS, and an associated potential for higher levels of exploration and production activity. These larger estimates translate into a greater oil spill risk. The 40-km coastal buffer should be expanded to 97 km and a deferral area around Hannah shoal should be added. All lessees should be required to consult with the AEWC and other appropriate marine mammal user groups and sign a CAA. Data gaps must be addressed, along with human health impacts.

Collier, C. (2014). Seldovia Village Tribe Comments on Cook Inlet Lease Sale 244 EIS. November 25, 2014. 3 pp.

This comment letter is from the CEO of the Tribe. BOEM needs to consider the subsistence areas of all Cook Inlet Tribes (including Seldovia Village Tribe) potentially affected by future development in the Lease Sale area. Furthermore, BOEM should ensure they are utilizing current subsistence and scientific data when considering Lease Sale boundaries, and not just relying on old or limited data provided

during the Sale 191 process. The comment also recommends future environmental studies: use NOAA "hydropalooza" mapping; include all studies in the analysis especially studies regarding polycyclic aromatic hydrocarbons (PAHs) in Seldovia Bay; and collaboration with the Alaska Native Harbor Seal Commission to test for PAH levels in Cook Inlet marine mammals.

Fagnani, M. (2014). Aleut Corp Comments on Chukchi Lease Sale 193 Draft SEIS. December 9, 2014. 1 pp.
These comments are from the CEO of the Aleut Corporation. They express strong support for the Draft SEIS and ask that a ROD be quickly issued. The letter stresses the economic benefits of oil development.

Galginaitis, M. (2014). Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). BOEM 2013-218, 236 pp.
The author summarized findings from eleven annual reports (2001-2011) and information from the 2012 subsistence hunt for bowhead whales near Cross Island, Alaska. Beyond summarizing 12 years of subsistence whaling at Cross Island, the project developed a protocol for collecting future information that the whalers could adopt or adapt, if they chose to. The following information was summarized by year regarding whaling operations: 1) number of whaling crews and number of boats used in the hunt, 2) size and composition of whaling and boat crews, 3) number of whales harvested, 4) days spent whaling, 5) subsistence activity other than whaling, 6) locations for whale sightings and whale harvest, 7) local weather and ice conditions, 8) bowhead whale behavior in the vicinity of Cross Island and comparisons with past experiences, and 9) changes in access to whales during the season. The report also contains an historical account of the change in Nuiqsut whaling practices and discusses the variability measured in the 2001-2012 seasons in terms of environmental factors as well as possible anthropogenic impacts.

Oceana and Kawerak Inc. (2014). Bering Strait Marine Life and Subsistence Use Data Synthesis. Oceana, Kawerak Inc. 499 pp.
This document is a book of over 317 pages that presents a synthesis of the Bering Strait marine ecosystem and subsistence activities. It was prepared in cooperation between Oceana and Kawerak Inc. The authors noted that in this region, where 12 coastal communities exist, 68% of subsistence food by weight was from marine mammals, involving over 9000 animals annually. The following topics are discussed in detail: 1) traditional knowledge and traditional management, 2) subsistence hunting methods and knowledge for marine mammals and fish, and 3) distribution, abundance, and ecology of marine mammals, marine birds, and fish. In addition, several chapters in the book are dedicated to zooplankton, seafloor life, primary production and sea ice. The authors concluded the book with a chapter on ecosystem analysis. Throughout the book quotes from local hunters and community members are presented, which contributed to the goal of synthesis of western science and traditional knowledge. One of the highlights of this volume relative to information presentation is the extensive use of figures that depict the geographical distribution of marine life and subsistence hunter activity. The authors noted that climate change and global warming is making the Arctic more accessible to shipping, oil and gas development and fishing. These activities could harm the Bering Strait marine ecosystem. The authors identified the need for regulations that protect local environments and cultures, and that were based on up to date studies and information. The authors' objective in preparing this synthesis was to help inform decision makers who manage the Bering Straits environment.

Patkotak, H. (2014). Olgoonik Corp Comments on the Chukchi Lease Sale 193 Draft SEIS. December 17, 2014. 2 pp.
This letter is from the CEO of the corporation. Olgoonik Corporation supports BOEM's alternative Ill with the exception of vacating the five current leases within Corridor I. While oil and gas development would bring business opportunities, jobs and economic benefits to shareholders, subsistence would be affected. Concern regarding the potential for major oil spills and how monitoring, and clean would be addressed should a spill occur. Olgoonik expects to be informed, consulted and continually debriefed, and included on decision making in clean-up efforts, both onshore and offshore by all governmental agencies from the time a spill occurs no matter what the magnitude is.

Rasmuson, E.B. (2014). Comments Chukchi Lease Sale 193 SEIS. November 20, 2014. 1 pp.
This comment letter expresses strong support for the SEIS and requests that a ROD be swiftly issued. The letter stresses the economic benefits of oil development.

Whiting, A. and Okleasik, U.T. (2014). Native Village Kotzebue Comments Chukchi Lease Sale 193 Draft SEIS. December 16, 2014. 8 pp.
These comments are from the Environmental Specialist and the Executive Director of the Native Village of Kotzebue. Village residents depend on a healthy Chukchi Sea for subsistence, cultural meaning, spirituality, and way of life. There is great risk to the tribal community from any harm that befalls this environment. The SEIS could be improved with visual maps that show the migratory patterns and routes of marine mammals, fish and birds with the OCS development areas. The Tribe would like to request a community workshop to be held in Kotzebue regarding OCS development, spill response which includes community-tribal readiness, and input from residents and tribal citizens on the SEIS, particularly subsistence resources. The Tribe also requests that the SEIS recommend the establishment of a subsistence trust fund that would be jointly administered with tribes from the Northwest Arctic, North Slope and Bering Strait regions. Specific corrections to the text are also provided such as: correcting the status of bearded seals; broadening statements on subsistence; include Kotzebue in the list of villages that hunt beluga; include Kotzebue in the terrestrial harvest discussion; need additional discussion on noise impacts to fish; and other specific corrections.

Alaska Eskimo Whaling Commission (2015). AEWC Comments Liberty Development and Production Plan (DPP) and EIS. November 17, 2015. 8 pp.
AEWC has heard many concerns from the local community, particularly the village of Nuiqsut, regarding the potential for adverse impacts of the proposed project on the fall hunt of bowhead whales at Cross Island. The location of the facility to the southeast of Cross Island, places it "upstream" of Cross Island during the fall east-to-west migration. In addition, the inclusion of production facilities on the island, could result in an increase in underwater noise that has the potential to deflect bowhead whales from their migratory path and/or make them more skittish and more difficult to hunt. We have also heard concerns about the level of vessel traffic associated with construction and operation of the island as well as the length of the drilling season. Finally, the village of Nuiqsut has expressed serious concern about the possibility of silting caused by the proposed island location could affect westward fish migrations. The AEWC encouraged Hilcorp to participate in the Camden Bay Science Initiative. Additional detailed comments addressed the inadequacy of the consultation process by Hilcorp; concerns that the DPP did not include substantive and detailed mitigation measures to avoid conflicts with the fall subsistence bowhead hut at Cross Island; and inadequate monitoring of underwater noise and impacts to bowheads.

Brower, C. (2015). NSB Comments on the Liberty Development and Production Plan (DPP) and EIS. November 17, 2015. 18 pp.
These comments are from the NSB Mayor. Overall, the NSB is supportive of oil and gas exploration, provided the activities are conducted in manner that is safe for the environment and does not impact subsistence activities or resources. Hilcorp's proposal includes a number of important mitigation measures that NSB has found acceptable on prior Beaufort Sea projects. The comments provide: three additional alternatives that should be analyzed in the EIS (move the island closer to shore, add relief well capability, add seasonal drilling alternative); describe unique aspects of oil and gas operations in the Arctic; clarification of issues and mitigation measures important to the NSB; identification of BMPs; and other information that will benefit the project. Specific comments address a CAA; an oil spill contingency mitigation agreement; protection of subsistence resources; aircraft and vessel limitations; boulder patch protection; native allotment mitigation; noise mitigation and monitoring; offshore monitoring; improvements in blow-out protection; safety of the proposed primary drilling rig; seasonal drilling restrictions, well capping equipment and relief well rig; OSR Plan and well control plans; waste management and disposal; subsea pipeline and leak detection; tank or pipeline source controls and spill prevention methods; air quality impacts; human health impacts; economic benefit plans; and abandonment plans.

Fagnani, M. (2015). Aleut Corporation Comments on Liberty Development and Production Plan (DPP). November 16, 2015. 2 pp.
The commenter who is the CEO of the Aleut Corporation offers support for the Liberty Project, citing the job opportunities, economic benefits, past responsible construction of artificial islands, and a 30-year safety record of operating offshore in the Arctic

Gadamus, L., Raymond-Yakoubian, J., Ashenfelter, R., Ahmasuk, A., Metcalf, V. and Noongwook, G. (2015). Building an indigenous evidence-base for tribally-led habitat conservation policies. *Marine Policy*, 62:116-124.
In this paper the authors presented a case study for the use in management of indigenous knowledge of habitat use and observed drivers of habitat change for marine mammals in the Bering Strait region. TK was systematically documented using qualitative methods. They further documented differences between indigenous evidence-based policy goals and western science-based policy goals. Nine of 20 federally recognized tribes in the region participated in the study. Interviews and focus groups were conducted with 82 indigenous hunters and elders, who had been identified locally as experts on ice seals and walrus. The local experts identified four factors that could be used to describe seal and walrus habitat quality: 1) sea ice characteristics (i.e., usage of sea ice, environmental factors that change the sea ice habitat for marine mammals, long term patters regarding loss of sea ice), 2) prey abundance and distribution (i.e., impacts from commercial fishing and pollution), 3) level of disturbance caused by human activities and 4) landscape features. The following policy differences between TK and western science based management were identified: 1) whether seals and walrus would be able to adapt to loss of sea ice driven by climate change (local experts considered adaptation likely; federal managers are seeking ESA protections, which implies a lack of adaptability on the part of seals and walrus), 2) local experts and management agencies prioritize threats differently (local experts considered commercial fishing a more significant threat to seal and walrus persistence than federal managers, who considered loss of sea ice the primary threat), and 3) local experts preferred management at larger spatial scales than federal managers (i.e., use of relatively small marine protected areas).

Hilcorp Alaska LLC (2015). Plan of Cooperation: Liberty Unit Shallow Geohazard Surveys, Beaufort Sea, Alaska, 2015. Anchorage, AK. 165 pp.
This POC is intended to document Hilcorp's stakeholder engagement and to describe the measures Hilcorp will take, or has taken, to minimize adverse effects that its proposed shallow geohazard surveys may have on the availability of marine mammals for subsistence use. A shallow geohazard survey, using multibeam echosounder, sidescan sonar, subbottom profiler and magnetometer is proposed over the site survey location and subsea pipeline corridor area. The purpose of this proposed survey is to look for geologic hazards and archaeological resources on the seafloor and in the shallow subsurface. The survey vessel is approximately 12-m long and will travel at a speed of 3 kts. The survey has a proposed length of 483 km. Either single-beam (i.e., 220 dB re 1 uPa @ 1 m; at a frequency of 210 kHz) or multibeam sonar (i.e., 220 dB re 1 uPa @ 1 m; at a frequency of 240 kHz) will be used in the study. Side scan sonar and a marine magnetometry will also be used during the study. Meeting schedules between Hilcorp personnel, local community members, and State and Federal agencies were provided. The passive acoustic monitoring plan is presented in Attachment A.

Nukapigak, I. (2015). Kuukpik Corp Corporation Comments on Liberty Development and Production Plan (DPP) and EIS. November 17, 2015. 36 pp.
This letter is from the President of the corporation. Kuukpik believes the Development and Production Plan (DPP) is deficient and needs substantial revisions, corrections, and additions. Based on all of the available information, Kuukpik cannot support this proposal at this time. We request additional consultations, a more complete drilling plan, and meaningful mitigation measures. Specifically, Hilcorp has failed to fulfill its Lease Stipulation Number 6 requiring it to consult with affected subsistence communities prior to submitting its drilling plan. The EIS analysis must be suspended until Hilcorp completes the required consultations and re-submits an updated DPP. The DPP and Environmental Impact Assessment seriously understate the risks of developing the Liberty project. Analysis of impacts on and mitigation measures to protect Cross Island whale hunts are lacking. Subsistence will be reduced. Hilcorp must commit to providing alternative or compensatory mitigation for the unavoidable impacts.

Huntington, H.P., Nelson, M.W. and Quakenbush, L. (2016). Traditional Knowledge Regarding Ringed Seals, Bearded Seals, Walrus, and Bowhead Whales near Kivalina, Alaska. Final report to the Eskimo Walrus Commission, the Ice Seal Committee, and the Bureau of Ocean Energy Management, 8 pp.
The authors in this report summarized information on marine mammal subsistence use in Kivalina, AK. Information was collected via interviews with hunters and knowledgeable residents from this community in January 2016. A semi-directed interview format was used. Five individuals were interviewed. The participants commented that the number of marine mammals traveling past Kivalina has decreased since the construction of the Red Dog Mine in the 1980s. It was reported that bearded seals, caribou and fish are the primary subsistence resources used by residents of Kivalina. Other species of marine mammals (e.g., bowhead whale, walrus, ringed seal, beluga) are also hunted opportunistically. It was further noted that period over which hunting on shore fast ice is available has decreased over time. Figure 1 presented an excellent summary of changes in both marine mammal travel/migratory routes and the area used by hunters over time (i.e., historic versus present). Summaries by marine mammal species relative to their presence and absence in the region were reported.

Huntington, H.P., Quakenbush, L.T. and Nelson, M. (2016). Effects of changing sea ice on marine mammals and subsistence hunters in northern Alaska from traditional knowledge interviews. *Biology Letters*, 12:20160198.
Hunters noted that: 1) extensive changes in sea ice and weather has affected the timing of migrations and the distribution and abundance of marine mammals in their traditional hunting areas, 2) industrial activity (e.g., shipping and oil and gas development) was a concern because these activities cause marine mammals to avoid areas important to the hunters, 3) offsetting technological advancements (e.g., better and more reliable outboard engines) and changes to hunting practices have allowed hunters to adjust to some of the observed changes in the environment and human activity patterns. It was uncertain as to whether or not the hunters could adapt to further changes.

Kofinas, G., BurnSilver, S.B., Magdanz, J., Stotts, R. and Okada, M. (2016). Subsistence Sharing Networks and Cooperation- Kaktovik, Wainwright, and Venetie, Alaska. U.S. Dept. of the Interior, Bureau of Ocean Energy Management and the University of Alaska Fairbanks, School of Natural Resources and Extension. BOEM Report 2015-023DOI; AFES Report MP 2015-02., Fairbanks, AK. June 26, 2016. 520 pp.
This study documented and analyzed social networks of sharing and cooperation that are part of Alaska Native subsistence-cash economies, and explored the potential vulnerability and resilience of Alaska rural communities to conditions of social and ecological change. This is a comprehensive report of over 500 pages. Research activities were initiated in 2008. Two coastal communities were included in the study (i.e., Kaktovik and Wainwright) to assess the potential impacts of oil and gas development; one interior community was included (i.e., Venetie), as a control. The goals of the study were to provide agencies and communities with quantitative and qualitative baseline data on patterns of cooperation and exchange in subsistence-cash economies, and the vulnerability of communities to social-ecological changes relevant to food security and well-being. Key findings included: 1) a significant source of subsistence food was provided by inter-household cooperation in all three villages, 2) whaling relationships in Kaktovik and Wainwright were responsible for 33-46% of subsistence food (e.g., cooperative hunting, sharing involving the entire village), 3) subsistence activities involve more than hunting (e.g., sharing of labor), 4) a disproportionate number of harvesters/hunters (e.g., 30%) produced a majority of the subsistence food (e.g., 71-86% in Kaktovik and Wainwright), 5) highly productive households tended to have older heads of households, a greater number of hunters, and a source of cash income, 6) subsistence hunting has persisted in spite of engagement in the cash economy in Kaktovik and Wainwright, 7) reports of food insecurity ranged between 35% and 45%, 8) gifting of subsistence resources extends beyond village boundaries (to other communities in Alaska), 9) men are responsible for a majority of harvested food by weight; however, women are a key source of food ties by count. The authors concluded that considerable variability among households exists regarding vulnerability to economic and climatic change among the three communities. Further, the authors noted that a significant change in the availability of subsistence resources would result in high costs to social, cultural and economic well-being. Comments regarding the problems with the methodological approach were also discussed.

Opheim, M. (2016). Seldovia Village Tribe Comments Cook Inlet LS 244 EIS. September 6, 2016. 2 pp.
This letter is from the Environmental Coordinator for the Tribe. Lease sales in lower Cook Inlet are and will continue to be a bad idea no matter who proposes them. One concern we have is that BOEM needs to consider the subsistence areas of all Cook Inlet Tribes (including Seldovia Village Tribe) potentially affected by future development in the Lease Sale area. Furthermore, BOEM should ensure they are utilizing current subsistence and scientific data when considering Lease Sale boundaries, and not just relying on old or limited data provided during the Sale 191 process. We would encourage BOEM to take

advantage of the data already collected by NOAA and others. A good resource for identifying species that maybe BOEM should consider focusing on (at least for the communities of Seldovia, Port Graham, Nanwalek, and Tyonek) is the Tribe's report, "Assessment of Cook Inlet Tribes Subsistence Consumption". We would also like BOEM to consider potentially collaborating with the Alaska Native Harbor Seal Commission and/or the Alaska Sea Otter and Steller Sea Lion Commission to test for PAH levels in tissue samples from animals collected within Cook Inlet.

Owl Ridge Natural Resource Consultants Inc. (2016). Plan of Cooperation: Quintillion Subsea Operations Cable Project Bering, Chukchi, and Beaufort Seas, Alaska. Quintillion Subsea Operations LLC. Anchorage, AK. March 2016. 124 pp.

Quintillion as part of IHA applications regarding the installation of Subsea fiber optic cable produced this POC. The POC report included a description of operational monitoring and mitigations, as well as serving as a record of consultation. The 1904 km long cable will be installed 26-100 km offshore of the communities of Nome, Kotzebue, Point Hope, Wainwright, Barrow (Utqiagvik), and Oliktok Point between July and October 2016. A detailed figure of the route map for the cable laying is included in the report. Quintillion will lay cable by segments and with such timing as to avoid areas of active subsistence hunting. A daily operations plan was agreed to be distributed daily by email to each community. On-board PSOs will be stationed on each of the three vessels used to install the cable. Details of meetings with local communities was provided in Table 1. Finally, Quintillion established a 24-hour contact line for community members to call or leave messages regarding their concerns.

Martinez-Levasseur, L.M., Furgal, C.M., Hammill, M.O. and Burness, G. (2017). Challenges and strategies when mapping local ecological knowledge in the Canadian Arctic: the importance of defining the geographic limits of participants' common areas of observations. *Polar Biology*, 40:1501-1513.

In this paper, the authors examined and implemented strategies to address the limitations and biases they identified in local ecological knowledge while analyzing the mapped observations collected from 27 interviews of male hunters as part of a larger project on walruses in Nunavik (Canadian Arctic). The main objectives of the study were to: (1) examine the importance of recording participants' temporal and spatial limits of observations; (2) identify the factors influencing the quantity and diversity of mapped observations; (3) study the importance of documenting approximate numbers of animals observed; (4) examine the importance of gathering and presenting data at consistent and standardized spatial scales. The authors found that by adding to maps the geographic limits of participants' common areas of observations, they were able to distinguish areas that hunters typically visited and did not see walruses, from areas that hunters never visited. Furthermore, the authors demonstrated that the variability in the quantity of mapped observations was explained by the community of residence and average number of hunting trips per participant. The authors concluded that TK is a valuable source of knowledge for wildlife conservation, but also that it must be collected and handled carefully to avoid limitations and bias in the results.

Nasgovitz, M. (2017). Anthropogenic Noise in the Alaskan Arctic. Duke University. Nicholas School of the Environment. Master's Project Proposal, May 2017. 34 pp.

This thesis investigates the potential to limit anthropogenic Arctic Ocean noise in Alaska by 1) using species occurrence data to map anthropogenic noise threats for the purpose of developing a planning tool to inform policy on the way anthropogenic noise is monitored and regulated and 2) considering how future anthropogenic noise law and policy regulations could be monitored through the use of geospatial technologies. The premise of the thesis is that being able to spatially describe marine mammal movements in relation to a management under the MMPA and ESA. That is, regulations need

to be implemented that limit anthropogenic noise in Arctic waters off Alaska to adequately protect the habitat of 15 marine mammal species (e.g., establishment of acoustic buffer zones). These spatial data and their analyses should be used to develop management tools to better inform managers and law-makers so that much-needed regulation can be put in place. The presentation of the relative magnitude of anthropogenic noise and the spatial analyses regarding the distribution and migration of Arctic marine mammals in the thesis was both insightful and creative. The information in the thesis was never published, which is unfortunate.

Stephen R. Braund & Associates (2017). Social Indicators in Coastal Alaska-Arctic Communities. U.S. Dept of Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2017-035, Anchorage, AK. May 31, 2017. 538 pp.

Between January and March 2016, Steven Braund and Associates interviewed 664 randomly selected heads of households in selected North Slope communities. The report outlines findings from a study to develop a baseline understanding of the well-being of North Slope residents before major oil and gas development activities over their individual lifetimes. Social indicators of well-being focused on seven domains: 1) economic well-being, 2) physical environment, 3) health and safety, 4) cultural continuity, 5) education, 6) local control and 7) overall well-being. Findings were summarized by community, gender, and over time, and across regions (Alaska and two other Inupiat regions in Canada and Greenland). Key findings included: 1) 58% of the heads of households in the six communities were satisfied with their life as a whole in 2016, 2) the results of surveys/interviews over the past 40 years were remarkably consistent, in the opinion of the authors, given the magnitude of oil and gas development and increasing exposure to technology (e.g., social indicators were as positive or more positive than they were in 1977, wage working hours has increased since 1977), 3) with some exceptions, measures of well-being did not vary by gender, and 4) North Slope participants in the survey scored higher on well-being indicators than most other regions in Canada and Greenland. The authors noted the importance of these data as a baseline for comparisons with future surveys regarding social indicators. It should be noted that the authors provided excellent graphics to summarize information in this document (e.g., Figures 1.2 and 3.2 on oil and gas activities on the North Slope), as well as summary tables that provided for an easy overview of results (e.g., Table 4-56 and Table 4- 79 on subsistence hunting patterns)

McWhinnie, L.H., Halliday, W.D., Insley, S.J., Hiliard, C. and Canessa, R.R. (2018). Vessel traffic in the Canadian Arctic: Management solutions for minimizing impacts on whales in a changing northern region. *Ocean and Coastal Management*, 160:1-17.

The authors noted that predictable decrease in sea ice extent in the Canadian Arctic in the near future would likely be associated with increased risks to cetacean populations due to increased vessel traffic, including impacts of vessel noise, ship strikes, and chemical pollution. The authors purpose in writing this paper was to explore possible mitigation measures in the Arctic based on measures taken to reduce adverse cetacean – vessel interactions in waters to the south. The area of interest for this paper was the Beaufort Sea. Two cetacean species were the focus of the paper (i.e., bowhead whale and beluga). The authors provided an evaluation of how mitigation measures used to the south could be adapted for use in the Arctic. These measures were based on existing regulations to safe guard cetaceans in Marine Protected Areas (MPA; see Hoyt 2011). Thirty-three of the MPAs identified by Hoyt included active vessel management schemes, and from these schemes, 14 different management tools were identified for further evaluation regarding mitigation of cetacean- vessel interactions in the Beaufort Sea. In Table 1- the management tools are listed, along with attributes and evidence of effectiveness where implemented. The management tools included: 1) mandatory exclusion zones, 2) restricted areas/permitting systems, 3) voluntary exclusion zones, 4) vessel re-routing, 5) pilotage, 6) code-of-conduct, 7) reporting, 8) speed reduction, 9) passive acoustic monitoring, 10) visual monitoring by marine

mammal observers, 11) automatic identification systems, and 12) training. Management tools were classified as to whether they involved spatial tools, vessel-based tools, monitoring, or outreach. Two spatial tools – voluntary avoidance and slow down areas were evaluated as having high potential for successful application in the Beaufort Sea.

Robards, M.D., Huntington, H.P., Druckenmiller, M., Lefevre, J., Moses, S.K., Stevenson, Z., Watson, A. and Williams, M. (2018). Understanding and adapting to observed changes in the Alaskan Arctic: Actionable knowledge co-production with Alaska Native communities. *Deep Sea Research Part II: Topical Studies in Oceanography*, 152:203-213.

Global changes in climate, connectivity, and commerce are having profound impacts on the Arctic environment and inhabitants. There is widespread recognition of the value of incorporating different worldviews and perspectives when seeking to understand the consequences of these impacts. In turn, attention to local needs, perspectives, and cultures is seen as essential for fostering effective adaptation planning, or more broadly, the resilience of local peoples. The emerging literature on "knowledge co-production" identifies factors that can help incorporate such local needs and information. This field focuses on how different models of what has been termed the "science-policy interface" can incorporate multiple epistemologies. Such an approach goes beyond observing or assessing change from different scales and perspectives, to defining conditions that support the co-production of actionable knowledge. This approach requires the development of response tools that can accommodate the dynamic relationships among people, wildlife, and habitats that straddle cultures, timescapes, and sometimes, national boundaries. We use lessons from seven Alaskan cases studies to describe a typology of five elements important for the co-production of locally relevant actionable knowledge. Three elements are consistent with earlier work, including 1) evolving communities of practice, 2) iterative processes for defining problems and solutions, and 3) presence of boundary organizations, such as a government agency, university, or co-management council. Our results for the Alaskan Arctic also emphasize the critical need to incorporate 4) the consistent provision of sufficient funds and labor that may transcend any one specific project goal or funding cycle, and 5) long temporal scales (sometimes decades) for achieving the co-production of actionable knowledge. Our results have direct relevance to understanding the mechanisms that might foster greater success in more formalized co-management regimes.

Suydam, R.S. and George, J.C. (2018). Subsistence harvest of bowhead whales (*Balaena mysticetus*) taken by Alaskan Natives, 1974 to 2016. International Whaling Commission. SC/67B/AWMP06, 16 pp.

The authors presented in this paper a comprehensive review of the subsistence harvest by Alaskan Natives of bowhead whales from 1974 to 2016. The paper was submitted to the Scientific Committee of the IWC and does is not a peer-reviewed publication. A comprehensive review of harvest statistics for all years was provided, including: 1) total number of whales harvested for subsistence purposes (n=1373) from 12 coastal villages, 2) a summary of whales landed by village, 3) summary of harvest efficiency (i.e., whales landed/whales struck), where the authors noted a marked increase in the efficiency of the harvest over the time period summarized, and 4) the length distribution and sex ratio of the harvest, where overall the sex ratio of the harvest during this time period was near unity. This report was prepared as part of the Implementation Review of the BCB stock of bowhead whale. Harvest data were collected by NMFS from 1973 to 1981 for Barrow (Utqiagvik) and Point Hope, by whaling captains during these years intermittingly in other whaling villages, and by the North Slope Borough in collaboration with the AEWC since 1982. Details of the harvest monitoring are provided by village and by year.

Galginaitis, M. (2019). Summary of the 2018 Subsistence Whaling Season at Cross Island. Report prepared for Hilcorp Alaska, LLC. Anchorage, AK. 70 pp.
The author reported on information regarding the subsistence whaling season at Cross Island, AK. The report was a continuation of similar reports, going back to 2001. It was noted that whalers reported multiple whale sightings on only six of the twelve scouting days, with single reports on five days and zero reports on one day. The whalers scouted for whales on August 30, September 1–2, September 4–10, and September 12–13. Conditions were generally favorable, in terms of wind and sea state, for whaling during this period, with only two days when weather prevented scouting (August 31 and September 11). Whales were landed September 2, 8, and 13. The author provided summaries of comparisons with environmental and hunting conditions from previous years, as well as an overview of whaling practices at Cross Island over the years. Extensive use of photos, figures, and tables were used by the author to clarify findings and information contained in this report. The author noted that the 2018 season was longer and more difficult than most seasons. Whalers were able to use 3 of the 4 whale strikes allowed under their quota. Three whales were landed.

Holen, D. (2019). Coastal Community Vulnerability Index and Visualizations of Change in Cook Inlet, Alaska. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2019-031, Fairbanks, AK. July 2019. 23 pp.
The author in this report described the use and application of a web-based data integration and visualization platform designed to assist with planning for oil and gas extraction activities in the region and to improve outcomes in the event of an environmental crisis (referred to as the Cook Inlet Response Tool [CIRT]). The CIRT is a component of the Alaska Ocean Observing System (AOOS) portal. The author created a new module for the CIRT dealing with a socio-economic layer (i.e., Wild Resource Harvest and Use by Cook Inlet Communities) that focused on patterns of subsistence harvest and gathering. Three villages were targeted in this project: Tyonek, Seldovia, and Nanwalek; however, information from other villages was included in the report. Data on harvest activity for the layer were collected in 2013-2014. Harvest data information was shared with village members. Some village members noted that between 2013 and 2019, use subsistence use patterns have changed, as well as concerns regarding pollution from frequent breaks in oil pipelines. One application for this tool would be to help managers identify key areas for subsistence hunters and harvesters in the event of an oil spill from either a vessel or a platform. In addition, the author developed a vulnerability risk index for coastal areas as part of the CIRT.

Stevenson, T.C., Davies, J., Huntington, H.P. and Sheard, W. (2019). An examination of trans-Arctic vessel routing in the central Arctic Ocean. *Marine Policy*, 100:83-89.
The authors examined possible mitigation strategies for vessel routing in the Transpolar Sea Route (e.g., Northern Sea Route and Northwest Passage) that is likely to increase in the near future due to global warming causing an increase in the open water season in the Arctic. They noted that transiting vessels pose a risk to the marine environment through mechanisms such as vessel noise, air pollution, collisions with wildlife, introduction of non-native species, oil spills, and vessel discharges. In this paper the authors: 1) reviewed the available literature on central Arctic Ocean (CAO) vessel traffic to assess the nature and magnitude of anthropogenic stressors on the marine environment, 2) based on the above, recommended vessel traffic routes that would reduce environmental risks, and 3) provided examples of vulnerability assessments focused on impacts from vessel traffic in the Arctic as potential models for future work specific to the CAO. Further, the authors noted that designation as a Particularly Sensitive Sea area under international law could provide a useful precautionary measure for creating and updating shipping routes in the CAO.

Collier, C. (2020). Seldovia Village Tribe Comments on Proposed Cook Inlet Lease Sale 258. October 8, 2020. 2 pp.
This letter is from the CEO of the Tribe. Seldovia Village Tribe wants to exclude the parcels overlapping the areas designated as critical habitat for the Cook Inlet beluga whale population and the Northern sea otter from the sale. There is also special concern for the area known locally as "Compass Rose." located roughly 27.4 km west of the Homer spit and for the Kamishak Bay herring spawning grounds.

Stinchcomb, T.R., Brinkman, T.J. and Betchkal, D. (2020). Extensive aircraft activity impacts subsistence areas: Acoustic evidence from Arctic Alaska. *Environmental Research Letters*, 15:115005.
The authors reported on the results of a study to describe the nature and magnitude of the soundscape over Nuiqsut's traditional harvest area. Twenty acoustic monitoring stations were deployed in the area from June- August 2016. The authors noted that the peak of industrial activities and research activities in the vicinity of Nuiqsut temporally overlap with the peak harvesting season for caribou (June-September), and that aircraft noise made caribou more difficult to hunt and caused them to avoid certain areas. The experimental design included noted that distance of each monitoring station from airstrips and drill sites (i.e., 0-15 km, 15-30 km, and over 30 km). Recording systems were mounted 1.5m above ground. The study focused on two types of potential disturbance: 1) aircraft and watercraft activity (number of aircraft or watercraft events per day) and 2) magnitude of sound from aircraft or watercraft. Natural components of the soundscape were differentiated from anthropogenic components. 7,465 aircraft events were recorded during the study. Details of the results were reported in Table 1. A heat map that displayed noise free intervals from each monitoring station provided an excellent overview of the soundscape. The authors reported that: 1) local areas within 30km of Nuiqsut or oil and gas activities experienced the greatest disturbance from aircraft and watercraft, 2) hunters typically travel less than 30 km from Nuiqsut to hunt caribou, and 3) the quietest soundscapes, however, may be the most vulnerable to disturbance relative to anthropogenic noise.

Bin 6 - Climate Change

Tynan, C.T. and Demaster, D.P. (1997). Observations and Predictions of Arctic Climatic Change: Potential Effects on Marine Mammals. *Arctic*, 50:308-322.
This paper was published over 20 years ago and used information on trends in sea ice extent from the late 1960s to the 1990s to make predictions regarding the impacts of loss of sea ice on Arctic marine mammals. The authors noted that 1) the Arctic Ocean and adjacent seas strongly influence global climate, 2) polar amplification of warming in the Arctic was attributable to feedback from differences in snow-ice and water albedo, 3) loss of sea ice could potentially influence ocean currents (e.g., thermohaline circulation in the North Pacific), 4) the following populations of cetaceans will be valuable indicators of persistent change in the Arctic environment- eastern Arctic bowhead whale, Okhotsk Sea bowhead whale, and all stocks of narwhal and beluga, 5) the Arctic cod is a pivotal species in the Arctic food web. Its distribution and abundance could be greatly impacted by changes in the extent and placement of marginal sea ice, which in turn will impact marine mammal species that evolved in this unique environment, 6) in the High Arctic, the base of the marine food web is ice algae rather than phytoplankton, 7) for species like the gray whale, for which sea ice acts as a barrier to benthic foraging, a warmer Arctic may be beneficial. Conversely, for those species that are dependent on prey whose abundance is positively correlated with sea ice extent, a warmer Arctic may be unfavorable, 8) the timing and seasonal patterns of migration of marine mammals could change as sea ice losses continue, and 9) monitoring of key species in the Arctic is critical to understanding the risk posed by climate change to Arctic marine mammal populations.

George, C., Huntington, H., Brewster, K., Eicken, H., Norton, D. and Glenn, R. (2003). Observations on Shorefast Ice Dynamics in Arctic Alaska and the Responses of the Iñupiat Hunting Community. *Arctic*, 57:363-374.
In this paper the authors evaluated the way in which sea ice dynamics affect the hunting behavior and success rate of Inupiat hunters and how advances in technology affect their use of the sea ice habitat. Two case studies were examined: 1) a breakup of the shorefast ice in May 1957 and 2) a large calving event in May 1997. The objectives of the authors in writing this paper were to describe the Inupiat reliance on sea ice and the risk associated with that reliance, describe the shorefast ice environment and the uncertainty associated with its stability, and examine natural and societal factors that influence decision making regarding risk. The details of both case study were presented, along with Inupiat terminology for many of the ice conditions. The authors concluded with a discussion regarding the risk whale hunters face during whaling operations, and how hunters evaluate the potential risks versus the potential gains of hunting on a given day.

Burek, K.A., Gulland, F.M.D. and O'Hara, T.M. (2008). Effects of Climate Change on Marine Mammal Health *Ecological Applications*, 18:S126-S134.
The authors noted that the impact of climate change on Arctic marine mammals will: 1) be both direct and indirect, 2) be mediated in part due to changes in pathogen transmission pathways, 3) vary by species and region, 4) be dependent on adequate baseline information, which are currently lacking, 5) be mediated in part due to changes in body condition related to changes in the prey field, and 6) be mediated in part due to changes in exposure to toxicants. A summary of possible health impacts was summarized in Table 1. The authors recommended that priority should be given to base line studies on species considered most at risk (e.g., see Laidre et al. 2008). The authors also noted that many of the disease agents to which marine mammals are susceptible are of concern regarding human health issues.

Hopcroft, R., Bluhm, B. and Gradinger, R. (2008). Arctic Ocean Synthesis: Analysis of Climate Change Impacts in the Chukchi and Beaufort Seas with Strategies for Future Research. Institute of Marine Sciences, University of Alaska Fairbanks. 184 pp.

The authors noted in this paper the urgent need to integrate and synthesize the present state of knowledge of the biology and oceanography of the US Arctic Large Marine Ecosystem (LME, i.e., composed of the Beaufort and Chukchi Seas). This urgency is related to fast rate of change in the Arctic LME associated with global warming. To achieve a comprehensive synthesis, the authors organized an interdisciplinary workshop, which was convened in February of 2006. Workshop participants were from the US, Canada, Russia, and Japan. Workshop participants were asked to identify: 1) the most crucial information gaps, 2) "pulse points" that require specific monitoring, and 3) how climate change might impact the marine biota. Ten working groups were formed and this paper provided a summary of findings and research recommendations from each group.

Laidre, K.L., Stirling, I., Lowry, L.F., Oystein, W. and Heide-Jørgensen, M.P. (2008). Quantifying the Sensitivity of Arctic Marine Mammals to Climate-Induced Habitat Change. *Ecological Applications*, 18:S97–S125.

This review article focused on the possible consequences of unidirectional warming in Arctic marine mammals, primarily mediated through loss of sea ice. Seven Arctic species were considered, along with four sub-Arctic species. Data regarding risk were quantified using a "sensitivity index", which incorporated information on nine variables: 1) population size, 2) breadth/extent of geographic range, 3) habitat specificity, 4) diet diversity, 5) migrations, 6) individual site facility, 7) influence of changes in sea ice, 8) influence of changes in the trophic web, and 9) maximum rate of population increase. Species sensitivity index scores ranged from 12 to 25 (with lower numbers being associated with greater risk). Three species scored below or equal to 15: hooded seal, narwhal, and polar bear. Six species scored between 15 and 20: bowhead whale, beluga, harp seal, spotted seal, ribbon seal and walrus. wo species were considered least sensitive: ringed and bearded seals. A summary for each species by factor is presented in Table 2. Additionally, some regional aspects of risk due to climate change were discussed (e.g., Pacific and Atlantic walrus), as was an evaluation of risk associated with breeding ecology for ice seals.

Ragen, T.J., Huntington, H.P. and Hovelsrud, G.K. (2008). Conservation of Arctic Marine Mammals Faced With Climate Change. *Ecological Applications*, 18:S166-S174.

The authors of this paper presented a rather dire conclusion regarding the fate of many Arctic marine mammals species/populations faced with the ecological and environmental changes driven by global warming (e.g., loss of sea ice). That is, there are no known conservation measures that can be used to mitigate the direct and indirect manifestations of climate change as forecasted to occur over the next century. Therefore, the authors conclude that many of these populations are at risk, although species specific differences in response to global warming were expected. The authors further noted that existing conservation measures have been designed to only conserve these populations relative to impacts of increased human activity, where increasing human activities are on-going due to greater access to the marine Arctic environment associated with greater periods of open water (i.e., ice free). These conservation measures included in part: 1) restrictions on hunting, 2) protection of key habitat areas from development, and 3) reduction of incidental take related to such things as commercial fishing, vessel strikes, etc. Table 1 provided a summary of the potential utility of existing conservation measures. The authors commented on the importance of monitoring Arctic marine mammal populations as a way to assess the impact of cumulative risks in the future. The authors concluded that a dilemma exists for managers that are being required to provide certainty regarding the impacts of climate change on Arctic marine mammals prior to significant changes in greenhouse gas production, but where reducing

uncertainty to levels required will take sufficient time that at that point in the future, changes related to climate change will be irreversible.

Ashjian, C.J., Braund, S.R., Campbell, R.G., George, J.C.C., Kruse, J., Maslowski, W., Moore, S.E., Nicolson, C.R., Okkonen, S.R., Sherr, B.F., Sherr, E.B. and Spitz, Y.H. (2010). Climate Variability, Oceanography, Bowhead Whale Distribution, and Iñupiat Subsistence Whaling near Barrow, Alaska. *Arctic*, 63:171-194.

The authors in this paper investigated the 1) mechanisms that form prey aggregations for feeding bowhead whales and 2) how the oceanography of the region and climate variability could impact the availability of bowhead whale prey in the future. Oceanographic surveys, as well as aerial surveys, where conducted during August and September in 2005 and 2006. Details of three principal water masses in the vicinity of Barrow were described. Short term variability in hydrography was associated with changes in wind speed and direction. Wind speed and direction directly impacted the taxonomic composition of the plankton community. The authors speculated that euphausiids and copepods were upwelled onto the Beaufort Sea shelf during east or southeast winds. The authors noted that favorable foraging conditions were created near Barrow, Alaska when winds and currents retained and concentrated prey. The location of the prey aggregation was consistent with traditional knowledge. The authors concluded that formation of bowhead whale prey aggregations in the vicinity of Barrow were 1) recurrent, 2) the result of a combination of environmental factors that synergistically promote prey aggregations, 3) persistently used by whales in the fall, and which was therefore an area traditionally used by bowhead whale subsistence hunters from the area.

Kovacs, K.M., Lydersen, C., Overland, J.E. and Moore, S.E. (2010). Impacts of changing sea-ice conditions on Arctic marine mammals. *Marine Biodiversity*, 41:181-194.

The authors in this paper highlighted the premise that Arctic marine mammals (especially endemic species) are at risk due to direct and indirect impacts of loss of sea ice in the Arctic. They noted that anticipated impacts include: 1) increased competition with temperate species that moved north in response to ocean warming, 2) increased predation associated with loss of sea ice (e.g., predation by killer whales), 3) increased exposure to disease and parasitic infections. The linkages between sea ice and 11 species of Arctic marine mammals was summarized in Table 1. Impacts of reduced sea ice were related to both loss of sea ice and thinning of sea ice. The authors provided an excellent species-specific summary of impacts related specifically to loss of sea ice. The authors noted the need for ecosystem based research efforts to provide for an evaluation of indirect effects of loss of sea ice on Arctic marine mammals, as well as monitoring of key sentinel species. The paper included an excellent overview of published literature on previously reported responses of marine mammals to loss of sea ice.

AMAP (2011). The Impact of Black Carbon on Arctic Climate. By: Quinn, P.K., Stohl, A., Arneth, A., Berntsen, T., Burkhart, J. F., Christensen, J., Flanner, M., Kupiainen, K., Lihavainen, H., Shepherd, M., Shevchenko, V., Skov, H., Vestreng, V., Arctic Monitoring and Assessment Programme (AMAP). Technical Report No. 4, Oslo, Norway. 72 pp.

The authors noted that black carbon (BC) is the most efficient atmospheric particulate at absorbing visible light. In this report, the authors included: 1) a review of the literature up and through 2010/11 on the chemical, physical and optical properties of BC, 2) results of model calculations regarding the impact of BC on the Arctic climate, 3) a review of emissions of BC and sources to the Arctic, 4) transport mechanisms of BC to the Arctic, 5) estimates of radiative forcing, and 6) a section on knowledge gaps and recommended research. Considerable detail is provided through the use of extensive graphics. A summary of findings related to the impact of BC on Arctic climate is provided in Chapter 9. Finally, as would be expected, the literature cited section of this report is extensive.

USGS (2012). Changing Arctic Ecosystems: Polar Bear and Walrus Response to the Rapid Decline in Arctic Sea Ice. U.S. Geological Survey Fact Sheet, 4 pp.
This fact sheet was part of a publication series by USGS referred to as "science for a changing world". It is a non-technical report. The authors noted their use of Bayesian network models as a framework for projecting the status of polar bear and walrus in the 21st century under various scenarios of ice change. For walrus, the loss of sea ice in the near term is considered to be one of the greatest influences on their rates of survival and reproduction. The authors noted that they are trying to use bioenergetic models to assess how changes in the habitat use of walrus will affect their energetics and ultimately their population dynamics. Regarding polar bear, the loss of sea ice has led to increased use of onshore habitat after the ice recedes. The authors noted they are studying the abundance, distribution and diet of onshore bears to assess how the overall population of bears in the Southern Beaufort Sea stock will respond.

Gradinger, R. (2013). Annual Report 19, Calendar Year 2012. U.S. Dept. of the Interior, Bureau of Ocean Energy Management and University of Alaska Coastal Marine Institute. Alaska OCS Region. BOEM 2013-0112, Anchorage, AK. March 2013. 49 pp.
IThis report provides six separate reports in response to an agreement with BOEM. The overall report constitutes the annual report from Gradinger to BOEM. BOEM published this report as an OCS Study. Chapter 6 (pages 31-36) described the efforts undertaken to create an animated film on a life in the year of a bowhead whale (investigators: Mr. Roger Topp, Dr. Steve Okkonen). The purposes of the film were to improve public understanding of the marine ecosystem, with emphasis on the whales and the zooplankton. Specific topics covered included whale taxonomy, physiology, diet, behaviors, and overall movement through subarctic and arctic waters, as well as on-going tagging and aerial observation programs and work with Inupiat whalers. The animated feature was anticipated to be completed in the first quarter of 2013. Details of the animation, sound design, costs and project schedules were included in the report. [Note – the animated film is available on YouTube at https://www.youtube.com/watch?v=I-ksl2YXdd4].

IPCC (2014). Climate Change 2014 Synthesis Report. Intergovernmental Panel on Climate Change. Geneva, Switzerland. 151 pp.
This detailed report (i.e., 151 pages) is part of a series produced periodically by the IPCC) regarding state-of-the-art knowledge related to climate change. This report is now 6 years old; more recent reports of the IPCC are now available. The authors concluded the following: 1) human influence on the climate is clear, 2) recent changes in climate have had widespread impacts on human and natural systems, 3) warming of the climate system is unequivocal, 4) ocean warming dominates the increase in energy stored in the earth's climate system, 5) the pH of the ocean has decreased by 0.1 with high confidence, 6) the annual mean Arctic sea-ice extent decreased over the period 1979 to 2012, with a rate that was very likely in the range 3.5 to 4.1% per decade, 7) anthropogenic greenhouse gases and other anthropogenic drivers are extremely likely to have been the dominant cause of the observed warming since the mid-20th century, 8) changes in many extreme weather and climatic events have been observed since about 1950 including: a decrease in cold temperature extremes, and increase in warm temperature extremes, an increase in extreme high sea levels, and an increase in the number of heavy precipitation events in a number of regions, 9) continued emissions of greenhouse gases will cause further warming and cause long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems, 10) limiting climate change would require substantial and sustained reductions in greenhouse gas emissions, which together with adaptation, can limit climate change risks, 11) the high latitudes and the equatorial Pacific are likely to experience an

increase in annual mean precipitation under the Representative Concentration Pathways (RCP) 8.5 scenario, 12) year round reductions in Arctic sea ice are projected for all RCP scenarios, 13) by mid-century, an ice-free Arctic Ocean is expected, 14) climate change is projected to undermine food security, 15) many aspects of climate change and associated impacts will continue for centuries, 16) the risk of abrupt or irreversible changes increase as the magnitude of warming increases, 17) effective decision-making to limit climate change and its effects can be informed by a wide range of analytical approaches, and 18) adaptation can reduce the risk of climate change impacts, but there are limits to its effectiveness. The authors use of graphics and tabular data greatly enhance the readability of this report.

Bromaghin, J.F., McDonald, T.L., Stirling, I., Derocher, A.E., Richardson, E.S., Regehr, E.V., Douglas, D.C., Durner, G.M., Atwood, T. and Amstrup, S.C. (2015). Polar bear population dynamics in the southern Beaufort Sea during a period of sea ice decline. *Ecological Applications*, 25:634-651.
The authors report on the results of mark-recapture models for polar bears in the southern Beaufort Sea in this paper for the years 2001 - 2010. The report states: 1) low survival caused the population to decline by 25-50% between 2004-2006, 2) in 2007, survival of cubs and adults improved, which caused the population to stabilize between 2008-2010, and 3) during this period, subadult survival continued to decline. Figures 3 and 4 provide an excellent summary of age and sex specific changes in survival during the study. The estimated maximum abundance of bears in this population was 1158 (2004), while the minimum abundance of bears was 376 (2009). The authors conclude that reduced temporal and spatial access to sea ice would continue to be a forcing factor for the population dynamics of this population, although other factors at present were important. They note that a better understanding of polar bear population dynamics is needed to better predict the impact of continued loss of sea ice on this population of polar bear.

Atwood, T.C., Peacock, E., McKinney, M.A., Lillie, K., Wilson, R., Douglas, D.C., Miller, S. and Terletzky, P. (2016). Rapid Environmental Change Drives Increased Land Use by an Arctic Marine Predator. *PLoS One*, 11:e0155932.
The authors used information from satellite tracking collars on polar bears to asses changes in land use patterns over the past 15 years along the North Slope of Alaska. The authors noted that polar bear use of land habitat has tripled over this time period. Further, on average bears arrived earlier on land, used land habitats longer, and returned later to the sea ice in the fall. This change was associated with a mean increase in the duration of the open water season by 36 days. Polar bear scavenging, while on land, was reported to be influenced by the availability of subsistence-harvested bowhead whale carcasses. The authors speculated that in the near future, polar bear use of land habitats would increase as sea ice losses continue, and that bears may be exposed to a greater array of risk factors, including those associated with human activities.

Ferrara, G.A. (2017). Assessing the Vulnerability of Marine Mammal Subsistence Species in the Bering Sea to Climate Change. University of Washington. Seattle, WA. 35 pp.
This paper is a Master's Thesis from the University of Washington's School of Marine Affairs. The author reported on the results of a Climate Change Vulnerability Analysis (CCVA) to quantify the risk of 8 species of marine mammals in the Bering Sea region to loss of sea ice and other environmental changes associated with climate change and to assess the vulnerability of the coastal communities in this region that rely on these species of marine mammals as a food resource. Four of the eight species are ice dependent (i.e., polar bear, walrus, bearded seal, and ringed seal) and four species are ice-associated (i.e., bowhead whale, beluga whale, ribbon seal and spotted seal). For each species a short summary on the distribution, ecology and level of use by subsistence hunters is presented. The author noted the following: 1) CCVAs have been used over the past two decades to asses risk, 2) the vulnerability of marine

mammals to climate change was assessed as a function of exposure, sensitivity, and adaptive capacity, and 3) scores for each variable were presented for each species. Final vulnerability scores were determined qualitatively by comparing potential impact (based on exposure and sensitivity scores) and adaptive capacity. Species rated with high vulnerability were bearded seal and walrus; moderate vulnerability was assigned to polar bear, ribbon seal and ringed seal; and low vulnerability species were bowhead whale and spotted seal. Beluga whales were not given a vulnerability score because the author was unable to estimate a potential impact score for this species. The author concluded that species with high risk vulnerability scores were more likely to disappear from the range where they can be successfully hunted by subsistence hunters. She recommended that next steps include a CCVA to assess community vulnerability.

Udevitz, M.S., Chadwick V. J., Taylor, R.L., Fischbach, A.S., Beatty, W.S. and Noren, S.R. (2017). Forecasting Consequences of Changing Sea Ice Availability for Pacific Walruses. *Ecosphere*, 8:e02014.
The authors reported on the results from behavioral models for walrus that related changes in sea ice availability to the following: 1) changes in adult female movements and activity levels, 2) associated energy requirements, and 3) the ability of adult females to meet the anticipated energy needs. The behavioral models were linked to general circulation model projections of future sea ice availability. These results were used to forecast the body condition of adult females in the fall during the mid and late century time period. The model results indicated that as sea ice becomes less available in the Chukchi Sea, females will spend more time in the southwestern region of the Chukchi Sea, less time feeding and less time resting. These predictions were associated with the prediction that female body condition would decline over time (i.e., loss of average body mass on the order of 7-12%), although the level of uncertainty associated with these projections was large. The authors noted that quantitative relationships between body condition, reproductive success and survival currently do not exist. They recommended that the approach described in this paper could serve as a valuable framework for future research efforts linking changes in sea ice or other environmental conditions to changes in the behavior and bioenergenics of a species.

Druckenmiller, M.L., Citta, J.J., Ferguson, M.C., Clarke, J.T., George, J.C. and Quakenbush, L. (2018). Trends in sea-ice cover within bowhead whale habitats in the Pacific Arctic. *Deep Sea Research Part II: Topical Studies in Oceanography*, 152:95-107.
The authors in this paper reported on changes in the number of open water days (OWD) between 1974 and 2014 in the western Beaufort Sea in the migratory area used by the Bering-Chukchi-Beaufort Seas population of bowhead whale. The authors noted that: 1) ice cover in the northern extent of the core-use area decreased more than in the southern extent of the core-use area, 2) the number of OWD near Pt. Barrow increased by 13 days/decade and on the shelf and slope of the western Beaufort Sea by 20 and 25 days/decade, respectively, and 3) sea ice coverage in the winter core-use area has not changed significantly. The authors speculated that bowhead whales will: 1) spend more time on summer and fall feeding grounds, 2) delay their arrival to the wintering grounds, 3) may start to overwinter in the southern Chukchi Sea, and 4) may display greater variability in the timing and movements of feeding in the summer and fall.

Hauser, D.D.W., Laidre, K.L. and Stern, H.L. (2018). Vulnerability of Arctic marine mammals to vessel traffic in the increasingly ice-free Northwest Passage and Northern Sea Route. *PNAS*, 115:7617-7622.
The authors developed a vulnerability assessment for 80 subpopulations of Arctic marine mammals to vessel traffic during the ice-free season. Vulnerability was evaluated based on a combination of spatially explicit exposure to sea routes and a suite of sensitivity variables. Forty-two of the 80 subpopulations were reported to be exposed to open-water vessel transits in the Arctic Sea routes (e.g., Northern Sea

Route and Northwest Passage). Narwhal subpopulations were found to be the most vulnerable, while polar bear subpopulations were found to be the least vulnerable. Subpopulations that occurred in the vicinity of geographic bottlenecks (e.g., Bering Strait, eastern Canadian Arctic) were considered more vulnerable than subpopulations in remote areas. The authors recommended that the framework developed herein be used for assessing vulnerability of Arctic marine mammals to vessel traffic during the ice-free season. The authors concluded that such an approach was necessary to implement best practices among maritime vessel operators and industries active in the Arctic during this period of global warming and associated loss of sea ice.

Lone, K., Kovacs, K.M., Lydersen, C., Fedak, M., Andersen, M., Lovell, P. and Aars, J. (2018). Aquatic behaviour of polar bears (*Ursus maritimus*) in an increasingly ice-free Arctic. *Scientific Reports*, 8:9677.
Polar bears are ice-associated marine mammals, and as such are being impacted by reductions in Arctic sea ice. In this paper, the authors quantify the behavior of female polar bears in the water. The methods relied heavily on instrumentation to determine when a bear was in the water and whether it was at the surface or at depth. Seventy-nine deployments on female polar bears were used in the analysis. The authors reported that: 1) there were strong seasonal patterns. From April to October, 90% of the bears were in the water sometime during the day. This percentage declined to 60% from December to January, 2) females with cubs spent less time in the water than other females from den emergence until mid-summer, and 3) some bears swam notably long distances (i.e., over 50 km), 4) dives greater than 5 m were common. This paper reports the first results regarding the diving behavior of instrumented female polar bears.

Mioduszewski, J., Vavrus, S. and Wang, M. (2018). Diminishing Arctic Sea Ice Promotes Stronger Surface Winds. *Journal of Climate*, 31:8101-8119.
In this paper the authors described patterns of wind changes over all seasons across the Arctic. In addition, the authors identified likely causative mechanisms, especially those related to loss of sea ice over the next 80 years. The authors noted that mean near-surface wind speeds over the Arctic were expected to increase by late century, with increases in the fall and winter being the greatest (i.e., up to 50%). The change in wind speed was associated with decreasing surface roughness and lower-tropospheric stability, which results from loss of sea ice. The authors noted that greater wind speed, when combined with a reduction in sea ice and sea level rise, would likely contribute to the problem of coastal erosion in the Arctic.

Moore, S.E. and Reeves, R.R. (2018). Tracking Arctic marine mammal resilience in an era of rapid ecosystem alteration. *PLoS Biology*, 16:e2006708.
The authors proposed in this paper a basic framework to both broaden and simplify metrics used to assess marine mammal population status as a means to prioritize and expedite urgently needed conservation and management actions in a rapidly changing Arctic.The authors used summed rankings for four resilience metrics (i.e., population size, seasonal range, behavioral plasticity, and health) to assess population status and to prioritize management actions. A summary of resilience measures by species is provided. Further, the authors noted that marine mammal species were recently recognized as "essential ocean variables" within a Global Ocean Observing System (GOOS). An arctic marine mammal tracking framework such as the one described in this paper could provide the GOOS with information on the status of these species, and the GOOS could in turn provide an online portal for delivery of information to resource managers.

Niemi, A., Ferguson, S., Hedges, K., Melling, H., Michel, C., Ayles, B., Azetsu-Scott, K., Coupel, P., Deslauriers, D., Devred, E., Doniol-Valcroze, T., Dunmall, K., Eert, J., Galbraith, P., Geoffroy, M., Gilchrist, G., Hennin, H., Howland, K., Kendall, M., Kohlbach, D., Lea, E., Loseto, L., Majewski, A., Marcoux, M., Matthews, C., McNicholl, D., Mosnier, A., Mundy, C.J., Ogloff, W., Perrie, W., Clark Richards, Richardson, E., Reist, J., Roy, V., Sawatzky, C., Scharffenberg, K., Tallman, R., Tremblay, J.-E.r., Tufts, T., Watt, C., Williams, W., Worden, E., Yurkowski, D. and Zimmerman, S. (2019). State of Canada's Arctic Seas. Fisheries and Oceans Canada. Canadian Technical Report of Fisheries and Aquatic Sciences-3344, 206 pp.

The authors in this technical report provided a synthesis of information over the previous 5 years regarding the Canadian Arctic region. Information from scientific research programs and from Inuit traditional knowledge is included. Ecosystem variability and connectivity are common themes throughout the report. Each sections of the report contained case studies specific to the chapter. Chapters addressed: 1) Ocean reporting, 2) stressors of the Arctic Ocean ecosystems, 3) structure of the Arctic Ocean ecosystem, 4) ecosystem variability, including stability in marine mammal populations, 5) neighborhood connections, including a case study on beluga migration dates and changing ice regimes based on Inuit land-based sightings, 6) coastal ecosystems, and 7) co-management of the Canadian Arctic Ocean. In appendix A, the authors provided a summary of how sea ice dependencies for marine mammals. Key messages in the report included: 1) the collective efforts of scientists and indigenous peoples have yet to produce a holistic knowledge adequate for management of ecosystem level changes in the Canadian Arctic, 2) knowledge of the biodiversity of key ecosystem elements is not yet comprehensive, 3) community based monitoring programs are expanding, where Inuit knowledge informs the selection of metrics being monitored, 4) changes in the structure of the water column has been associated with changes in habitat availability for multiple species, 5) knowledge of marine fish movements and genetic separation is informing management strategies for harvested species and, for species at risk, conservation strategies, and 6) data streams of at least 20 years are needed to discriminate variability from change at a useful level of confidence. Observations related to changes in the distribution of polar bears, killer whales and other marine mammal species were discussed, where speculated causes were described.

Tempel, J.L. (2019). Life Without Ice: Climate Change and the Subsistence Communities of St. Lawrence Island. 32 pp.

The Bering Strait region is undergoing rapid environmental change in part associated with loss of sea ice. The purpose of this report was to assess the impact of environmental change on the marine resources important to subsistence users and the subsistence users from communities on St. Lawrence Island. Discussions were held with 24 local stakeholders (i.e., see table 1 for participant ages and gender). Five themes were addressed during each interview: 1) what are the key marine resources utilized by subsistence hunters, 2) how have these resources changed, 3) how has the community responded to these changes, 4) community attitudes towards oil and gas development, and 5) perceptions regarding the future of the subsistence life style on St. Lawrence Island. Key findings included: 1) a reduction in the walrus harvest due to decreased availability, 2) the impacts of oil and gas development was a considerable concern to participants (i.e., marine animals avoiding areas of such activity and possible contamination of food sources), 3) in the future, subsistence hunters will likely harvest fewer food resources, and 4) in the future, subsistence hunter will have to diversity the species they hunt for food. The author stressed the importance throughout the report of ascertaining local "truth" rather than identifying regional trends. The author noted that walrus and ice seals constituted the largest sources of subsistence food for members of St. Lawrence Island communities. Further, of the walrus harvested by subsistence hunters in US waters, 84% are taken by St. Lawrence Island hunters. One particularly

important theme identified by the author was that loss of sea ice has led to increased concerns regarding food security.

VanWormer, E., Mazet, J.A.K., Hall, A., Gill, V.A., Boveng, P.L., London, J.M., Gelatt, T., Fadely, B.S., Lander, M.E., Sterling, J., Burkanov, V.N., Ream, R.R., Brock, P.M., Rea, L.D., Smith, B.R., Jeffers, A., Henstock, M., Rehberg, M.J., Burek-Huntington, K.A., Cosby, S.L., Hammond, J.A. and Goldstein, T. (2019). Viral emergence in marine mammals in the North Pacific may be linked to Arctic sea ice reduction. *Scientific Reports*, 9:15569.

The premise being tested in this paper was whether the loss of sea ice in the Arctic has or will increase contact between Arctic and sub-Arctic marine mammals and lead to Phocine Distemper Virus (PDV) transmission across the Arctic Ocean to marine mammals in the North Pacific. The authors noted that PDV was recognized as an important pathogen in phocid seals in 1988, when an outbreak occurred in harbor seals in the North Atlantic. A second outbreak for this species in this region was reported in 2002. PDV was first confirmed in the North Pacific in 2004 when it was detected in northern sea otters. Between 2001 – 2016, Arctic ice seal species were live captured, where blood samples and nasal swabs were collected. As possible, samples were also collected from dead ice seals, Steller sea lions, northern fur seals, and northern sea otters that were harvested for subsistence purposes. Serology to detect antibodies to PDV (n = 1,227 animals tested 2001– 2013) was performed by micro neutralization. Molecular analyses were performed using total RNA extraction. Prevalence of PDV viral shedding for all species combined peaked in 2004 and 2009. Increased levels of PDV exposure or infection in the sampled animals were associated with the presence of an open water route along the Russian coast. Given the limited serologic data for species other than Steller sea lions and the sparse PCR data for each species across the study period, the authors were unable to determine if PDV was reintroduced in association with changing sea ice extent following the 2003–2004 peak of exposure and infection in the North Pacific Ocean, or whether viral transmission was maintained among marine mammal species. Linking movement data from satellite-tagged marine mammals with biological information on viral shedding illustrates that exposed animals have the potential to carry PDV long distances.

Bin 7 Scientific Studies

Richardson, W.J., Greene Jr., C.R., Malme, C.I. and Thomson, D.H. (1995). Marine Mammals and Noise. Academic Press. San Diego. 387 pp.
Book. Not annotated.

Miller, G.W., Elliott, R.E. and Richardson, W.J. (1998). Ringed seal distribution and abundance near potential oil development sites in the central Alaskan Beaufort Sea, spring 1997; Appendix A in Richardson 2008. LGL Rep. TA2160-3, 43 pp.
This report was originally a technical report prepared for LGL Alaska Research Associates Inc, which was reprinted as an appendix in Richardson (ed.) 2008. The authors described an aerial survey in the vicinity of the Northstar and Liberty development sites. Survey protocol was standard relative to prior surveys done by ADFG. Chi Square statistics were used to test the significance of individual variables. The survey results in 1997 were similar to those reported by Link et al. (1999), with some notable differences, which are detailed in Link et al.

Lesage, V., Barrette, C., Kingsley, M.C.S. and Sjare, B. (1999). The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River Estuary, Canada. *Marine Mammal Science*, 15:65-84.
The authors reported on a study that tested whether there was a change in the vocal behavior and surface behavior of belugas in the St. Lawrence River Estuary when exposed to specific anthropogenic noise (i.e., vessel noise associated with ferry traffic and small boat traffic). The study was conducted in June-July 1991.The region where the study was conducted was an important feeding area for belugas. Each experimental trail was composed of a pre-exposure, exposure and post-exposure period where beluga underwater vocalizations were recorded continuously. Beluga behavior was assigned to one of six categories: directional swimming, resting, social interaction, milling, stationary diving and porpoising. Beluga vocalizations were classified using a scheme developed for Arctic belugas by Sjare and Smith. Noise from the small boat had a peak frequency at about 6 kHz, while peak frequency for the ferry noise was below 6 kHz. The authors reported that vocalization behavior was influenced by both vessel types. During the exposure period, fewer calls per minute were recorded. Changes in the frequency of underwater vocalizations during the exposed period were described by the authors. A summary of behavioral changes during the three trial periods was presented in Table 1. Finally, the mean frequency used by beluga when calling was 3.6 kHz during control periods, but shifted upwards to 5.2-8.8 kHz during the exposed period. An increase in the use of strong and acoustically simple calls was noted during the exposure period. The authors recommended that additional controlled experiments to better evaluate how vocalization behavior of marine mammals change in the presence of anthropogenic noise be carried out.

Link, M.R., Olson, T.L. and Williams, M.T. (1999). Ringed seal distribution and abundance near potential oil development sites in the central Alaskan Beaufort Sea, spring 1998; Appendix B in Richardson 2008. LGL Rep. P-430, 69 pp.
This report was originally a technical report prepared for LGL Alaska Research Associates Inc, which was reprinted as an appendix in Richardson (ed.) 2008. The authors described an aerial survey in the vicinity of the Northstar and Liberty development sites. Survey protocol was standard relative to prior surveys done by ADFG. Chi Square statistics were used to test the significance of individual variables. The survey results in 1998 were: 1) seal density was 0.34 seals/km^2 during the 1997 survey and 0.45 seals/km^2 during the 1998 survey, 2) lower densities were reported in the shallow areas (below 3 m; see Table 2), 3) the density of seals was lower in areas of high ice deformation in 1997, but was not statistically significant in 1998, 4) temporal and weather variables influence the sighting rate of ringed seals, 5) there was no evidence that seal density varied with distance from Seal Island (Northstar site) or Tern Island

(Liberty site), and 6) the density of ringed seals was lower in the "vibroseis area" than the control area. The authors recommended multivariate statistical methods be applied to the data set.

Moore, S.E. (2000). Variability of cetacean distribution and habitat selection in the Alaskan Arctic, Autumn 1982-91. *Arctic*, 53:448-460.
Ten years of autumn aerial survey data from offshore northern Alaska were analyzed to investigate variability in habitat use patterns and distribution. Data were similar to those analyzed in Moore et al. (2000). The statistical significance of habitat selection was tested with a Chi Square analysis. The following was reported: 1) bowhead whales selected shallow, inner-shelf waters under light ice conditions, and deeper slope habitat in heavy ice conditions, 2) belugas consistently selected slope habitat, and 3) gray whales consistently selected coastal/shoal and shelf/trough habitat. In addition, in the northern Chukchi Sea, gray whales selected coastal/shoal habitat in areas of high transport conditions. Bowhead whale and beluga habitat selection was independent of transport rate. Moore concluded that habitat selection behavior was likely mediated through prey availability and prey preference for each species, but a rigorous test of this hypothesis is not possible without additional information.

Moore, S.E., DeMaster, D.P. and Dayton, P.K. (2000). Cetacean habitat selection in the Alaskan Arctic in the summer and autumn. *Arctic*, 53:432-447.
Sightings data from aerial surveys (1982-1991) of offshore northern Alaska were used to characterize seasonal use patterns of various habitats by cetaceans. Species-specific use patterns were identified for bowhead whale, beluga, and gray whale. Habitat use patterns were quantified using habitat selection ratios based on ice cover and bathymetry. Habitat use patterns varied by season (i.e., summer and fall) for all species. Inter-seasonal depth and ice cover varied significantly for bowhead whales, but not for gray whales. Depth habitat varied significantly for beluga seasonally, but not ice-cover habitat. The integration of information on Alaska Arctic oceanography provides useful mechanisms for how bathymetry and water transport patterns influence the marine habitat and how it influences the behavior of these three cetacean species.

Harris, R.E., Miller, G.W. and Richardson, W.J. (2001). Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. *Marine Mammal Science*, 17:795-812.
This publication documents the reaction of ringed seals and other pinnipeds to open-water seismic noise PSOs were stationed on the source vessel to monitor the numbers and reactions of seals and other marine mammals during seismic surveys, and to call for the airguns to be shut down, when marine mammals were within a radius (referred to as the "shutdown radius"), such that the received sound level would exceed 190 dB re 1 uPa. 3-D seismic surveys occurred between 24 July and 18 Sept 1996. A total of 112 shutdowns took place because of seals sighted within the "shutdown radius". 19% of 362 sightings were beyond 250 m from the source vessel. Seal sightings consisted mostly of ringed seals (92%), bearded seals (7%), and spotted seals (1%). Seals were seen at nearly identical rates during periods with no guns firing, one gun firing, and the full- array firing. However, sighting rates stratified by distance did vary significantly during seismic operations and no seismic operations. The results indicate that seals avoided the zone within 150 m of the vessel during full-array firing operations. However, it appears that few seals moved beyond 250 m from the vessel, as sighting rates beyond 250 m from the vessel did not change significantly with or without seismic operations. Seal behavior (categorized as one of five states) did not very with seismic state. The authors concluded that arctic seals (mostly ringed seals) exhibit no more than a localized avoidance of an approaching seismic vessel. The authors noted that the "shutdown" protocol could be problematic for some surveys and recommended urgent research on the effects of seismic noise on Arctic seals.

Moulton, V.D., Richardson, W.J., McDonald, T., Elliott, R.E. and Williams, M.T. (2002). Factors influencing local abundance and haulout behaviour of ringed seals (*Phoca hispida)* on landfast ice of the Alaskan Beaufort Sea; Appendix K in Richardson 2008. 19 pp.

This paper represents a peer-review publication of the data reported in Miller et al. (1998) and Link et al. (1999), but also includes a third survey year of data from 1999. Survey protocol was standard relative to prior surveys done by ADFG. Chi Square (univariate) statistics were used to test for significance, as well as a multivariate, Poisson regression. Survey results included: 1) the overall ringed seal density was 0.39, 0.35, and 0.56 seals/km^2 for years 1997-1999, respectively, 2) sighting density was significantly related to water depth in all three years, and 3) regression model results indicated that sighting density decreased as distance inshore of the ice edge increased, with increasing ice deformity, and with increasing percent melt water one surface. Sighting density was not significantly related to distance to industrial activity in any of the 3 years. Regarding seal density differences related to presence or absence of vibroseis activity, the multivariate findings in this paper were different from the univariate results reported by Link et al. (1999). The authors also noted the significant difference in sighting density on fast ice in water less than 3 m and greater than 3 m. The relationship between environmental variables and sighting density is well displayed in Figure 3, using the multivariate regression.

Patenaude, N.J., Richardson, W.J., Smultea, M.A., Koski, W.R., Miller, G.W., Würsig, B. and GReene JR., C.R. (2002). Aircraft Sound and Disturbance to Bowhead and Beluga Whales During Spring Migration in the Alaskan Beaufort Sea. *Marine Mammal Science*, 18:309-335.

The authors of this paper reported on opportunistic observations regarding the response of bowhead whales and belugas to a Bell 212 helicopter and a Twin Otter fixed-wing aircraft. The following categories of behavioral responses were used: short surfacings, immediate dives or turns, changes in behavior state, vigorous swimming and breaching. The results included: 1) most reactions occurred when the helicopter was at an altitude of less than 150 m and a lateral distance of less than 250 m, 2) few bowhead whales and belugas responded to fixed-wing aircraft flying overhead at 60 – 460 m, and 3) there was little reaction from bowhead whales when aircraft circled (1 km radius) at an altitude of 460 m. Received sound levels associated with both types of aircraft were recorded at 3 and 18 m. The authors noted that behavioral observations typically lasted for less than 3 minutes. Sound levels at source and frequency for each sound source were well described in the paper.

Richardson, J.W. (2002). Marine Mammals Versus Seismic and Other Acoustic Surveys: Introduction to the Noise Issues. *Polarforschung*, 72:63-67.

This article summarizes information from a presentation on the known and suspected impacts of noise on marine mammals. The author also summarizes information on the characteristics of seismic noise and other anthropogenic sounds. The author noted that although disturbance effects have been demonstrated, there are many reported situations where marine mammals tolerate strong pulsed noises without showing strong disturbance responses. The following findings are reported: 1) disturbance of baleen whales (i.e., bowhead, gray, and humpback whales) to seismic noise is relatively well studied. This is not the case for toothed whales and pinnipeds, 2) less information is available on the impact of medium and high frequency pulsed sources on marine mammals, although some information on masking and auditory effects is available from captive toothed whales, 3) it is not appropriate to assume that the effects of one medium or high frequency sound source can be used to characterize all such sound sources, 4) the proximity to a single seismic vessel likely causes little masking effect on natural sounds relevant to baleen whales (including communication), 5) for baleen whales there is a near total lack of knowledge concerning the auditory effects of exposure to high level sounds from airguns, 6) sperm whales appear to be less responsive to airgun pulses than suspected based on previously published

results, 7) pinniped tolerance to airgun pulses vary by species, with ringed seals showing considerable tolerance relative to gray seal or harbor seal responses, and 8) available data on temporary threshold shifts caused by continuous sound sources cannot be used to make inferences regarding the impacts of seismic noise (i.e., pulsed sound). The author recommended additional species-specific studies that incorporate a wide range of human related sound sources to better evaluate the potential impact on marine mammals and to find a better management balance between marine mammal conservation and human activities.

Blackwell, S.B. and Greene Jr., C.R. (2003). Acoustic Measurements in Cook Inlet, Alaska, during August 2001. National Marine Fisheries Service. Protected Resources Division. Greeneridge Report 271-2, Anchorage AK. August 12, 2002, Revised June 14, 2003. 44 pp.

Anthropogenic noise was characterized in during August 2001 using underwater and in-air recording for the purpose of quantifying the acoustic habitat of Cook Inlet belugas. Three main types of anthropogenic sounds were analyzed, as well as ambient noise in areas removed from industrial activity. None of the measured SPLs approached values that might be expected to injure belugas. However, for certain frequencies and some recordings, one-third octave band levels were as much as 50 dB higher than the whales' hearing threshold. The authors provide an excellent summary of beluga hearing thresholds across a wide range of frequencies, as well as signal analysis methods and detailed descriptions of sounds levels produced by the three primary sound sources studied. Sound propagation models were presented for each sound source. An observation of beluga whales swimming a few meters from the hull of cargo/freight vessel at dock, along with the accompanying sound level measurements, was used to illustrate the point that beluga whales frequently tolerate sounds produced by large vessels in industrial areas. However, the authors also provided evidence that belugas can react to icebreaker and other vessel noise at distances greater than 35 km. Therefore, the authors recommended against generalizing in regard to the response of belugas to most anthropogenic sounds. They further recommended that in regard to Cook Inlet belugas and possible adverse effects of anthropogenic noise, that simultaneous observations of belugas and sound level measurements are needed.

NRC (2003). Cumulative environmental effects of oil and gas activities on Alaska's North Slope. National Research Council, National Academic Press. Washington, DC. 460 pp.

This Congressionally mandated report sponsored by the National Academy of Sciences and completed by NRC reviews impacts of oil and gas activities up until 2000 with an emphasis on the cumulative effects on the environment and local community members. The report is considered unbiased and of very high academic standard. Findings and recommendations are reported at the end of each chapter. There are many knowledge gaps that are detailed in this report. The report calls for the preparation of a comprehensive planning document, which would include all phases of oil and gas activity, from lease sales to dismantlement and removal of infrastructure, to environmental rehabilitation and restoration. The plan called for should also identify areas for future research, where specific research elements are identified. The authors noted that the research plan should be a cooperative effort with local communities. The appendices provide useful summaries of history of oil and gas exploration, and traditional knowledge, including how such information should be collected. There are over 800 references cited in the report. An analysis of the degree to which recommendations reported in the document were addressed would be useful to BOEM

Moulton, V.D., Richardson, W.J., Elliott, R., McDonald, T.L., Nations, C. and Williams, M.T. (2005). Effects of an Offshore Oil Development on Local Abundance and Distribution of Ringed Seals (*Phoca hispida*) of the Alaskan Beaufort Sea. *Marine Mammal Science*, 21:217-242.
The authors report on the results of investigations to determine how ringed seal densities are affected by construction and oil production activities at the Northstar facility in the nearshore Alaskan Beaufort Sea. Aerial surveys for basking ringed seals were conducted over landfast ice for six seasons (i.e., 3 seasons before construction, 1997-99; and 3 seasons either after intense construction or after drilling or oil production, 2000-2002). Seal densities varied over the six years of survey by a factor of 2 (i., 0.35 to 0.72 seals/km^2). Seal densities in the proximity of the Northstar facility were not significantly different in 2000-2002 than the period prior to construction/operations. A statistical power analysis indicated that there was high power to detect small scale changes. Certain environmental factors (e.g., bathymetry, degree of ice deformation, percent cloud cover, and date) were found to explain a much higher proportion of the variability in sightings rates than did proximity to the Northstar facility. The authors concluded that the impact of construction and operation of a gravel island facility, such as Northstar, on the local distribution of basking ringed seals was no more than slight and was small in comparison to the effects of environmental factors.

NRC (2005). Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. National Research Council, National Academy of Sciences, . Committee on Characterizing Biologically Significant Marine Mammal Behavior. Washington, DC. 142 pp.
The report by the NRC Ocean Studies Board committee contains a conceptual model to serve as a roadmap for developing a predictive model to be used to relate anthropogenic noise to population level changes mediated through behavioral change. Further, the report identifies current gaps in knowledge for each element of the model. Research activities are then described to address these deficiencies. Finally, the authors provide recommendations for regulatory changes that are needed to more broadly protect marine mammal populations from anthropogenic noise. Specific recommendations in this report include: 1) Complete high priority research identified in previous NRC reports regarding marine mammals, 2) Complete the development of a conception model to provide for the evaluation of the impact of anthropogenic noise on marine mammals, 3) Develop and support a centralized marine mammal sightings database and associated responses to anthropogenic noise, 4) Develop methodology to use hormone steroids to characterize stress levels in marine mammals, and 5) Develop a pragmatic and practical methodology or protocol to assess the likelihood that a specific anthropogenic noise source will disrupt normal behavioral patterns of a given marine mammal species. This is the third NRC report related to impacts of anthropogenic noise on marine mammals (see also NRC 1994, NRC 2000).

HDR Alaska Inc., LGL Alaska and Greeneridge Sciences Inc. (2006). Final Underwater Measurements of Pile- Driving Sounds During the Port MacKenzie Dock Modifications,13–16 August, 2004. Alaska Department of Transportation & Public Facilities. Anchorage, AK. 48 pp.
This is a technical paper prepared by contractors for the Knik Arm Bridge and Toll Authority and is not a peer-reviewed article. The paper details measurements made by Greeneridge Science Inc of sound levels associated with pile driving during the Port MacKenzie dock modifications in Cook Inlet, Alaska. Two 91 cm steel pipes of length 46 m were driven 13-18 m into the seabed. The authors noted that noise levels associated with vibratory pile driving are not comparable to existing studies. Sound levels of impact pile driving were comparable to other studies. The distance at which mean received sound levels drop below 180 dB re 1uPa at the shallow water hydrophone was 195 m, while 250 m at the deep water hydrophone. If maximum sound levels are used, the distances increase to 330 m and 650 m, respectively. Considerable detail was provided in a large number of figures and tables. The authors also include in the discussion an extensive comparison of their findings with published findings in the literature.

Williams, M.T., Nations, C.S., Smith, T.G., Moulton, V.D. and Perham, C.J. (2006). Ringed Seal (*Phoca hispida*) Use of Subnivean Structures in the Alaskan Beaufort Sea During Development of an Oil Production Facility. *Aquatic Mammals*, 32:311-324.
In this paper, the authors address the question as to whether construction of and drilling at Northstar Island affected the use of breathing holes and lairs during the winter and spring. Trained dogs were used to search the sea ice for structures within 3.5 km of Northstar Island during three survey periods (i.e., November/December 2000, March 2001 and May 2001). Temperature sensors were used to determine dates of abandonment. The authors reported that: 1) active seal structures were evenly distributed across the study area in relation to the Northstar facility at the end of the study, 2) abandonment of ice structures in 2000/2001 were higher than those reported in Kelly et al. (1988) and Frost and Burns (1989), 3) higher rates of abandonment occurred in areas of high sea ice deformation, and 4) repeated searches of the sea ice using trained dogs is necessary to detect sea ice selected by ringed seals.

Nowacek, D.P., Thorne, L.H., Johnston, D.W. and Tyack, P.L. (2007). Responses of cetaceans to anthropogenic noise. *Mammal Review*, 37:81-115.
The authors noted that since the last review of responses of cetaceans to anthropogenic noise in 1995, considerable new research has been published. The purpose of this review is to synthesize new information through 2007 with the findings reported by Richardson et al. (1995). The authors noted that the primary sources of anthropogenic noise remain unchanged (i.e., ships, seismic exploration, and sonars of various sorts), although in the recent period noise from windfarms and from acoustic harassment devices (used to mitigate interactions between commercial fisheries and marine mammals) has become worth including. In this review, the authors considered three categories of response: 1) behavioral, 2) acoustic, and 3) physiological (i.e., permanent and temporary threshold shifts only). The authors literature cited section was extensive (pages 110-115). Further, the paper was organized by noise source and then taxa. For example, there was a specific section on the response of marine mammals to acoustic deterrent devices that was both comprehensive and comprehendible. They noted that progress in documenting the response of cetaceans to anthropogenic noise has been significant, but that experiments or research using certain sound sources were inadequate (i.e., commercial sonars, depth finders, and acoustic gear used as part of commercial fisheries). The authors recommended that wherever possible opportunities for research should be taken advantage of, and that any such experiments should include rigorous measurements and modelling of experiments.

Southall, B., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Jr., C.R.G., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A. and Tyack, P.L. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. *Aquatic Mammals*, 33:411-509.
This publication is a 98 page report that includes chapters on: 1) structure of noise exposure criteria, 2) criteria for injury (temporary and permanent threshold shifts), 3) criteria for behavioral disturbance, and 4) research recommendations. It forms the basis in part for the federal approach to regulating anthropogenic noise in regards to impacts on marine mammals. Appendix 1 provides an excellent summary of acoustic measurements and terminology. Appendices 2 and 3 provides a summary of research on marine mammal behavioral responses to pulsed and non-pulsed sounds. This paper proposed, for various marine mammal groups and sound types, levels above which there is a scientific basis for expecting that exposure would cause auditory injury to occur. The authors noted that behavioral responses of marine mammals to anthropogenic noise are strongly affected by the context of exposure and by the animal's experience, motivation, and conditioning. They further noted that this reality hampered their efforts to formulate broadly applicable behavioral response criteria for marine mammals based on exposure level alone. Research recommendations in Chapter 5 are extensive, as is the

literature cited section (i.e., pages 482-497). Finally, the authors noted that additional criteria are needed to address the issue of cumulative effects of repetitive, long-term noise exposure, as well as the issue of ecosystem level effects.

URS (2007). Port of Anchorage Marine Terminal Development Project Underwater Noise Survey Test Pile Driving Program Anchorage, Alaska. U.S. Dept. of Transportation, Port of Anchorage, and Integrated Concepts & Research Corporation. Anchorage, AK. December 2007. 60 pp.
This technical report is not a peer-reviewed publication. It summarizes research and monitoring required by USACE for the POA and the Department of Transportation in relation to construction noise in October 2007. An underwater noise survey was conducted 16-18 October 2007 to measure sound levels associated with pile driving and other human activities. Survey requirements included the estimation of distances from the sound source to the 190, 180, and 160 dB re 1 uPa root-mean-square isopleth for each type of pile (H and sheet) and each type of pile installation technique (vibratory and hammer). However, only one sheet pile was tested, and that was with a vibratory hammer. Measurements for pile driving H piles and the one sheet pile were not distinguished in the report. For vibratory pile driving, the reported distances were less than 10 m for the 190 and 180 dB level, and 50 m for the 160 dB level. For pile driving, the distances were 10 m, 20 m, and 350 m, respectively. The authors concurred with the size of the existing recommended safety zone for marine mammals of 50 m for Level A harassment; however, the they considered the size of the existing recommended safety zone for Level B harassment to be overly conservative. Detailed results for each type of pile and installation protocol were presented in Chapter 3 of the report.

Greene, C.R., Jr., Blackwell, S.B. and McLennan, M.W. (2008). Sounds and vibrations in the frozen Beaufort Sea during gravel island construction. *Journal of the Acoustical Society of America*, 123:687-695.
BP Exploration (Alaska) began construction of an artificial gravel island in 2000 5 km seaward of the barrier islands northwest of Prudhoe Bay, Alaska. Two ice roads were constructed to support the construction and operation of 30-well production facility from the Northstar prospect. Measurements of noise, sound and vibration levels were recorded from 1 February to 17 May 2000. Information from this study were used in Blackwell et al. (2004), which reported that ringed seals were not displaced by the construction of this development. Greene et al. herein present basic sound level measurements related to the construction of this gravel island. Activities were sounds levels were measured included: ice road construction, pipeline trenching, vehicle movements, impact and vibratory sheet driving, and the use of a Ditchwitch to cut ice. One-third octave band levels were presented for each type of machinery at a standardized distance of 100 m. Underwater background noise ranged from 77 to 116 dB re 1 uPa. Table IV presents a summary of sound and vibration measurements from seven principal sound sources. Distances to where machinery-specific sound levels equaled the median background sound levels are also presented. The longest distance to background noise levels was for use of Ditchwitch equipment which was 7.3 km. Truck and backhoe noises carried the next longest distances underwater, which was 3.3 km. The authors noted that 90% of the anthropogenic noise measurements attenuated to background noise levels in less than 4 km, with the exception of noise produced by the Ditchwitch.

Hatch, L., Clark, C., Merrick, R., Van Parijs, S., Ponirakis, D., Schwehr, K., Thompson, M. and Wiley, D. (2008). Characterizing the relative contributions of large vessels to total ocean noise fields: a case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary. *Environmental management*, 42:735-752.
The authors characterized received sounds levels from vessels transiting a marine sanctuary, where sound levels were recorded on nine autonomous recording units for two months in 2006. The national

sanctuary is in close proximity to a densely population coastal area (i.e., Boston, MA). Substantial vessel traffic transits waters of the sanctuary. Automatic Identification System (AIS) d data from 541 vessels were used in the analysis. Acoustic data from all nine recording units were used to create synchronized, nine-channel, time-aligned files. AIS data was integrated with acoustic data in two ways: 1) recorded sound levels were examined relative to all vessels transiting the area at given time scales and 2) the acoustic "footprint" of all classes of vessels was characterized for the closest point of transit to recording units in the array. The authors concluded that commercial vessel traffic contributes significantly to total noise levels in the sanctuary. Further, noise levels were found to be proportional to the number of commercial vessel transits. Finally, the authors reported that the average area ensonified over 120 dB re 1 uPa by an oil/chemical product tanker transiting the sanctuary was 632 nmi^2 and raised concerns regarding the likelihood of communication masking for large whale species in the sanctuary. Several management recommendations were included in the conclusion. It should be noted that the list of literature cited related to anthropogenic noise from vessel traffic is extensive.

Koski, W.R., Ireland, D., Lyons, C., Macrander, A.M. and Voparil, L. (2008). Feeding by Bowhead Whales Near an Offshore Seismic Survey in Central Beaufort Sea. 14 pp.
Aerial surveys conducted in the Central Beaufort Sea during late summer and early autumn of 2007 detected large numbers of feeding bowhead whales in an area where feeding has been seen in the past, but is not common. Whales remained in the same general area while seismic surveys were conducted 10-50 km east of them and bowheads were seen as close as 1.4km from the source vessel. There was evidence of small-scale avoidance of the seismic operation, but one group of three whales tolerated received levels of seismic sounds ~180dB re 1 ųPa, three groups (5 individuals) tolerated levels >170dB and at least 12 groups (19 individuals) tolerated levels 150-70dB. These levels are much higher than the 120-30dB levels that migrating bowhead whales avoided during seismic operations near the same location in 1996-98. Thus, it appears that bowhead whales will tolerate much higher levels of seismic sounds when food sources are available than they will when food is not available. Similar tolerance to seismic has been seen in the summer feeding areas in Canadian waters.

Laidre, K.L., et al. (2008). Quantifying the sensitivity of Arctic marine mammals to climate-induced habitat change. *Ecological Applications*, 18:97-125.
This review article focused on the possible consequences of unidirectional warming in Arctic marine mammals, primarily mediated through loss of sea ice. Seven Arctic species were considered, along with four sub-Arctic species. Data regarding risk were quantified using a "sensitivity index", which incorporated information on nine variables: 1) population size, 2) breadth/extent of geographic range, 3) habitat specificity, 4) diet diversity, 5) migrations, 6) individual site facility, 7) influence of changes in sea ice, 8) influence of changes in the trophic web, and 9) maximum rate of population increase. Species sensitivity index scores ranged from 12 to 25 (with lower numbers being associated with greater risk). Three species scored below or equal to 15: hooded seal, narwhal, and polar bear. Six species scored between 15 and 20: bowhead whale, beluga, harp seal, spotted seal, ribbon seal and walrus. Two species were considered least sensitive: ringed and bearded seals. A summary for each species by factor is presented in Table 2. Additionally, some regional aspects of risk due to climate change were discussed (e.g., Pacific and Atlantic walrus), as was an evaluation of risk associated with breeding ecology for ice seals.

Moore, S.E. and Huntington, H.P. (2008). Arctic marine mammals and climate change: Impacts and resilience. *Ecological Applications*, 18:157-165.
The authors evaluate the premise as to whether seven species of marine mammals, uniquely adapted to the Arctic, will have the adaptive capacity to survive changes in the Arctic environment due to climate

change. They note that, in addition, nine species of marine mammals seasonally occupy Arctic and sub-Arctic habitats, and one or more of these species may encroach on the habitats used by the extant Arctic species. Impacts related to climate change and loss of sea ice were categorized for nine species: 1) ice-obligate species, 2) ice-associated species, and 3) seasonally migrant species. Impacts were based on projections of sea ice reductions by 2050 and existing shelf oceanography. A summary of the anticipated changes in population status due to loss of sea ice is summarized in Table 3. The authors conclude that some populations (but not all) of ice-obligate marine mammals will survive either in regions where sea ice refugia exist or by adapting to ice-free coastal areas. However, the authors noted that interspecific interactions (e.g., competition) between Arctic species and sub-Arctic species will likely increase. The authors recommend research to monitor the distribution, abundance and life history of marine mammals as sentinels for how the Arctic ecosystem is changing and to better provide for effective resource management.

Southall, B. and Hatch, L. (2008). Draft Preliminary Comprehensive Overview of the Impacts of Anthropogenic Underwater Sound in the Marine Environment, Module 5: Shipping. Convention for the Protection of the Marine Environment of the North-East Atlantic. August 2008. 13 pp.
This report was produced as part of a program sponsored by the Convention for the Protection of the Marine Environment of the North-East Atlantic (i.e., the OSPAR Convention). The report is labeled a draft as of August 2008. A final version was not found at the OSPAR website. The report considers 2 categories of vessels: 1) small vessels (under 80 m), and 2) large vessels (over 80 m). The latter is thought to represent a significant portion of the underwater noise generated by human activities. The authors noted that there has been an approximately doubling of anthropogenic noise in some oceans (e.g., eastern North Pacific). The most probable source of noise for this increase is commercial shipping. Regarding potential impacts of shipping noise on marine mammals, the authors noted that anthropogenic noise may interfere with critical biological functions in various ways (e.g., stress related to long-term exposure, temporary hearing loss related to sustained or repeated exposure, masking of auditory information critical to successful breeding or foraging). Mitigation strategies discussed in the paper include: 1) quieting technologies, and 2) changes in operational measures (e.g., ship speed and course). The cost of either mitigation strategy was noted to be poorly described at this time.

Tyack, P.L. (2008). Implications for Marine Mammals of Large-Scale Changes in the Marine Acoustic Environment. *Journal of Mammalogy*, 89:549-558.
The author noted that marine mammals rely on sound for short- and long-range communication, for orientation, and for locating prey. This reliance has raised concern that elevated sound levels from human sources may interfere with the behavior and physiology of marine animals. The dominant source of human sound in the sea stems from propulsion of ships. The author further noted that shipping has elevated the global deep water ambient noise 10- to 100-fold in this frequency band over the past few decades. As well, shipping noise centers in the 20- to 200-Hz band, which is the same frequency band used by baleen whales for some of their communication signals. Based on these findings, concerns have been raised regarding the potential impact anthropogenic noise may have on the efficacy and range of marine mammal communication, and the impacts of masking and other influences on the life history and status of marine mammal populations. The author discriminates between acute impacts of anthropogenic sound (e.g., temporary threshold shifts) and risks associated with chronic exposure to anthropogenic noise, and concludes that the latter may pose a more significant risk to marine mammal populations than the former. Tyack concludes by recommending research approaches that incorporate the theories of predator risk and allostasis. He notes that such an approach may help to provide a framework for progress in understanding how to mitigate the impacts of anthropogenic sound on individuals and populations of marine mammals.

Weir, C.R. (2008). Overt Responses of Humpback Whales (*Megaptera novaeangliae*), Sperm Whales (P*hyseter macrocephalus*), and Atlantic Spotted Dolphins (*Stenella frontalis*) to Seismic Exploration off Angola. *Aquatic Mammals*, 34:71-83.
Marine mammal observations were made from a 3-D seismic survey vessel off the coast of Angola from August 2004 to May of 2005. Details of the source array on the survey vessel were provided. Two marine mammal observers alternated watch periods during daylight hours from the heliceck of the vessel (18m above sea level). Observations were made with 10x binoculars and the naked eye. The following marine mammal sightings were reported: 1) humpback whale (n=66), 2) sperm whale (n= 124) and Atlantic spotted dolphin (n=17). The encounter rate (sightings/hr) did not change significantly in the presence of seismic operations from baseline for humpback whales and sperm whales. Atlantic spotted dolphins were sighted at greater distances on average during seismic operations than during the baseline period. No evidence for large scale displacement for any species was reported. A discussion of how these results compared to results reported in other publications was included.

Wyatt, R., Seiche Measurements Ltd, Thatton Farm, Peter Smarland and Great Torrington (2008). Joint Industry Programme on Sound and Marine Life: Review of Existing Data on Underwater Sounds Produced by the Oil and Gas Industry, Issue 1. Joint Industry Programme on Sound and Marine Life. Seiche Measurements Limited Ref – S186, London, UK. 106 pp.
During the exploration, development, production and decommissioning phases of offshore oil and gas reserves these activities contribute to the noise levels in the oceans, estuaries and rivers of the world. The purpose of this report is to catalogue and assess the available data that characterize the underwater sounds made by the oil and gas industries in all phases of their activities. The report is non-technical in nature. The following sections are included: 1) overview of noise measurements, 2) a review of information on noise associated with oil and gas development and production, 3) a review of other ocean noise (both anthropogenic and natural), and 4) a review of available information on the impact of underwater sound on marine mammal populations. The authors note that the literature cited section of the report is available as a searchable database. The article presented a very useful summary (i.e., table format for each sound source) for all noise levels extrapolated to source level for a comprehensive list of activities, including aircraft, construction, dredging, drilling, use of explosives, well-head decommissioning, mitigation activities, seismic surveys, and vessel noise.

Huntington, H.P. (2009). A preliminary assessment of threats to Arctic marine mammals and their conservation in the coming decades. *Marine Policy*, 33:77-82.
In this paper, the author noted that Arctic marine mammals over the next several decades will face threats from: 1) climate change, 2) environmental contaminants, 3) offshore oil and gas activities, 4) shipping, 5) hunting, and 6) commercial fisheries. The author concluded that climate change, oil and gas activities and commercial fishing pose the most serious threat to populations of Arctic marine mammals. Further, the author commented that addressing the impacts of all six factors would be necessary to avoid further declines in marine mammal abundance in the Arctic.

Lucke, K., Siebert, U., Lepper, P.A. and Blanchet, M.A. (2009). Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli. *Journal of the Acoustical Society of America*, 125:4060-4070.
Harbor porpoise are characterized as cetaceans with high frequency hearing capability with their best hearing capability above 100 kHz. The objective of this study was to ascertain the tolerance limit of the auditory system of the harbor porpoise to single impulsive sounds. A single male harbor porpoise held in captivity was used in the study. The animal was 9-10 years of age. The measurements of TTS were

conducted by measuring the auditory evoked potentials in response to amplitude-modulated sounds. After obtaining baseline hearing data the animal was exposed to single airgun stimuli at increasing received levels. Immediately after each exposure the animal's hearing threshold was tested for significant changes. The received levels of the airgun impulses were increased until TTS was reached. At 4 kHz the predefined TTS criterion was exceeded at a received sound pressure level of 199.7 dBpk-pk re 1 uPa and a sound exposure level SEL of 164.3 dB re 1 uPa2 s. These findings differ from published results for bottlenose dolphins and belugas. The results of this study represent the first reliable information on how harbor porpoise would be impacted by seismic noise. The results further emphasize the need for dedicated studies on the cumulative effects of multiple exposures.

Mann, D., Cott, P. and Horne, B. (2009). Under-ice noise generated from diamond exploration in a Canadian sub-arctic lake and potential impacts on fishes. *Journal of the Acoustical Society of America*, 126:2215-2222.

This study measured and reported on the under-ice noise produced by a variety of anthropogenic sources (drilling rigs, helicopters, aircraft landing and takeoff, ice-road traffic, augers, snowmobiles, and chisels) at a winter-based diamond exploration project on Kennady Lake in the Northwest Territories, Canada to infer the potential impact of noise on fishes in the lake. The authors noted that most of the anthropogenic sounds were likely detectible by fishes with hearing specializations, like chubs and suckers. The greatest potential impact of noise from diamond exploration is likely to be the masking of sounds for fishes with sensitive hearing. A summary of acoustic measurements is provided in Table 1. Maximum received sound levels approached 150 dB re 1 uPa. Average ambient noise levels and peak ambient noise levels were 82.3 dB and 114.4 dB re 1 uPa, respectively.

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

Blue whale vocalization behavior was investigated relative to seismic operations in August 2004 that occurred in the St. Lawrence Estuary, Canada. his area is an important feeding ground for this species. Call rates from 4 days with seismic operations (n= 4 blue whales sighted in study area; 117 10 min recordings collected, of which 51 contained seismic noise) were compared to call rates from 4 days without seismic operations (n=3 blue whales sighed in study area; 129 10-minute recordings collected). Blue whales emitted significantly more calls on "seismic days" compared to "non-seismic days". The mean sound pressure level in the study area was estimated to be relatively low (i.e., 131 dB re 1 *u*Pa). This is the first study to demonstrate an increase in call rates associated with seismic disturbance. This type of response has only been observed previously in response to continuous vessel noise. The authors suggest that this response is an effort on the part of the whales to compensate for decreased efficiency in communication related to masking of information by noise. They further noted that the type of call and communication context of the call are important factors in how vocalization rates could be affected by seismic noise.

Landro, M. and Amundsen, L. (2010). Marine Seismic Sources Part V: The Hearing Of Marine Mammals. *GeoExPro*, 7:10 pp.

This reference is a non-technical paper published in an interdisciplinary magazine. The paper presents an introduction to readers regarding the auditory capabilities of marine mammals. The authors describe an audiogram and two methods for collecting information (i.e., traditional behavioral tests or auditory brainstem response). Further, the authors present a few species-specific examples of audiograms (e.g., bottlenose dolphin and beluga), and compare hearing by taxa for mysticetes, odontocetes, pinnipeds and humans.

Moulton, V.D. and Holst, M. (2010). Effects of Seismic Survey Sound on Cetaceans in the Northwest Atlantic. Natural Resources Canada for the Minister of Natural Resources Canada. Environmental Studies Research Funds. Environmental Studies Research Funds Report No. 182, St. John's, Newfoundland. 38 pp.

The authors present sightings and behavioral data from eight seismic vessel based monitoring programs between 2003-2008. Vessel surveys were conducted in waters off Nova Scotia and Newfoundland. All seismic programs involved the acquisition of 3-D seismic data with airgun arrays consisting of 24-32 airguns and a total discharge volume of 3000-5085 in^3. Details of the protocol for marine mammal observers was provided. Data were stratified by 2-week periods and by state of airgun use (i.e., no use, single airgun, ramp up, array, testing and all seismic). Table 3 presents a summary of sightings by airgun status for mysticetes, delphinids, and large toothed whales. When airguns were inactive, mysticetes were observed at nearly twice the rate of delphinids. Sighting rates of mysticetes were significantly higher during periods of no use vs array use (0.167 vs 0.128 sightings/hr). No such difference existed for delphinids and large toothed whales. Further, mysticetes and delphinids were seen significantly further from the seismic vessel during array use compared to no use. Species specific information is provided in Tables 4 and 5. Species-specific behavioral responses to seismic noise were documented. Finally, for mysticetes, animals were more likely to swim away from the vessel when the array was in use. Based on 15 sightings of beaked whales, there was little evidence to suggest that beaked whales respond overtly to seismic noise. Regarding mitigation protocols, the authors noted that the efficacy of "ramp up" periods varies by mysticete species and by circumstance, and is largely ineffective for odontocetes. Because poor sighting conditions were common, the authors recommended augmenting visual vessel sightings with either aerial surveys or passive acoustic monitoring.

Guerra, M., Thode, A.M., Blackwell, S.B. and Macrander, A.M. (2011). Quantifying seismic survey reverberation off the Alaskan North Slope. *Journal of the Acoustical Society of America*, 130:3046-3058.

In shallow water environments, characterizing the nature and magnitude of anthropogenic noise is complex. For example, seismic noise signals in shallow water interact with the ocean surface and bottom, and the bottom substrate. This interaction throughout the water column is referred to as reverberation. Reverberation has two important consequences in shallow water: 1) it elevates background noise levels such that passive acoustic monitors are less able to detect and localize marine mammal sounds and 2) it reduces the communication space of marine mammals (i.e., increases potential for masking of sounds important to marine mammal communication). Two metrics are proposed that allow for improvements in characterizing actual seismic noise levels (i.e., minimum level metric and reverberation metric). The descriptions in the paper are technical in nature. An example of the application of the methodology is provided using data from a seismic survey. In this example, the authors estimated that the shallow-water seismic survey increased background noise levels by 10 – 25 dB within 15 km of the survey area. Detectable modifications to ambient noise levels were possible out to 128 km. The authors further noted that detecting the presence of marine mammals via underwater vocalizations would be significantly reduced within a few km of an ongoing seismic survey.

Hammay, D., Racca, R. and A., M. (2011). Model based assessment of underwater noise from an airgun array soft-start operation. International Association of Oil and Gas Producers (OGP). OGP Report No. 451, London, UK. February 2011. 108 pp.

This report reported on the results of an acoustic modelling study that estimates the received sound levels at locations in the water column near a towed seismic airgun array during a typical soft-start procedure in which the number and total volume of the airguns in the source array increase over time. The soft-start approach is a mitigation measure for reducing the risk that marine mammals near an airgun array are exposed to harmful sound levels as the seismic source starts to operate. The underlying

assumption is that an animal will take evasive action and establish a safe distance between itself and the source when exposed to lower sound levels during the initial phases of the soft-start sequence. A modelling study was performed to quantify the received sound levels from a representative soft-start sequence, in both a shallow 50 m water depth scenario and a deep 2000 m water depth scenario, and to evaluate those sound levels in the context of current knowledge about injury thresholds. The authors described in detail the two models used to perform this analysis. The following injury criteria were used: 1) Sound exposure level (SEL): 198 dB re 1 µPa2-s (M-weighted) for cetaceans and 186 dB re 1 µPa2-s (M-weighted) for pinnipeds, and 2) Peak Sound Pressure Level (SPL) 230 dB re 1 µPa (flat-weighted) for cetaceans and 218 dB re 1 µPa (flat- weighted) for pinnipeds. The more conservative approach was used for any given situation. The results included: 1) SEL levels were higher in shallow water than at the corresponding locations from the deep site, 2) In terms of the SEL metric, the estimated cumulative level for an animal located just 100 m to the side of the source line at the midpoint of Step 1 of the soft-start in deep water was 22 dB below the Southall et al. (2007) criterion for cetaceans and 10 dB below the criterion for pinnipeds, 3) in a deep-water environment a marine mammal in the immediate vicinity of the airgun array in the first three steps of soft-start is unlikely to suffer from auditory injury according to the Southall criteria unless the animal passes within 100 m of the source line as the seismic array passes, and 4) the cumulative SEL level 100 m off the mid-point of Step 1 of soft start reaches 182 dB re 1 Pa2s which is 17 dB below the PTS onset criterion threshold for cetaceans and 4 dB below the threshold for pinnipeds. Further, for an animal that remains fixed at 100 m to the side of the source line at the mid-point of Step 3 of soft-start the maximum cumulative SEL is predicted to reach 185 dB 1 Pa2s which is still 1 dB below the criterion threshold for PTS onset. The authors inclusion of a considerable number of figures greatly improves the readability of this technical document.

McQuinn, I.H., Lesage, V., Carrier, D., Larrivee, G., Samson, Y., Chartrand, S., Michaud, R. and Theriault, J. (2011). A threatened beluga (*Delphinapterus leucas*) population in the traffic lane: vessel-generated noise characteristics of the Saguenay-St. Lawrence Marine Park, Canada. *Journal of the Acoustical Society of America*, 130:3661-3673.

The Saguenay-St. Lawrence Marine Park (SSLMP), located in the St. Lawrence Estuary, Canada, is home to a resident and threatened beluga population. In this paper, the authors characterize anthropogenic noise levels from a variety of sources. Vessel types were classified as large ship, ferry, small ship, medium cruise ship, cruiser, whale-watching rigid-hulled inflatable boat (RHIB) with outboard motors, and sailboat. Sound measurements were made from a number of sites important to beluga life history. Sounds levels varied considerably by site (i.e., 17-19 dB differences between the noisiest and quietest sites), although even the quietest sites had periods of relatively high noise levels. The authors concluded that outboard-motored boats (i.e., RHIB) were the dominant noise source for beluga at the various sites, due to their relatively high occurrence, their closer proximity to beluga habitats, and the higher sensitivity of beluga to their noise signatures. The authors noted that impacts of these noise levels on St. Lawrence beluga will depend on exposure recurrence and individual responses.

Small, R.J., Moore, S.E. and Stafford, K.M. (2011). Chukchi Sea Acoustics Workshop: Final Report. 38 pp.

A workshop was convened to develop a strategy for hydro-acoustic monitoring in the Chukchi Sea, with participants from the oil and gas industry, Alaska Native marine mammal organizations, the North Slope Borough, the State of Alaska, National Oceanic and Atmospheric Administration (NOAA) Fisheries, the academic and private research communities, and Minerals Management Service (now referred to as BOEM). The workshop (referred to as the CSAW) was held in Anchorage, AK from 9-10 February, 2009. The stated purpose of the workshop was "*Briefly review acoustic monitoring studies in the Alaskan Arctic and determine priority research objectives for acoustic monitoring of natural and anthropogenic*

underwater noise in the Chukchi Sea from a marine ecosystem and marine mammal perspective." The workshop report includes the following: 1) a synthesis of the discussions held at the CSAW workshop; 2) recommendations; and 3) a review of the primary acoustic signal parameters for western Arctic marine mammals, ambient noise, and anthropogenic noise (Appendix 1; page 14). The minutes from CSAW are available by request. The proceedings provides an excellent summary of the history of passive acoustic monitoring in the Chukchi and western Beaufort Sea. Recommendations from workshop participants included: 1) foster and maintain communication across groups and disciplines, 2) research studies should minimize disturbance to marine mammals and impacts on subsistence hunting, 3) complete a synthesis of available information that can be used to develop mitigation strategies, 4) develop a strategy for long-term acoustic monitoring, 5) obtain information on marine mammals prior to oil and gas activities, 6) seek collaboration with oceanographers, 7) explore feasibility of use of "play back" studies, and 8) ensure the integration of scientific and traditional knowledge.

Ellison, W.T., Southall, B.L., Clark, C.W. and Frankel, A.S. (2012). A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. *Conservation Biology*, 26:21-28.
The authors are critical of federal management of anthropogenic noise that focuses exclusively on the amplitude of the received sound (i.e., SPL), and which ignores factors related to an animal's behavior, sound characteristics, and sound duration. These other factors may affect an animal's perception of the received sound, as well as the animal's response (e.g., orientation of the animal to the sound source). Further, other acoustic measures (e.g., SEL, PK, and exposure time for chronic sounds) may better characterize sounds that have the potential to injure a marine mammal. The authors recommend that federal government regulators abandon their focus on the acute effects of anthropogenic noise on marine mammals. Rather regulators should include chronic effects in their risk assessment protocols, including the effects on hearing of long-term exposure and the effects of masking on communication. In particular, the authors express concern over the potential impacts of anthropogenic noise on large whales, where low frequency sound sources impact much larger areas and have much longer duration periods than high frequency sound sources.

Gervaise, C., Simard, Y., Roy, N., Kinda, B. and Menard, N. (2012). Shipping noise in whale habitat: characteristics, sources, budget, and impact on belugas in Saguenay-St. Lawrence Marine Park hub. *Journal of the Acoustical Society of America*, 132:76-89.
The objective of this paper was to characterize the soundscape of a high vessel-traffic area in eastern Canada (i.e., Saguenay Ford). Passive acoustic recordings were collected from 4 May to 10 June 2009 at Point Noire. Details of recorded sound levels for ferry vessels and whale watching vessels are presented. Details of beluga hearing thresholds are also presented. The authors conclude that the primary impact of nonpulse vessel noise, which is characteristic of this area, is the masking of communication and echolocation signals. Temporary threshold shifts in belugas at the sound levels produced by the vessels trafficking this area are unlikely. The authors estimate that communication ranges for beluga calls were reduced by 70% relative to ambient noise approximately 50% of the time. That is, the expected communication range absent vessel noise was estimated to equal 4.5 km. At current vessel traffic levels, this communication range is reduced to 1.5 km roughly 50% of the time. The authors also conclude that the echolocation capability of beluga could be compromised by vessel noise in this area, which would likely reduce foraging efficiency. The ecological or physiological costs of adaptations required to accommodate anthropogenic noise by belugas, as well as the limits of resilience beyond which habitat desertion would be expected, remain to be evaluated.

Guy, L.S., Moore, S.E. and Stabeno, P.J. (2012). Synthesis of Arctic research (SOAR) science workshop report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. BOEM 2012-031, 25 pp.
A workshop was held in March 2012 in Anchorage, AK for the purpose of 1) refining draft science themes and related questions, 2) forming research teams to undertake preparation of peer-reviewed scientific papers, and 3) developing proposals to identify project milestones and financial requirements needed to complete a Synthesis of Arctic Research (SOAR). The report was not part of a peer-reviewed publication. The synthesis was organized around three research themes: hotspot mechanisms and trophic dynamics, a year in the life of a selected seabird and marine mammal species, and responses to a step-change in the physical drivers of the marine ecosystem. Funding for the research was provided by BOEM through a grant to NOAA. Research took place between 13 May 2011 and 12 May 2016 (i.e., 5 years). Program leadership brought together a multidisciplinary group of Arctic scientists and Alaskan coastal community representatives. An open session was also convened during the workshop to inform colleagues from BOEM, North Pacific Research Board, Alaska Ocean Observing System, industry and other interested parties regarding progress on research to date.

Hoffman, C.A. (2012). Mitigating impacts of underwater noise from dredging on beluga whales in Cook Inlet, Alaska. *Advances in Experimental Medicine and Biology*, 730:617-619.
This relatively short article recommended that NMFS use beluga-specific hearing thresholds in mitigating potential injury associated with anthropogenic noise generated by marine construction projects in Cook Inlet, Alaska. The author noted that species-specific thresholds for many species of marine mammals still need to be refined, or for some (i.e., large cetaceans) have yet to be defined. Nonetheless, as these thresholds do exist for belugas, they should be employed by NMFS in managing the impacts of anthropogenic noise on the ESA listed population of Cook Inlet belugas. The author further noted that such an approach would help NMFS secure "buy in" from development proponents and contractors. No specific field measurements are reported in the article.

Moore, S.E., Reeves, R.R., Southall, B.L., Ragen, T.J., Suydam, R.S. and Clark, C.W. (2012). A New Framework for Assessing the Effects of Anthropogenic Sound on Marine Mammals in a Rapidly Changing Arctic. *BioScience*, 62:289-295.
Federal regulations require scientists and oil and gas operators to acquire incidental harassment authorizations for activities that may disturb marine mammals in US waters. To date, authorization requests are focused on the impacts of sound from activities considered in isolation of one another, and this precludes any possibility of a meaningful analysis of the cumulative impacts from multiple sources. The authors proposed a new assessment framework that is based on the acoustic habitats that constitute the aggregate sound field (i.e., the sound scape) from multiple sources, compiled at spatial and temporal scales consistent with the ecology of Arctic marine mammals. The proposed framework is qualitative. Significant effort both nationally (e.g.,MMC) and internationally (Protection of the Marine Arctic Environment [PAME]/Arctic Council) has been undertaken by the authors to implement this framework since publication. Implementation of the sound scape framework across the Federal government will provide a more synthetic approach that considers the impact of all of the natural and anthropogenic sounds in a given marine habitat.

Quakenbush, L., Citta, J., George, J.C., Heide-Jørgensen, M.P., Small, R., Brower, H., Harwood, L., Adams, B., Brower, L., Tagarook, G., Pokiak, C. and Pokiak, J. (2012). Seasonal Movements of the Bering-Chukchi-Beaufort Stock of Bowhead Whales: 2006–2011 Satellite Telemetry Results. Alaska Department of Fish and Game. S/64/BRG1, 22 pp.
It should be noted that IWC Scientific Committee documents are not considered independently, peer-reviewed papers. The authors reported on the movements of 57 satellite tagged BCB bowhead whales.

All but one whale migrated past Point Barrow in the spring and went to Amundsen Gulf. One whale migrated up the Chukotka coast and summered in the Chukchi Sea. Movements in the summer months of tagged whales were more extensive than the literature would suggest. Core use areas important for feeding included: 1) Amundsen Gulf in the spring and summer, 2) Point Barrow in the summer and fall, 3) Wrangel Island (in some years) in the fall, 4) the northern Chukotka coast in the fall, and 5) and the western Bering Sea in the winter. The figures in this report are very helpful in visualizing the movements of satellite tagged bowhead whales.

Reine, K., Clarke, D. and Dickerson, C. (2012). Characterization of Underwater Sounds Produced by a Backhoe Dredge Excavating Rock and Gravel. U.S. Army Engineer Research and Development Center. DOER Technical Notes Collection. ERDC-TN-DOER-E38, 29 pp.

This is a technical report published by the U.S. Army. It is not an independently peer-reviewed publication. The focus of the article is on the potential impact of noise associated with backhoe dredging operations on fish populations. In this article, the authors characterize underwater sound produced by a backhoe dredge during rock removal as part of the widening and deepening of New York/New Jersey Harbor. A separate vessel was used to record noise levels associated with the dredging operation at distances from the source vessel that varied between 55 m and 2.67 km. Ambient sound ranged from 97 to 131 dB re 1µ Pa rms (mean = 117.1 dB re 1µ Pa). Ambient sound pressure levels were recorded for the frequency ranges of 50-1000 Hz, which is within the hearing sensitivity of most fish. Engine/generator noise at source was estimated to average 49.9 dB above average ambient noise levels. Noise levels associated with backhoe dredging operations exceeded average ambient noise levels by 15.4 to 20.2 dB. The authors also presented results specific to the hearing range at which fish are considered most sensitive (i.e., 100-400 Hz). Noise associated with the use of an hydraulic ram, barging and anchoring were also measured and discussed. The authors speculated that potential impacts on fish would be limited to behavioral responses and would likely to be limited to the area within a radius of 60-100 m from dredging operations. The authors also compared their results with published results for other dredging operations.

Stewart, B. (2012). Interactions between beluga whales (*Delphinapterus leucas*) and boats in Knik Arm, upper Cook Inlet, Alaska: Behavior and Bioacoustics. National Marine Fisheries Service and Hubbs-SeaWorld Research Institute. Hubbs-SeaWorld Research Institute Technical Report. NOAA Fisheries P.O. AKR-7-020, Juneau, AK. 28 pp.

This article is a technical report and likely does not constitute a peer-reviewed publication. The author describes the results of his making behavioral observations and acoustic recordings of Cook Inlet belugas in Knik Arm, Alaska from 24 July to 14 September 2008. Acoustic recordings were made both from an anchored small vessel and from a small towed array. Based on NMFS conducted aerial surveys, it was estimated that between 25 and 61 belugas were in the study area. Shore based operations successful observed belugas on 14 of 31 days. No belugas were present in the study area after 4 September 2012. 89% of the observed beluga movements occurred during a falling tide. Regarding acoustic behavior, a preponderance of calls was non-echolocation sounds and was indicative of social behavior (i.e., communication). The author noted that small vessel traffic was not common. Small vessels were observed on 10 of the 31 days of the study. Belugas were present in the area on 8 of these days. The towed array was able to detect vocalizing belugas out to a maximum distance of 471 m. Figures and tables are presented that describe or summarize field operations and qualitative results from behavioral observations and acoustic recordings. No statistical analyses of the results were reported.

Aerts, L.A.M. and Streever, B. (2013). Modeled and Measured Underwater Sound Isopleths and Implications for Marine Mammal Mitigation in Alaska. BP Exploration Inc. 11 pp.
This is a white paper produced by the authors, where the level of independent peer-review cannot be assessed. The authors compared modeled and measured airgun sound isopleths from 2006-2012 and found poor coherence, although a formal statistical comparison was not presented. Specifically, the authors noted the importance to management under the MMPA of knowing the distance from a given sound source in a given application at which received sound levels are below sound levels used in mitigation (e.g., 190 dB, 180 dB, 160 db, and 120 dB re 1 uPa). Modeled and measured sound isopleths from airgun operations were obtained from publicly available Incidental Harassment Authorization requests and associated reports. 133 records of modeled and measured sound isopleths from airgun operations were used in the analysis. Differences in modeled and measured sound isopleths were as high as 920 m, 2900 m, 13,405 m and 130,000 m for the 190, 180, 160, and 120 dB re 1 uPa, respectively. The authors were not able to develop a consistent correction factor for observed discrepancies. The authors recommend efforts to better understand these discrepancies will contribute to improvements in efforts to mitigate the potential impact of seismic noise on marine mammals. The authors questioned the value of some mitigation measures, given the results of their analysis.

Erbe, C., McCauley, R., McPherson, C. and Gavrilov, A. (2013). Underwater noise from offshore oil production vessels. *Journal of the Acoustical Society of America*, 133:EL465-470.
The acoustic signatures of six Floating Production Offloading and Storage facilities were characterized. Vessels were all moored off Western Australia. Sound levels were both variable and inconsistent temporally, with higher sound levels being associated with propeller cavitation of ancillary vessels (i.e., tankers, rig tenders and tugs). The median broad band sound level for the six facilities was 181 dB re 1 uPa @ 1 m. The modeled monopole depth was 10 m, which was provided to allow for prediction of noise exposure in environmental impact assessments. Maximum source levels were recorded for frequencies of 20-63 Hz.

Heinis, F., JOng, C.D., Ainslie, M., Borst, W. and Vellinga, T. (2013). Monitoring Programme for the Maasvlakte 2, Part III - The Effects of Underwater Sound. *Terra et Aqua*, 1321:40 pp.
Terra et Aqua is a quarterly published technical journal that disseminates knowledge of professional dredging experts. The article presents an excellent description of a monitoring program for the Port of Rotterdam for underwater noise associated with the construction of Maasvlakte 2. The graphics presented in the article are extremely helpful in understanding the objectives, methods, and results of the monitoring program (e.g., see Figure 10, which graphically demonstrates sound exposure levels with shipping and with shipping/dredging). The article does not appear to be peer-reviewed. In 2008, acoustic measurements were made prior to dredging to serve as a baseline for measurements made during dredging operations. The authors conclude that the risk threshold for a temporary threshold shift for swimming harbor seals and harbor porpoise is not exceeded.

Marine Environment Protection Committee (2013). Noise From Commercial Shipping and its Adverse Impacts on Marine Life. International Maritime Organization. 11 pp.
This study measured and reported on the under-ice noise produced by a variety of anthropogenic sources (drilling rigs, helicopters, aircraft landing and takeoff, ice-road traffic, augers, snowmobiles, and chisels) at a winter-based diamond exploration project on Kennady Lake in the Northwest Territories, Canada to infer the potential impact of noise on fishes in the lake. The authors noted that most of the anthropogenic sounds were likely detectible by fishes with hearing specializations, like chubs and suckers. The greatest potential impact of noise from diamond exploration is likely to be the masking of sounds for fishes with sensitive hearing. A summary of acoustic measurements is provided in Table 1.

Maximum received sound levels approached 150 dB re 1 uPa. Average ambient noise levels and peak ambient noise levels were 82.3 dB and 114.4 dB re 1 uPa, respectively.

Robertson, F.C., Koski, W.R., Thomas, T.A., Richardson, W.J., Würsig, B. and Trites, A.W. (2013). Seismic operations have variable effects on dive-cycle behavior of bowhead whales in the Beaufort Sea. *Endangered Species Research*, 21:143-160.
The authors provide an analysis of how the behavioral response of bowhead whales to seismic noise may negatively affect the detection of bowhead whales during aerial surveys. They noted that the durations of surfacings decreased in response to seismic operations. However, the observed behavioral responses of bowheads to seismic noise is also dependent on other variables, such as season and whale activity. The authors conclude that estimates of abundance and distribution of bowhead whales near seismic activities should incorporate correction factors that account for sound exposure, season, reproductive status, and whale activity. This paper uses data from Robertson's 2014 Ph.D. dissertation. Additional details and analyses can be found there.

Stafford, K. (2013). Anthropogenic Sound and Marine Mammals in the Arctic: Increases in Man-Made Noises Pose New Challenges. PEW Charitable Trusts. July 2013. 20 pp.
This article was prepared for the Pew Charitable Trusts' Arctic Program. It does not appear to be an independent, peer-reviewed article. The author refers to the article as a "science brief", where its purpose was to describe in non-technical terms how anthropogenic noise could interfere with sounds produced and received by Arctic marine mammals. The author notes that hearing is the most important sense for marine mammals. However, determining distances over which a given sound (i.e., frequency and amplitude) will be heard and cause a response is difficult because of the unknown auditory thresholds for many species of marine mammals and because behavioral studies in the wild are difficult to carry out. The author further notes that most of the high amplitude anthropogenic noise sources produce low frequency sounds (e.g., seismic noise, large vessel noise). Finally, the author identifies several mechanisms by which anthropogenic noise can impact Arctic marine mammal populations (e.g., avoid areas of high anthropogenic noise that could be important to their life history, decreased vocalization rates), as well as several mitigation strategies (e.g., spatial, temporal or operational restrictions on certain anthropogenic activities).

CSA Ocean Sciences Inc. (2014). Quieting Technologies for Reducing Noise During Seismic Surveying and Pile Driving Workshop: Summary Report. US Department of the Interior, Bureau of Ocean Energy Management. Headquarters. BOEM 2014-061, Herndon, VA. March 2014. 308 pp.
A scientific/technical review panel was convened by BOEM to consider the issue of anthropogenic noise and the potential for sound reduction protocols or technologies to serve as a mechanism to mitigate adverse impacts on marine mammal populations. Three primary anthropogenic noise sources were considered: 1) seismic noise produced by underwater airguns, 2) pile driving, and 3) associated support vessels. A number of key points important to this issue were recognized including: 1) numerous information gaps exist that reduce confidence that sound reducing strategies will be successful, 2) there are no federal requirements regarding vessel noise and therefore there is no standardized effort focused on quieting technology, 3) while marine vibroseis technology is a possible alternative to seismic surveys, it will not replace seismic surveys until it becomes fully cost-effective under the current regulatory authorities, 4) there are no fully tested alternatives to pile driving, although research on alternative methods continue, and 5) there are two primary noise sources associated with vessel activities – propeller cavitation and noise from diesel engines. The age of vessels currently in use and the cost of retrofitting quieting technology act as deterrents to implementation of available mitigation protocols for vessel noise. Workshop participants concluded that a dialog among industry, non-government

organizations and BOEM is needed to help identify appropriate incentives and requirements (e.g., government regulations) to resolve this issue.

MacGillivray, A.O., Racca, R. and Li, Z. (2014). Marine mammal audibility of selected shallow-water survey sources. *Journal of the Acoustical Society of America*, 135:EL35-40.
Seven geophysical survey operations were characterized for sound source levels in this paper. This information was used to model sound propagation in a shallow water environment (40 m). Audiogram weighting was carried out for six species of marine mammals considered representative of marine mammal hearing by taxa. Model results included: 1) for humpback whales, the low frequency sources were most audible at all distances, 2) mid frequency sources were most audible to odontocetes at ranges below 3 km, 3) seals had similar estimated audibility for low and mid frequency sound sources, and 4) for all species, modeled sensation levels were lowest for the high frequency sources. The authors noted that the true threshold for audibility in the presence of background noise was species specific and further research was needed to determine how the audibility of the sound sources modeled in this paper would be affected by background noise and environmental conditions.

Moore, S.E. and Gulland, F.M.D. (2014). Linking marine mammal and ocean health in the 'New Normal' arctic. *Ocean & Coastal Management*, 102:55-57.
This paper is an opinion piece. The authors recommended that an Arctic-focused Marine Mammal Health Map framework be initiated internationally. In the U.S., such a framework could build on existing programs supported by the Alaska Ocean Observing System (ocean data access, community-based monitoring, and spatial tools for data visualization). Such an approach would provide for a better understanding of how climate change will impact Arctic marine mammals, aid in the prioritization of management activities designed to mitigate the impacts of climate change, and complement existing ecosystem monitoring programs internationally. Further, it was noted that wildlife diseases can significantly affect the health of marine mammal populations, these impacts will vary by region, and are very likely to change in transmissibility and magnitude due to environmental changes related to climate change. The authors also commented that in the "new normal", on-going terrestrial efforts to develop predictive models regarding infectious disease and climate change should be extended to include marine ecosystems, especially in the Arctic. The authors concluded that, if successful, this approach should be incorporated into the GOOS by considering Marine Mammal Health Map products as essential ocean variables.

Reeves, R.R., Ewins, P.J., Agbayani, S., Heide-Jørgensen, M.P., Kovacs, K.M., Lydersen, C., Suydam, R., Elliott, W., Polet, G., van Dijk, Y. and Blijleven, R. (2014). Distribution of endemic cetaceans in relation to hydrocarbon development and commercial shipping in a warming Arctic. *Marine Policy*, 44:375-389.
This paper provides a summary of the movements and distribution of three Arctic species of marine mammal: narwhal, beluga and bowhead whale. The paper maps areas of seasonal aggregation with a focus on high-density occurrences during the summer. Sites of oil and gas exploration and development, along with routes used for commercial shipping in the Arctic are compared to the distributions of the three cetacean species for the purpose of identifying areas of special concern for conservation and management of these three species. The authors cite extensive literature that documents the risk climate change poses to Arctic marine mammals. The authors further document the magnitude of shipping in the Arctic (Table 1) and on-going or planned oil and gas development and production (Table 2). The authors recommend the following as possible mitigation strategies: 1) careful planning of ship travel lanes, and where necessary, speed restrictions, 2) spatial or temporal closures of specific areas to specific industrial activities, 3) regulation of noise generated by seismic surveys and other sources of loud underwater noise, and 4) adequate monitoring of populations of each species to detect change in

abundance related to environmental change. The figures provide an excellent way to visualize the distribution information presented herein. Further, the literature cited section is extensive.

Robertson, F.C. (2014). Effects of Seismic Operations on Bowhead Whale Behaviour: Implications for Distribution and Abundance Assessments. 131 pp.
The authors provide an analysis of how the behavioral response of bowhead whales to seismic noise may negatively affect the detection of bowhead whales during aerial surveys. They note that the durations of surfacings decreased in response to seismic operations. However, the observed behavioral responses of bowheads to seismic noise are also dependent on other variables such as season and whale activity. The authors conclude that estimates of abundance and distribution of bowhead whales near seismic activities should incorporate correction factors that account for sound exposure, season, reproductive status, and whale activity. This paper uses data from Robertson's 2014 Ph.D. dissertation. Additional details and analyses can be found there.

Vedenev, A. and Shatravin, A. (2014). Safety zones and noise exposure criteria for marine mammals exposed to anthropogenic noise. Arctic Climate Change, Economy and Society. 36 pp.
This paper is a technical report to the Arctic Climate Change, Economy, and Society. The authors noted that one of the best mitigating strategies regarding the impact of anthropogenic noise on marine mammals and fish was the establishment of safety zones. In the first part of this report, the history of the application of this mitigation strategy, along with the noise exposure criteria, was summarized. In the second part of the report, results of acoustic modeling were presented, which evaluated how changes in the size of Safety Zones for different types of manmade noise could occur related to predicted warming of Arctic's water with changing of climate. The size of safety zones in this report were based on peak sound levels, rather than root-mean-square levels, which are used in the US for establishing the size of a safety zone. The authors noted that these metrics are different, and therefore are not directly comparable. A preliminary analysis of the model results for seismic surveys indicated that the shift in boundaries of the Injury Safety Zones (level 180 dB) would not be significant, while the shift of boundaries of the Disturbance Safety Zones (level 160 dB) could be up to several kilometers in the direction of the seismic source. This had to do with increased losses in sound levels associated with propagation in warm water relative to cold water. The results of similar analyses for other anthropogenic sound sources were presented, as well.

Williams, R., Ashe, E., Blight, L., Jasny, M. and Nowlan, L. (2014). Marine mammals and ocean noise: future directions and information needs with respect to science, policy and law in Canada. *Marine Pollution Bulletin*, 86:29-38.
The authors premise their analysis with the following: 1) anthropogenic noise represents a particular challenge to the conservation and management of marine mammals and 2) anthropogenic noise can affect marine mammal behavior, energetics and physiology. In this paper the authors compared how the policy and legal framework dealing with anthropogenic noise works in Canada (e.g., Oceans Act, Species at Risk Act, Fisheries Act) relative to other jurisdictions (U.S.- MMPA, ESA; EU- Marine Strategy Framework Directive). In addition, the authors identified a number of research activities that would improve efforts to conserve and manage marine mammal populations relative to anthropogenic noise. Specific management examples are provided for marine mammals in Canadian waters, including northern and southern killer whales and North Pacific humpback whales. Further, specific examples of management issues in Canada are discussed, including marine spatial planning, specific policies with regard to use of military sonar, specific policies with regard to use of seismic surveys, and specific policies with regard to cumulative impacts of multiple stressors. Concerning research to fill information gaps, the

authors recommended consideration of the use of proxy species rather than conducting research on covered under the Species at Risk Act.

Blackwell, S.B., Nations, C.S., McDonald, T.L., Thode, A.M., Mathias, D., Kim, K.H., Greene, C.R. and Macrander, A.M. (2015). Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds. *PLoS One*, 10:e0125720.
Blackwell et al. (2013) reported calling rates of fall migrating bowhead whales decreased in the presence of seismic operations at a distance of 41-45 km, where received sound levels were estimate at 116 dB re 1 uPa. In this paper, Blackwell et al. further refine thresholds for changes in calling rates of bowhead whales. Data were collected in 2007, 2008, and 2010. Two behavioral thresholds were identified: 1) at low received levels, calling rates increased over baseline and then reached a plateau (low threshold), and 2) at the high received sound level threshold, calling rates decreased rapidly (high threshold). Passive acoustic recordings were made with 31-40 DASARs in a given year. The research was conducted under an Incidental Harassment Authorization as part of an approved monitoring program. The methodology used in the analysis, while highly technical, was well described. Figures used in the paper were very informative. The estimated lower threshold varied between 92-97.1 dB re 1 uPa2 with the time periods of 5, 10 and 20 minutes. The estimated upper threshold occurred between 124.6-130.5 dB re 1 uPa-2 with the same time periods. Bootstrapped confidence intervals are presented in Table 4. In the discussion, the authors describe a number of caveats that need to be considered in evaluating the impacts of seismic noise on the call rate of bowhead whales during the fall migration.

Finneran, J.J. (2015). Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015. *Journal of the Acoustical Society of America*, 138:1702-1726.
The author provides a technical synthesis of major findings from marine mammal noise-induced TTS experiments. The first such research was published by Ridgway et al. in 1997. At least six facilities worldwide conduct Noise-Induced Threshold Shift (NITS) research on marine mammals. Species tested to date include: bottlenose dolphin, beluga, harbor porpoise, Yangtze finless porpoise, California sea lion, elephant seal, harbor porpoise. Facilities included ocean environments (with and without background noise), semi-natural outdoor pools, and indoor pools. Table 1 presents a summary of all available published research available to the author. Hearing threshold measurements were carried out with both behavioral (considered the gold standard for TTS measurements) and physiological techniques. Differences between the two techniques are discussed. The author noted that large potential differences exist between the two methods and this discrepancy needs to be better understood with further research. It was noted that, as expected, TTS generally increases with noise SPLs, but this increase is neither linear or monotonic. Further, when sound levels are integrated over time (i.e., SEL), TTS increases in an accelerated fashion. The author also noted that the frequency content of the sound can have a significant effect on whether or not a TTS is induced. Finally, information on recovery times, individual differences in TTS responses, and differences in TTS response to impulse and continuous noise was discussed.

Grebmeier, J.M., Cooper, L.W., Ashjian, C.A., Bluhm, B.A., Campbell, R.B., Dunton, K.E., Moore, J., Okkonen, S., Sheffield, G., Trefry, J. and Pasternak, S.Y. (2015). Pacific Marine Arctic Regional Synthesis (PacMARS) Final Report. North Pacific Research Board. The Pacific Marine Arctic Regional Synthesis (PacMARS) is a research synthesis effort funded by Shell Exploration & Production Company and ConocoPhillips, and administered and managed by the North Pacific Marine Research Institute through the North Pacific Research Board with oversight from the U.S. National Science Foundation Division of Polar Programs. The goal of the PacMARS effort was to facilitate new and cross-disciplinary synergies in our understanding of the marine ecosystem of the greater Bering Strait region, including the northern

Bering, Chukchi and Beaufort seas. The specific objectives of the PacMARS research team and collaborators included: (1) identify and synthesize existing data sets that are critical for evaluating the current state of knowledge of this marine ecosystem, including human dimensions, and (2) define the high-priority, overarching scientific themes and research needs for the next decade or more of marine ecosystem studies in the Pacific Arctic Region. Six research foci served as initial organizing principles for the PacMARS synthesis effort: 1) Sea Ice Cover (relationships with primary production, currents, and winds), 2) Phenology of Biological Production Cycles in Relation to Physical Environment, 3) Pelagic-Benthic Coupling in Relation to Physical-Chemical Environment, 4) Current State of Lower Trophic-Prey-Base and Higher Trophic Feeding Hot Spots, 5) Chemical Contaminants in Water, Sediments and Biota and 6) Subsistence Lifestyles in Times of Climate Change. The authors noted that data assembled and other synthesis products were publicly accessible at the PacMARS project data archive site: http://pacmars.eol.ucar.edu. The reference section in this report is extensive. The use of figures greatly enhanced the readability of this report. Appendix G1.3 provided results related to upper trophic species, included marine mammal species.

Hamilton, C.D., Lydersen, C., Ims, R.A. and Kovacs, K.M. (2015). Predictions replaced by facts: a keystone species' behavioural responses to declining arctic sea-ice. *Biology Letters*, 11:20150803.
TThe article reports a shift in the distribution of ringed seals associated with a major loss of sea ice event in waters around Svalbard, Norway. Key to changes in foraging and resting behavior of ringed seals was a shift in the summer position of the marginal sea ice zone from over the continental shelf northward to the Arctic Ocean basin. Nineteen seals transmitted data from over 25,000 dives over 764 tracking days. Two time periods were used as strata in the analysis (i.e., data from 2002-2003, n= 9, where ice zone was over continental shelf, and data from 2010-2012, n=10, where ice zone was over the Arctic basin. Seals in the latter time period first encountered sea ice approximately 111 km farther north than seals in the former time period. Seals in the latter time period spent significantly more time away from land, traveled greater distances per day and spent less time resting. These findings indicate that seals in the latter time period had higher energy costs associated with feeding relative to the other group. The authors speculate that the increase energy associated with foraging is mediated through a lower density of the preferred prey of ringed seals, Arctic cod. The authors further speculate that cascading ecological effects of this change in foraging behavior of ringed seals are expected (e.g., there could be reduced numbers of ringed seals in the Arctic and reduced numbers of polar bears, which are dependent on ringed seals as a primary diet item).

Laidre, K.L., Stern, H., Kovacs, K.M., Lowry, L. and Moore, S.E. (2015). Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century. *Conservation Biology*, 29:724-737.
The publication provides a summary of abundance and trends in abundance for Arctic marine mammals by species and recognized subpopulation. This is a first of its kind compilation. The authors are all well recognized and respected scientists. Information on trends in abundance was limited due to a lack of long-term monitoring. The authors noted that 61 of 78 species/subpopulations are legally harvested for subsistence use. Further, the authors reported profound changes in sea ice phenology and significant losses of sea ice in 11 of 12 regions (the exception being the Bering Sea). Recommendations included: 1) maintain and improve co-management by local, federal and international partners, 2) recognize spatial and temporal variability in a species/subpopulation response to climate change, 3) implement monitoring programs with clear goals, 4) mitigate cumulative impacts of increased human activity, and 5) recognize the limits of current protected species legislation.

Miller, J.H. (2015). Ocean Noise Variability and Noise Budgets. DOSITS Webinar, 38 pp.
This entry is a part of the Discovery of Sound in the Sea (DOSITS) webinar series. It was presented on 13 November 2013. The author recommended that noise budgets be developed in characterizing the relevance of anthropogenic noise in a given marine environment. He noted the difficulty in incorporating different types of sounds (e.g., pulsed versus continuous) in a noise budget. Wenz curves are used to provide examples of different source levels of anthropogenic and nature noise. An example of a noise budget is provided with an example of noise generated by wind farm turbines. This visual presentation, absent the verbal component, is not surprisingly difficult to understand and follow. The following website provides copies of the presentations, as a pdf file, but does not include the video presentation: https://dosits.org/decision-makers/webinar-series/.

Moore, S.E. and Stabeno, P.J. (2015). Synthesis of Arctic Research (SOAR) in Marine Ecosystems of the Pacific Arctic. *Progress in Oceanography*, 136:1-11.
TThis paper serves as the preface to an issue of Progress in Oceanography (16 papers) dedicated to information collected as part of the SOAR program. SOAR scientists represent a multidiscipline approach to understanding how climate change is impacting the Pacific Arctic. The authors provide an overview of the findings reported in this issue of the journal, including: 1) biophysics of the region, 2) changes in primary production and ocean acidification, 3) changes in the lower trophic level community, 4) benthic hotspots and marine fishes across a spectrum of habitats, and 5) upper trophic level species as ecosystem sentinels (i.e., marine birds and mammals). To update past models used to qualitatively integrate lower and upper trophic levels, the authors propose the "Arctic Marine Pulses" conceptual model, which aims to animate Grebmeier et al.'s advection model and link it to the pelagic-benthic coupling model. The authors concluded with research recommendations related to this synthesis project, including more multidisciplinary studies at medium spatial and temporal scales.

Nowacek, D.P., Clark, C.W., Mann, D., Miller, P.J., Rosenbaum, H.C., Golden, J.S. and Southall, B.L. (2015). Marine seismic surveys and ocean noise: time for coordinated and prudent planning. *Frontiers in Ecology and the Environment*, 13:378-386.
Given the international and transboundary nature of the impacts of seismic noise in the marine environment on marine animals, the authors recommend and provide justification for the creation of an international instrument to address this issue. All of the authors are well respected scientists in their respective fields. The authors further suggest consideration for an annex to the existing International Convention on the Prevention of Pollution from Ships. They also raised concerns regarding existing protocols for managing the risk of anthropogenic noise to marine animals, which they believe are too rigid, and to narrowly focused on single sound sources and single activities; rather than focusing on all sources of anthropogenic noise over appropriate spatial and temporal scales. They provided examples of marine animals, like blue whales, that are migratory and are likely to encounter seismic noise in many parts of their home ranges. A summary of documented effects of seismic noise on marine mammals and fish is presented in Table 1. The authors noted that an integrated approach to assessment must be coupled with appropriate mitigation that takes into account the acoustic ecology of marine animals. The authors further concluded that the existing spatial and temporal scale of monitoring is inadequate.

Aguilar de Soto, N., Gkikopoulou, K., Hooker, S., Isojunno, S., Johnson, M., Miller, P., Tyack, P., Wensveen, P., Donovan, C., Harris, C.M., Harris, D., Marshall, L., Oedekoven, C., Prieto, R. and Thomas, L. (2016). From physiology to policy: A review of physiological noise effects on marine fauna with implications for mitigation. *Proceedings of Meetings on Acoustics*, 27:040008.
The authors noted in this policy paper that a variety of physiological effects of intense anthropogenic noise in addition to hearing damage (e.g., temporary and permanent threshold shifts) have been

observed in marine mammals and other marine fauna. Nonetheless, it is further noted that mitigation of anthropogenic noise effects is in its infancy worldwide. They recommended an approach that focuses on the most vulnerable species, as a priority (e.g., beaked whales). Specifically, they describe the behavioral response of beaked whales to sounds produced by military sonars and the resulting observation of mass strandings. They propose that these strandings are related to the behavioral response of beaked whales to military sonars, which are at received sound levels below the threshold for auditory injury. The authors further describe technologies that could be used to address information gaps and, which if implemented, could be used to improve efforts to mitigate the impact of anthropogenic noise on marine mammals. Examples of technologies discussed include: 1) ocean bottom hydrophone arrays and 2) portable passive acoustic monitoring arrays.

Costa, D.P., Hückstädt, L.A., Schwarz, L.K., Friedlaender, A.S., Mate, B.R., Zerbini, A.N., Kennedy, A. and Gales, N.J. (2016). Assessing the exposure of animals to acoustic disturbance: Towards an understanding of the population consequences of disturbance. *Proceedings of Meetings on Acoustics*, 27:010027.

Satellite tracking data were collated for two migratory species of large whales: the blue whale (California Current) and humpback whale (Bering Sea and Western Antarctic Peninsula). A spatially explicit simulation model was used to calculate the proportion of the population that was exposed to randomly placed seismic surveys, the duration of the exposure for each individual, and the probability of individuals to be exposed during Area Restricted Search or transit behavior, where this behavior was used as a proxy for feeding behavior. Four circular disturbance areas were used in the analysis (radius equal to 5, 25, 50 and 100 km). The authors noted that humpback whales in the Bering Sea feed primarily on fish and their movements are spatially localized. This resulted in a relatively high level of exposure compared to humpback whales in the Antarctic and blue whales off California. An important list of caveats related to data interpretation are provided in the discussion. Further, the extensive list of references is worth a comprehensive review.

Ellison, W.T., Racca, R., Clark, C.W., Streever, B., Frankel, A.S., Fleishman, E., Angliss, R., Berger, J., Ketten, D., Guerra, M., Leu, M., McKenna, M., Sformo, T., Southall, B., Suydam, R. and Thomas, L. (2016). Modeling the aggregated exposure and responses of bowhead whales *Balaena mysticetus* to multiple sources of anthropogenic underwater sound. *Endangered Species Research*, 30:95-108.

The authors noted that current regulations related to takes of marine mammals by anthropogenic noise are codified in terms of instantaneous received sound levels (i.e., SPL). In this article, the authors expand on previous work by Moore et al. (2012) and Southall et al. (2007) and propose use of the SEL metric. Through the use of simulation models, the authors explored how changes in movement paths of simulated animals, which were programmed to avoid certain received levels of sound, would change sound exposure and travel distance of bowhead whales in the western Arctic (i.e., 144−152°W) during the fall migration. Data on anthropogenic noise included the following sources: oil and gas production, seismic exploration, and vessel traffic. Three acoustic metrics were evaluated in the model: root mean square SPL, per impulse SEL, and SEL_{cum}. Key to this analysis was estimating the aggregated received sound level for each simulated animal, which was done by summing the received sound energy for each source. Bowhead movement and diving behavior was based on available satellite telemetry and aerial survey data. he authors reported that “aversion behavior” to anthropogenic noise substantially changed the modeled results. That is, rather than a high proportion of animals being exposed to 155-160 dB sound levels, less than 50% of simulated animals would be exposed to that sound level. The authors emphasized the importance of quantifying the time-varying dynamics of animal behavior and the soundscape over periods of time that were ecologically meaningful.

Erbe, C., Reichmuth, C., Cunningham, K., Lucke, K. and Dooling, R. (2016). Communication masking in marine mammals: A review and research strategy. *Marine Pollution Bulletin*, 103:15-38.
In this paper the authors 1) review the existing information on masking of communication in marine mammals associated with natural or anthropogenic underwater noise, 2) summarize data on marine mammal hearing related to masking, 3) describe behavioral responses of marine mammal "receivers" and "signalers" to mitigate masking, and 4) develop a research framework to provide for improved risk assessment to marine mammals of masking related to anthropogenic noise. The paper is both technical and comprehensive regarding this topic. The list of literature cited is extensive. The authors note that the goal of ongoing and future research should be to develop and refine masking models that are both practical (in terms of data requirements) and accurate. A summary of research recommendations is provided in Table 4.

Ireland, D.S., Broker, K., Filippo, V.S., Brzuzy, L. and Morse, L. (2016). Adaptive Management Approach to Mitigating Oil and Gas Activities in Areas Occupied by Pacific Walrus. 1 pp.
The document is a poster that was presented at the 2016 Ocean Sciences Meeting (21-26 Feb 2016). It is not a peer-reviewed source of information. The poster describes a protocol for commercial activities in the marine environment that was integrated into a request for authorization to take marine mammals (i.e., walrus) to the USFWS. This particular protocol was proposed by SOI related to drilling operations in the Chukchi Sea in 2015. The protocol involves using near-real time information on sea ice position, walrus sightings from aircraft and vessels, and area-specific, industry operations. The protocol identified three levels of risk- low, medium and high; where at low risk, industry operations could proceed with no formal communication with USFWS, with medium risk, industry operations could proceed but with caution, and at high risk, industry operations could only continue after formal consultation. The authors concluded that this approach was preferred because it necessarily avoided the use of large scale restriction areas with course temporal resolution.

Moore, S.E. (2016). Is it 'boom times' for baleen whales in the Pacific Arctic region? *Biology Letters*, 12:0160251.
The author in this paper identified two well-documented alterations to the Pacific Arctic ecosystem (i.e., loss of sea ice and increased inflow of Pacific water through the Bering Strait). Further, the author noted that these two changes have caused an increase in the production and delivery of baleen whale prey in this region. The author speculated that these changes in the magnitude and distribution of baleen whale prey are favorable for five species of baleen whales, and that interspecfic competition for prey will not be a dominating ecological feature at least in the near term. Interestingly, these 5 species partition habitat through temporal separation and prey preference. Recent reports from sighting surveys and passive acoustic indicate that humpback, fin and minke whales over the past decade now occupy the southern Chukchi Sea from August through October. The author concluded that these five species individually and as an assemble could serve as "sentinel" species relative to the changes in bottom-up forcing mechanisms in the Pacific Arctic associated with loss of sea ice and continued warming in the Arctic, as well as changes in other regions of the Arctic.

Atwood, T.C., Duncan, C., Patyk, K.A., Nol, P., Rhyan, J., McCollum, M., McKinney, M.A., Ramey, A.M., Cerqueira-Cezar, C.K., Kwok, O.C.H., Dubey, J.P. and Hennager, S. (2017). Environmental and behavioral changes may influence the exposure of an Arctic apex predator to pathogens and contaminants. *Scientific Reports*, 7:13193.
Since 2000, the proportion of southern Beaufort Sea polar bears coming ashore during the summer and fall has increased from 6% to over 20%, while the length of stay on land has increased by over 30 days. The authors tested the hypothesis that polar bears from the southern Beaufort Sea stock, which are

increasingly using terrestrial habitats for foraging as loss of sea ice continues, will be more exposed to various pathogens and contaminants relative to bears that remain offshore on sea ice habitat during the summer and fall. The methodology involved testing bears captured on sea ice versus those captured on the coast for pathogen and contaminant exposure. The odds ratio for habitat use indicated that polar bears using land habitat during the summer were more likely to test positive for *Toxoplasma gondii.* No such finding was reported for *Brucella spp*. The authors further concluded that land habitat use by polar bears may have influenced exposure to persistent organic pollutants (POPs) and disease agents. The authors recommended additional research on the potential impact of pathogens and contaminants on polar bears from the southern Beaufort Sea stock.

Boveng, P.L., Cameron, M.F., Conn, P.B. and Moreland, E.E. (2017). Abundance Estimates of Ice-Associated Seals: Bering Sea Populations that Inhabit the Chukchi Sea During the Open-Water Period. Final Report. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2016-007, Anchorage, AK. 119 pp + appendices.

The report describes and summarizes the results of a state-of-the-art aerial survey in April and May to estimate abundance of breeding populations of ice seals in the central and eastern Bering Sea shelf in 2012 and 2013. Surveys were conducting using high resolution digital photography and thermal imaging sensors. In addition, satellite tags were attached to ribbon and spotted seals to determine the number of animals that use the Chukchi Sea during the open-water season. A detailed methods section clearly describes how the authors conducting the survey, processed the imagery, analyzed the data (including species identification protocols and abundance estimation). 87,000 km of trackline were observed, while 1.8 million images were collected. This survey represents the largest effort to date to survey ice seals in the Bering Sea and Sea of Okhotsk. Abundance estimates were: 1) bearded seal- 125,000 (SE=5,000), 2) ribbon seal – 38,000 (SE=4,000), 3) ringed seal – 119,000 (SE = 4,000), and 4) spotted seal – 163,000 (SE=6,000). Five peer-reviewed publications were prepared from the information presented in this report to BOEM, and are included as appendices.

Erbe, C. and McPherson, C. (2017). Underwater noise from geotechnical drilling and standard penetration testing. *Journal of the Acoustical Society of America*, 142:EL281.

Geotechnical site investigations often take place prior to marine construction. Investigations typically involve shallow, small-core drilling and standard penetration testing. Following drilling to the required depth, the drilling core is extracted for surface examination. Drilling is typically performed from “jack-up” rigs towed into place with barges. Penetration tests are typically performed to asses substrate hardness. The tube used in the penetration test is hammered into the ground at the bottom of the bore hole, which is very similar to pile driving in nature. The recordings of underwater noise associated with drilling and penetration tests took place in waters off western Australia in 2010 on two separate rigs. Vessel and drilling specifications are described in detail. Broadband drilling sound noise levels ranged from 142 to 145 dB re 1 uPa at 1 m. The broadband penetration test source levels ranged from 151 to 160 dB re 1 uPa at 1 m. The authors noted that sound levels at source from geotechnical drilling are less than from oil production drilling, which use large drilling rigs. Similarly, sound levels from penetration tests are less than from typical pile driving, which uses much larger hammers and tubes. Finally, the authors noted that while sound levels associated with geotechnical drilling and penetration tests were as much as 35 dB above ambient noise levels, they were generally at levels not regulated by agencies responsible for marine stewardship.

Liu, M., Dong, L., Lin, M. and Li, S. (2017). Broadband ship noise and its potential impacts on Indo-Pacific humpback dolphins: Implications for conservation and management. *Journal of the Acoustical Society of America*, 142:2766.
In this paper, underwater broadband noise from commercial ships in a critical habitat of Indo-Pacific humpback dolphins was recorded and analyzed. Previous reports have documented noise from recreational vessels and pile driving to interfere with communication in this species. Herein the authors document noise levels associated with commercial shipping (i.e., vessel speeds >15 km/h and vessel lengths > 50 m). The study was carried on in the Longteng Channel in Zhanjiang, China. For third-octive bands centered around 8 kHz, estimated source levels of commercial vessels varied between 137-150 dB re 1 uPa (mean= 143.8 dB). The authors estimated these noise levels could be detected by humpback dolphins at a distance of 2290 m on average. Details for 21 commercial vessels are presented in Table 2. The results from this study were in agreement with previous publications. One aspect of this study to note is the emphasis on impacts of mid to high frequency components of vessel noise (rather than low frequency components). The authors concluded that masking of communication and biosonar systems of humpback dolphins by vessel noise was likely, while temporary threshold shifts due to vessel noise could only occur in relatively rare situations. Mitigating measures including distance restrictions and quieting technologies are discussed in a section called "Implications for conservation and management".

Shelden, K.E.W., Hobbs, R.C., Sims, C.L., Brattström, L.V., Mocklin, J.A., Boyd, C. and Mahoney, B.A. (2017). Aerial Surveys, Abundance, and Distribution of Beluga Whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2016. National Marine Fisheries Service. Alaska Fisheries Science Center. AFSC Processed Report 2017-09, Seattle, WA. 62 pp.
As noted in the introduction to the report, this report does not constitute a publication and was made available for information purposes only. All data herein were to be considered provisional. The authors purpose in preparing this report was to summarize the results of an aerial survey in Cook Inlet, AK to determine abundance and distribution of beluga whales. Survey protocol was described in detail. One hundred percent of the coast line was surveyed, as this habitat is where belugas are primarily found in this region. Belugas were not seen in lower Cook Inlet, nor in the upper Inlet south of a line between the North Foreland and Moose Point. The authors noted that the annual sum of median counts from aerial surveys served as an index of abundance, which was not corrected for missed whales (i.e., 300 whales in 2016). The mean group size observed was 46 whales (SD=60). The estimated abundance based on reported sightings was 328 whales (CV= 0.083). The report includes considerable detail in the form of figures and tables regarding survey design, distribution of sightings, analysis protocol, summary of sightings by day, total abundance estimates over time (1994-2016), and changes in area occupied over time.

Silber, G.K., Lettrich, M.D., Thomas, P.O., Baker, J.D., Baumgartner, M., Becker, E.A., Boveng, P., Dick, D.M., Fiechter, J., Forcada, J., Forney, K.A., Griffis, R.B., Hare, J.A., Hobday, A.J., Howell, D., Laidre, K.L., Mantua, N., Quakenbush, L., Santora, J.A., Stafford, K.M., Spencer, P., Stock, C., Sydeman, W., Van Houtan, K. and Waples, R.S. (2017). Projecting Marine Mammal Distribution in a Changing Climate. *Frontiers in Marine Science*, 4:14 pp.
Changes in marine mammal distributions related to habitat changes caused by climate change over the past 40 years have been reported. Substantive additional changes in marine mammal distributions have been predicted based on models of future climate change. The purpose of this paper, as noted by the authors, was to assess a pathway to develop the capability to project changes in the distribution of marine mammals related to climate change at the multi-decadal and century time scale, and to evaluate the potential for mitigation through management and conservation. The authors noted that key requirements for credible mechanistic models include the observations necessary to build and validate

those models. They further noted that research necessary to collect these observations must be implemented prior to model development. In particular, information gaps for certain regions where current forecasts are highly uncertain must be filled. From a pragmatic perspective, the authors concluded with a recommendation to initiate these efforts using species that are considered 1) particularly vulnerable to climate change and 2) that have a high management priority (e.g., for which ecological data already exist). They added that close cooperation among scientists from multiple disciplines will be needed to achieve the goal of developing credible models for assessing the impact of climate change on marine mammal populations worldwide.

Ellison, W.T., Southall, B.L., Frankel, A.S., Vigness-Raposa, K. and Clark, C.W. (2018). An Acoustic Scene Perspective on Spatial, Temporal, and Spectral Aspects of Marine Mammal Behavioral Responses to Noise. *Aquatic Mammals*, 44:239-243.

The authors provide a quantitative approach to evaluating the likelihood that a particular anthropogenic noise will lead to a strong, moderate or minimal disturbance response in a marine mammal. The approach integrates proximity to a sound source and the rate of change in proximity. Figure 1 is particular useful in summarizing the information needed and assumptions required to implement. While their results are not specific to species, they do provide for potential discrimination of impacts of anthropogenic noise that is specific to the source level, the distance between the source and the marine mammal, and the relative speed at which the distance between the source and the marine mammal is changing. The severity of a given disturbance to ongoing behavior was informed by the severity scoring protocol in Ellison et al. (2016). As an example, strong disturbance responses were predicted in response to a 230 dB re 1 uPa at a distance of 2 km, where there was no encroachment. A moderate disturbance response was predicted for this situation out to 5 km. When the source noise was closing (i.e., moving towards the animal), disturbance was greater than for a similar configuration, but where the sound source was moving away. However, the proximity effect had greater influence on the disturbance level than did the rate or direction of encroachment. While there are no doubt species specific differences in the behavioral response of an animal to proximity and encroachment, the authors noted that the regulatory framework is also not species specific.

Hauri, C., Danielson, S., McDonnell, A.M.P., Hopcroft, R.R., Winsor, P., Lalande, C., Stafford4, K.M., Horne, J.K., Cooper, L.W., Grebmeier, J.M., Mahoney, A., Maisch, K., McCammon, M., Statscewich, H., Sybrandy, A. and Weingartner, T. (2018). From sea ice to seals: a moored marine ecosystem observatory in the Arctic. *Ocean Science*, 14:1423-1433.

The authors describe the sensor technologies used to monitor the Chukchi marine ecosystem in a state of the art marine observatory. The Chukchi Ecosystem Observatory consists of an array of closely co-located, subsurface moorings and was designed to continuously record a broad suite of ecosystem variables (e.g., physical, biogeochemical, and biological) in the northeast Chukchi Sea. The observatory is located in 45 m of water in the southeast corner of Hanna Shoal. The authors noted that the observatory is refurbished with “vessels of opportunity”, given the cost of dedicated ship time for such a purpose. A summary of data from the observatory from the 2015/2016 deployment is presented. These include data from acoustic, optical, electrochemical and gas membrane sensors, as well as direct sampling of collection devices. The authors noted that the time series of information collected by the Chukchi Ecosystem Observatory will provide a unique time line to address the extent to which cascading changes in the Artic related to patterns of global warming are impacting the function of the marine ecosystem in the Chukchi Sea. Similar “observatories” are being planned in other marine ecosystems in Alaska based on lessons learned from this observatory.

Haver, S.M., Jason Gedamke, Hatch, L.T., Dziak, R.P., Prijs, S.V., McKenna, M.F., Barlow, J., Berchok, C., DiDonato, E., Hanson, B., Haxel, J., Holt, M., Lipski, D., Matsumoto, H., Meinig, C., Mellinger, D.K., Moore, S.E., Oleson, E.M., Slodevilla, M.S. and Klinck, H. (2018). Monitoring long-term soundscape trends in U.S. waters: The NOAA/NPS Ocean Noise Reference Station Network. *Marine Policy*, 90:6-13.
NOAA and the National Park Service established their first Ocean Noise Reference Stations (NRS) in 2014. Eleven additional stations were added over the next two years. The twelve stations record data that can be used to quantify baseline levels and multi-year trends in ocean ambient sound across the continental United States, Alaska, Hawaii, and island territories within and near to the U.S. EEZ. The network provides multi-year, continuous observations of low-frequency underwater sound between 10 Hz and 2000 Hz to capture anthropogenic, biological, and geophysical contributions to the marine soundscape at each location. The authors noted that currently there are no widely accepted standards for analyzing or reporting soundscape conditions. The purpose of this study was to provide the initial analysis of a comprehensive and comparable data set of ocean noise, including ambient noise, in US waters. The authors noted the importance of long term data sets, like NRS, in evaluating the degree to which anthropogenic activities and associated noise levels may be compromising the health and safety of marine mammal populations in U.S. waters. Each of the 12 NRS is comprised of identical autonomous passive acoustic instrumentation (i.e., nine deep water and three shallow water moorings). Table 1 lists the 12 stations and their associated locations. Figure 5 displayed the time-aligned, long-term spectral averages of data from 2014-2016. Figure 6 provided a summary of the monthly median spectrum sound level at five deep water stations. The use of NRS is identified in NOAA's Ocean Noise Strategy Roadmap as a critical step in adequately monitoring underwater noise levels in U.S. waters.

Kuşku, H., Yiğit, M., Ergün, S., Yiğit, Ü. and Taylor, N. (2018). Acoustic Noise Pollution from Marine Industrial Activities: Exposure and Impacts. *Aquatic Research*, 148-161.
In this paper, the authors provide a review of exposure levels and the impacts of anthropogenic noise on marine life. Industrial activity was considered the prime source of anthropogenic noise, including sounds levels associated with: 1) pile driving, 2) dredging, 3) vibrio-densification, 4) underwater explosions, 5) wind farms, 6) construction and operation of oil platforms, and 7) vessel noise. While the focus of the authors is primarily on impacts to fish related to anthropogenic noise, a few marine mammal examples are provided (e.g., belugas), as well as a few general references (less than 10). The authors recommend research to develop species-specific thresholds to determine noise levels that are safe for marine animals. No original field measurement data are presented in this paper.

O'Corry-Crowe, G., Suydam, R., Quakenbush, L., Potgieter, B., Harwood, L., Litovka, D., Ferrer, T., Citta, J., Burkanov, V., Frost, K. and Mahoney, B. (2018). Migratory culture, population structure and stock identity in North Pacific beluga whales (*Delphinapterus leucas*). *PLoS One*, 13:e0194201.
The authors report on the results of genetic analyses of beluga whales in the North Pacific that were used to resolve uncertainty in the patterns of migration, dispersal, population structure and stock identity. The authors tested hypotheses on how the spatial proximity of summering and wintering areas may influence levels of dispersal and interbreeding among discrete summering aggregations of animals. Samples were available from 15 geographic strata across the North Pacific (see Table 1). Substantial levels of mtDNA differentiation were observed among the three primary regions (i.e., GOA, BCB, and Sea of Okhotsk). Five discrete population clusters were identified. The authors noted: 1) there is widespread natal philopatric behavior to both summering concentrations and migratory circuits, 2) patterns of dispersal of belugas were consistent at the decadal time scale with a few notable exceptions, 3) for the BCB populations, the results of the genetic analyses were consistent with satellite tracking data indicating that there are discrete wintering areas rather than a single, widely used wintering area, 4) while both sexes tend to be philopatric, dispersal is primarily due to males dispersing, 5) genetic distances were more strongly related

to distances between wintering grounds rather than summering grounds, and 6) all summering aggregations within a region act as demographically independent subpopulations. The authors concluded with an observation regarding the importance of the northern Bering Sea and Bering Strait region to belugas in the North Pacific, and that minor shifts in the environment or ecosystem in this region could have major impact on beluga populations that winter in this area.

Quakenbush, L., Citta, J., George, J.C., Heide-Jørgensen, M.P., Brower, H., Harwood, L., Adams, B., Pokiak, C., Pokiak, J. and Lea, E. (2018). Bering-Chukchi-Beaufort Stock of Bowhead Whales: 2006–2017 Satellite Telemetry Results with Some Observations on Stock Sub- Structure. International Whaling Commission. SC/67B/AWMP/04, 26 pp.

It should be noted that IWC Scientific Committee documents are not considered independently, peer-reviewed papers. The authors reported on the movements of 64 satellite tagged bowhead whales in the BCB, which is an update from Quakenbush et al. (2012). All but one whale migrated past Point Barrow in the spring and went to Amundsen Gulf. One whale migrated up the Chukotka coast and summered in the Chukchi Sea. Movements in the summer months of tagged whales were more extensive than the literature would suggest. Core use areas important for feeding included: 1) Amundsen Gulf in the spring and summer, 2) Tuktoyaktuk shelf in the summer, 3) Point Barrow in the summer and fall, 4) the northern Chukotka coast in the fall, and 5) and the western Bering Sea in the winter. Changes in feeding areas in the winter of 2016/2017 were observed and were likely related to ice-free conditions. From a management perspective, the authors noted that none of the movement patterns observed were consistent with a multi-stock management paradigm for bowhead whales in the BCB region. The figures in this report are very helpful in visualizing the movements of satellite tagged bowhead whales.

Shelden, K.E.W., Goetz, K.T., Hobbs, R.C., Hoberecht, L.K., Laidre, K.L., Mahoney, B.A., McGuire, T.L., Norman, S.A., O'Corry-Crowe, G., Vos, D.J., Ylitalo, G.M., Mizroch, S.A., Atkinson, S., Burek-Huntington, K.A. and Garner, C. (2018). Beluga Whale, *Delphinapterus leucas*, Satellite-Tagging and Health Assessments in Cook Inlet, Alaska, 1999 to 2002. National Marine Fisheries Service. Center, A.f.S. NOAA Technical Memorandum. NMFS-AFSC-369, February 2018. 284 pp.

The authors summarize tagging information of belugas in Cook Inlet, Alaska that were tagged between 1999 and 2002. The reported results include: 1) monthly movement maps, 2) dive behavior data, and 3) ice-associated information from all years. A link to an animation of whale movements is also provided. Further, the authors described the results of a health assessment program for animals at the time of tagging starting in 2000. Results from the following tests were reported on: 1) hematology and serum chemistry values, 2) hormones, 3) DNA extractions, 4) blubber lipid composition, 5) fatty acid profiles, 6) stable isotope ratios, and 7) persistent organic pollutant profiles. Movement data and association patterns of individual belugas with seasonal sea ice in Cook Inlet are clearly presented in numerous figures in the results section. The article concludes with a series of research recommendations. As a note, this paper is part of the NOAA Technical Memorandum series, and based on the review protocol, is considered an independently, peer-reviewed publication.

Taylor, R.L., Udevitz, M.S., Jay, C.V., Citta, J.J., Quakenbush, L.T., Lemons, P.R. and Snyder, J.A. (2018). Demography of the Pacific walrus (*Odobenus rosmarus divergens*) in a changing Arctic. *Marine Mammal Science*, 34:54-86.

This paper likely represents the most current stock assessment for Pacific walrus. The authors used additional vessel survey, harvest and life history data to update the stock assessment published by Taylor and Udevitz (2015). The authors developed a Bayesian population model that that allowed for density dependence in reproduction and calf survival, as well as temporally variable density independence for older age classes. Population models were used to estimate vital rates and population growth rates

through 2015. The statistical methods used in this paper were well described. A summary of primary population parameters was presented in Figure 4. The steepest rate of decline had a mean estimate of 5% per year in 1985, while the maximum rate of increase had a mean estimate of 1% per year (2013-2015). The 2015 population was estimated at 42% (CI = 23-64%) of the population size in 1981. There was a 45% chance that the population was declining, as of 2015 (and a 55% chance it was either stable or increasing). The results from two alternative models, in addition to the results from the most parsimonious model, were presented. Data deficiencies regarding Russian harvest were identified, although model results were robust to this uncertainty. Possible bias regarding population survey results did influence model results, as was the case for model output reported by Taylor and Udevitz (2015). The authors recommended research to uncertain in the age structure data of the population, and research to develop additional methods to estimate abundance and vital rates.

Wilson, R.R., Perham, C., French-McCay, D.P. and Balouskus, R. (2018). Potential Impacts of Offshore Oil Spills on Polar Bears in the Chukchi Sea. *Environmental Pollution*, 235:652-659.
There is currently limited information on the impact of an oil spill in the Arctic on marine mammal populations. In this paper, the authors simulated a 25,000 barrel spill of Prudhoe Bay crude oil per day over 30 days, caused by an underwater blowout for the purpose of evaluating a limit on the number of polar bears that would be impacted by such a spill. To model the transport, fate and of oil following a blowout, the authors used Spill Impact Model Application Package. Discharged oil was tracked for a period of 75 days. Two discharge sites were modeled in the Chukchi Sea, referred to as the Crackerjack and Wrangel spill sites (see Figure 1). Movement patterns of satellite tagged bears were used to inform the simulation model regarding overlap between discharged oil and bear movements. As a result of a spill at the Wrangel site, the authors estimated that 38% and 13% of the Chukchi polar bear population would be exposed to oil of medium and high density. For a spill at the Crackerjack site, an estimated 27% and 5% of the Chukchi polar bear population would be exposed to oil of medium and high density. The authors concluded that a worst-case-discharge oil spill in the Chukchi Sea during autumn would expose a large number of polar bears to oil (i.e., 100-800 oiled bears from a population of approximately 2000). Finally, the authors noted that there was a 2-3 week gap between the blowout event and polar bears being exposed to oil. This window is critical for managers because it is the time period where mitigation strategies must be employed to be optimally effective (e.g., *in situ* burning of surface oil). Further, these simulation results highlight the importance of coordination between US and Russian authorities should an oil spill event occur in the Chukchi Sea.

Castellote, M., Thayre, B., Mahoney, M., Mondragon, J., Lammers, M.O. and Small, R.J. (2019). Anthropogenic Noise and the Endangered Cook Inlet Beluga Whale, *Delphinapterus leucas*: Acoustic Considerations for Management. *Marine Fisheries Review*, 80:63-88.
Anthropogenic noise in Cook Inlet, AK was characterized through the use of an array of passive listening devices. Nine sources of anthropogenic noise were identified over 8,756 hours of recordings relative to potential adverse impacts on the endangered population of Cook Inlet belugas. Natural background noise was characterized as being below 120 dBrms re 1*uPa* in Upper Cook Inlet (rather than 125 dBrms, as previously reported). Anthropogenic noise was loudest and most common in the vicinity of the Port of Anchorage (i.e., lower Knik Arm habitat). This is important as this area is a passage way for belugas moving into Knik Arm to forage seasonally. Ship noise was identified as the highest priority for noise mitigation efforts by managers. Anthropogenic noise levels had the potential to chronically mask beluga communications throughout the study region. Cumulative effects of anthropogenic noise in the vicinity of Cairn Point was identified as a particular concern. That is, a combination of acute disturbances combined with chronic noise resulted in a condition of consistent acoustic disturbance to lower Knik Arm habitat. The authors recommended that cumulative or additive effects be incorporated into the

permitting process under NEPA and the MMPA. Further research was recommended to provide for a better characterization of unidentified machinery noise and other unclassified noise. In addition, greater effort to identify unpermitted activities that were potential sources of high levels of anthropogenic noise was recommended.

Erbe, C., Dähne, M., Gordon, J., Herata, H., Houser, D.S., Koschinski, S., Leaper, R., McCauley, R., Miller, B., Müller, M., Murray, A., Oswald, J.N., Scholik-Schlomer, A.R., Schuster, M., Van Opzeeland, I.C. and Janik, V.M. (2019). Managing the Effects of Noise From Ship Traffic, Seismic Surveying and Construction on Marine Mammals in Antarctica. *Frontiers in Marine Science*, 6:1-21.
The waters around the Antarctic continent are important for the reproduction and foraging of 8 mysticete, 10 odontocete, and 6 pinniped species (i.e., south of 60^{o} S). In this paper the authors review the prevalence of anthropogenic noise and the distribution of marine mammals in the Southern Ocean, as well as providing a summary of research gaps that prevent accurately assessing the impact of anthropogenic noise on Antarctic marine mammals. The 3 primary noise sources discussed include noise from research vessels, cruise ships, and fishing vessels, although vessel activity is not evenly distributed around the continent. In the near shore around research facilities, construction noise is also a concern (e.g., pile driving). A questionnaire was provided to 29 international experts on marine mammals regarding research needs. Table 2 provides a comprehensive summary of information available by species. High ranking research needs identified by these experts include: 1) improved information on distribution and abundance of Southern Ocean marine mammals, 2) improved information on marine mammal hearing, with a focus on large whales, 3) an evaluation of the effectiveness of measures taken to mitigate impacts of anthropogenic noise on marine mammals in the Southern Ocean, and 4) improved methods for data sharing (e.g., seismic and hydrographic data). The authors noted the discrepancies among country-specific requirements to mitigate noise pollution (e.g., for monitoring, should received sound levels be measured at the animal or at a set distance).

Miller, J.H. (2019). Pile Driving: Near Field Characteristics/Considerations. DOSITS Webinar, 14 pp.
This entry is a part of the DOSITS webinar series. It was presented on 22 May 2019. (see https://dosits.org/wp-content/uploads/2019/05/DOSITS_Webinar_05222019-Miller-final.pdf). The purpose of the presentation was to characterize the noise field associated with offshore impact pile driving. Various descriptions of pile driving equipment and operations are presented. Mitigation protocols to reduce the impact of the noise associated with pile driving are discussed. Seven references regarding this presentation are included in the last “slide”.

Protection of the Arctic Marine Environment (PAME) and Arctic Council (2019). Underwater Noise in the Arctic: A State of Knowledge Report. May 2019. 60 pp.
In the 2009 Arctic Marine Shipping Assessment PAME authors reported that anthropogenic noise produced by shipping could have adverse on Arctic species. This review is a more general report by PAME on underwater noise in the Arctic and its impact on marine mammals, fish and invertebrates and is intended to provide an overview of the current knowledge on underwater noise in the Arctic. Key findings included: 1) ambient sound levels in the Arctic Ocean are generally less than in other oceans, 2) the most common sound sources in the Arctic is from vessel traffic and oil and gas development. The latter is variable by season and region but not increasing over time, while the former has been increasing over time, 3) bowhead whales have been the main focus of studies on impacts of underwater noise on marine mammals, 4) bowhead whales generally avoid noise from seismic air guns and other sounds associated with oil and gas activities, 5) belugas and narwhals respond to noise generated by ice breakers, 6) ringed seals apparently are more tolerant of underwater noise than are cetaceans, and 7) many knowledge gaps exist by geographic region and by species. The chapter on marine mammals was

found on pages 31- 40. Polar bear response to underwater noise was not included in the review. Further no attempt was made to assess cumulative impacts of underwater noise on marine mammals in this report. Finally, gaps in knowledge were reported in Table 4. As would be expected for a report of this nature, the reference section is extensive.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Errata: Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals*, 45:569-572.
The following errata *inter alia* were reported: 1) On page 131, Kastelein (2013) was incorrectly identified as a new study of TTS from impulsive noise when it should have been listed as a new study of TTS from non-impulsive noise in the preceding paragraph, 2) There is a typographical error in Table 5 on page 149. What is indicated as parameter "B" should be parameter "b," which is consistent with "b" in Eq.(2) W(f) on page 146, 3) There are four typographical errors in Table 7 on page 156, 4) For PCA, the value in column "TTS onset: Peak SPL" should be 155 (rather than 138) and the value in column "PTS onset: Peak SPL" should be 161 (rather than 144), 5) For OCA the value in column "TTS onset: Peak SPL" should be 170 (rather than 161) and the value in column "PTS onset: Peak SPL" should be 176 (rather than 167), and 7) Data for the blue whale (*Balaenoptera musculus*) was inadvertently omitted from Appendix 1, Table 1 during publication. The corrected table for "Low-Frequency Cetaceans" is provided herein with the blue whale data included. All the references associated with the blue whale that are referred to in this table were provided within the appendix as it was published.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. *Aquatic Mammals*, 45:125-232.
This article evaluates Southall et al. (2007) in light of subsequent findings and proposes revised noise exposure criteria to predict the onset of auditory effects in marine mammals. Estimated audiograms, weighting functions, and underwater noise exposure criteria for TTS and PTS are reported for all marine mammal species, as well as other marine species. In-air criteria are also reported for amphibious species. For continuous noise sources, exposure criteria are given in frequency-weighted SELs. SEL and SPL criteria are reported for impulse noise. The authors noted that these criteria should be considered with regard to relevant caveats, recommended research, and with the expectation of subsequent revision. Further, eight discrete hearing groups of marine mammals were identified: 1) low-frequency cetaceans, 2) high-frequency cetaceans, 3) very high-frequency cetaceans, 4) sirenians, 5) phocid carnivores in water, 6) phocid carnivores in air, 7) other marine carnivores in water, and 8) other marine carnivores in air (see Table 1). Parameters for estimated audiograms are reported for each group (Table 2). TTS and PTS onset thresholds are also reported for each group for non-impulsive (Table 6) and impulsive (Table 7) noise. An extensive list of research needs that address specific information gaps are presented, along with a comprehensive update of literature cited since Southall et al. (2007).

Delean, B.J., Helker, V.T., Muto, M.M., Savage, K., Teerlink, S., Jemison, L.A., Wilkinson, K., Jannot, J. and Young, N.C. (2020). Human-Caused Mortality and Injury of NMFS-Managed Alaska Marine Mammal Stocks 2013-2017. National Marine Fisheries Service. NOAA Technical Memorandum. NMFS-AFC-401, January 2020. 86 pp.
The authors of this Technical Report provided a summary of data from documented interactions between human activities and pinnipeds or cetaceans belonging to stocks which appear in the Alaska Marine Mammal Stock Assessment Reports for the 5-year period from 2013 through 2017. A total of 922 unique interactions with evidence of human-caused mortality or injury are summarized in this report. The authors noted that the interactions summarized in this report represent a minimum number for the

Alaska region. Data for this report were primarily derived from records from the NMFS Alaska Regional Office Stranding Network, the NMFS West Coast Regional Office Stranding Network, NMFS fishery observer programs in the west coast and Alaska, the NMFS Marine Mammal Authorization Program, the NMFS Office of Protected Resources, and the ADFG. The protocol for categorizing marine mammal interactions with humans is detailed herein. 791 of the 922 interactions were categorized as either mortality, serious injury, removal from the population or were prorated to reflect the likelihood of serious injury. Cause of death from entanglement or entrapment was most common(n=589). The majority of deaths from this source were from fishing gear (n=295) and marine debris (n=182). Results are summarized by taxa: pinnipeds (note-there are a few records for ice seals), large cetaceans, and small cetaceans (note – there are a few records for beluga). Cases of human-caused mortality for sea otters or polar bears were not included in this report. Individual case reports are provided in the appendix. No records are included in this report regarding subsistence hunting.

Frankel, A.S. and Stein, P.J. (2020). Gray whales hear and respond to signals from a 21-25 kHz active sonar. *Marine Mammal Science*, 2020:1-15.

The introduction to the paper provides an excellent summary of playback and hearing experiments on gray whales to date. The methodology was based on the tracking of southbound migrating gray whales from 2 land-based tracking stations. Theodolites were used to track and record movements. The sonar array was deployed from a research vessel that was moored during experimental periods. Received sound levels were measured from a portable recording system deployed from a small inflatable boat. The sonar had a maximum source level of 215 dB re 1 µPa m, where the frequency ranged from 21-25 kHz. Change in behavior was measured as a function of swimming speed and relative orientation, as well as distance offshore. 532 whale groups were tracked over 119.7 hours of observation. One key finding was that migrating gray whales moved inshore during periods of sonar transmission relative to control periods. In addition, the authors noted a slight, but significant decrease in swimming speed when the sonar was broadcasting relative to the control. Regarding orientation, whales avoided the source vessel during periods of transmission. The significance of these results is that gray whales respond to sonar signals between 21-25 kHz at a received level of approximately 148 dB re 1 µPa2. It should also be noted that there were no overt or obvious responses to the sonar signals. Finally, the experimental design used in this study provided for robust statistical power and should be considered in the design of future behavioral studies related to large whale response to anthropogenic noise.

Halliday, W.D., Pine, M.K. and Insley, S.J. (2020). Underwater noise and Arctic marine mammals: review and policy recommendations. *Environmental Reviews*, 11:44 pp.

The authors reviewed available literature regarding ambient noise in the Arctic, as well as the reactions of Arctic and sub-Arctic marine mammals to anthropogenic sound. The authors noted that loss of sea ice has led to increased human activity levels in the Arctic and expressed concern over the potential adverse impact of anthropogenic sound on marine mammal populations mediated through masking of underwater communication. Finally, the authors further expressed concern regarding the adequacies of existing regulations and policies and questioned whether Arctic-specific policies are needed.

McGuire, T.L., Stephens, A.D., McClung, J.R., Garner, C.D., Shelden, K.E.W., Boor, G.K.H. and Wright, B. (2020). Reproductive natural history of endangered Cook Inlet Beluga whales: insights from a long-term photo-identification study. *Polar Biology*, 43:1857-1871.

Beluga whales (*Delphinapterus leucas*) occur broadly throughout the polar and subpolar regions of the Northern Hemisphere, and as a whole, the species is of low conservation concern. However, some populations, including Alaska's Cook Inlet beluga whales are in decline for reasons that remain poorly understood. Currently, information on population-specific reproductive parameters of Cook Inlet beluga

whales is non-existent. To address this data gap, the authors examined long-term photo-identification data of Cook Inlet beluga whales for insight into the reproductive natural history of this endangered subarctic population. Data are from 438 photo-ID surveys conducted 2005–2017 and over 400 identified individuals, augmented with data from strandings, biopsies, and tagging. During the April–October ice-free field season, we observed neonates July–October but never April-June. The authors photo-documented three suspected births during July–September. Neonates were present in 30% of groups and encountered and comprised 2% of all belugas observed. Over the course of the 13-year study, the number of calves seen with an individual mother ranged from 1 to 5, with inter-birth intervals ranging from 2 to 13 years. This corresponds to rates of 0.08–0.38 calves per year per mother. Known-aged mothers ranged in age from 13 to 31 years. Skin color was not a reliable indicator of sexual maturity. Calves photographed alongside their mothers were estimated to be 1–8 years old, although most were 1–4 years old. Some mothers (6%) were accompanied by a neonate and an older calf. These summaries of observational data provide critical insight into Cook Inlet beluga whale reproductive natural history that will inform future population modeling and management decision-making.

Reichmuth, C., Sills, J.M., Brewer, A., Triggs, L., Ferguson, R., Ashe, E. and Williams, R. (2020). Behavioral assessment of in-air hearing range for the Pacific walrus (*Odobenus rosmarus divergens*). *Polar Biology*, 43:767-772.

The authors present information on in-air hearing of walrus, using two trained walruses at zoological facilities. Their results confirmed an audible range of hearing extending from 60 Hz to 23 kHz in air. Hearing range in water is expected to be similar or broader at high frequencies. This study provided evidence that hearing in walruses is different from that of other marine carnivores, including seals, sea lions, and sea otters, and better than suggested by early reports for the species. The authors recommended additional research including: 1) underwater audiograms of walrus, 2) in air or underwater studies on walrus hearing in the presence of noise masking, and 3) a comprehensive risk assessment should be made to evaluate the potential for impacts of anthropogenic noise on the conservation status of this species.

USGS (2020). Analyses on Subpopulation Abundance and Annual Number of Maternal Dens for the U.S. Fish and Wildlife Service on Polar Bears (*Ursus maritimus*) in the Southern Beaufort Sea, Alaska. 24 pp.

This report reported on the results of an acoustic modelling study that estimates the received sound levels at locations in the water column near a towed seismic airgun array during a typical soft-start procedure in which the number and total volume of the airguns in the source array increase over time. The soft-start approach is a mitigation measure for reducing the risk that marine mammals near an airgun array are exposed to harmful sound levels as the seismic source starts to operate. The underlying assumption is that an animal will take evasive action and establish a safe distance between itself and the source when exposed to lower sound levels during the initial phases of the soft-start sequence. A modelling study was performed to quantify the received sound levels from a representative soft-start sequence, in both a shallow 50 m water depth scenario and a deep 2000 m water depth scenario, and to evaluate those sound levels in the context of current knowledge about injury thresholds. The authors described in detail the two models used to perform this analysis. The following injury criteria were used: 1) SEL: 198 dB re 1 µPa2-s (M-weighted) for cetaceans and 186 dB re 1 µPa2-s (M- weighted) for pinnipeds, and 2) Peak SPL 230 dB re 1 µPa (flat-weighted) for cetaceans and 218 dB re 1 µPa (flat-weighted) for pinnipeds. The more conservative approach was used for any given situation. The results included: 1) SEL levels were higher in shallow water than at the corresponding locations from the deep site, 2) In terms of the SEL metric, the estimated SEL_{cum} level for an animal located just 100 m to the side of the source line at the midpoint of Step 1 of the soft-start in deep water was 22 dB below the Southall et al. (2007) criterion for cetaceans and 10 dB below the criterion for pinnipeds, 3) in a deep-water

environment a marine mammal in the immediate vicinity of the airgun array in the first three steps of soft-start is unlikely to suffer from auditory injury according to the Southall criteria unless the animal passes within 100 m of the source line as the seismic array passes, and 4) the cumulative SEL level 100 m off the mid-point of Step 1 of soft start reaches 182 dB re 1 µPa2-s which is 17 dB below the PTS onset criterion threshold for cetaceans and 4 dB below the threshold for pinnipeds. Further, for an animal that remains fixed at 100 m to the side of the source line at the mid-point of Step 3 of soft-start the maximum cumulative SEL is predicted to reach 185 dB 1 1 µPa2-s which is still 1 dB below the criterion threshold for PTS onset. The authors inclusion of a considerable number of figures greatly improves the readability of this technical document.

Willoughby, A.L., Ferguson, M.C., Stimmelmayr, R., Clarke, J.T. and Brower, A.A. (2020). Bowhead whale (*Balaena mysticetus*) and killer whale (*Orcinus orca*) co-occurrence in the U.S. Pacific Arctic, 2009–2018: evidence from bowhead whale carcasses. *Polar Biology*, 43:1667-1679.
Imagery and sighting data on bowhead whale (*Balaena mysticetus*) carcasses documented from 2009 to 2018 during aerial surveys in the eastern Chukchi and western Beaufort seas have provided evidence for killer whale (*Orcinus orca*) predation on bowhead whales of the Bering–Chukchi–Beaufort Seas stock. The ASAMM project provides information on distribution, behavior, and relative density of marine mammals. ASAMM surveys large areas of bowhead whale and killer whale summer and autumn habitat and offers consistent information on bowhead whale carcasses. Thirty-three bowhead whale carcasses were documented in July–October, from 2009 to 2018. Carcasses were distributed across the eastern Chukchi and western Beaufort seas from 141.6° W to 168.1° W and 68.9° N to 72.0° N. Carcass sighting rates (carcasses/1000 km) varied by month, year, and region. Statistical results suggest an alternating series of high and low annual carcass sighting rates. Eighteen bowhead whale carcasses having injuries consistent with probable killer whale predation were photo-documented: four each in 2016 and 2018, three each in 2013 and 2015, two in 2012, and one each in 2010 and 2017. Four carcasses, two in 2015 and one each in 2013 and 2018, were likely whales struck and lost during aboriginal subsistence hunting. Cause of death could not be determined for 11 carcasses. This study is the first systematic inquiry into non-harvest related mortality of bowhead whales in the U.S. Pacific Arctic and provides multi-year evidence for killer whale predation on bowhead whales in this portion of their range.

Bin 8 - Oil Spill incidents, Preparation, and Response

Wright, S.K., Wilkin, S.M., Jensen, A.S., Rowles, T.K., Dushane, J. and Ziccardi, M. (2017). Arctic marine mammal disaster response guidelines: National Marine Fisheries Service guidance report. U.S. Dept. of Commerce. NOAA Technical Memorandum. NMFS F/AKR; 16, Juneau, Alaska. 84 pp.
The Alaska coastline and offshore areas provide seasonal feeding, breeding, and migratory habitat for large numbers of marine mammals; these species include important subsistence resources for Alaska Native communities. These Arctic Marine Mammal Disaster Response Guidelines were developed pursuant to statutory obligations under the Oil Pollution Act of 1990, and other regulatory obligations under the National Contingency Plan. The guidelines provide regionally-specific communication and response strategies within a flexible and practicable framework to accommodate the myriad scenarios that may be encountered during a disaster response in Arctic Alaska. Additionally, data collection protocols were developed to assist with the national Resource Damage Assessment process. The development of the guidelines was informed through meetings with leadership organizations from Alaskan coastal communities of the Bering Strait Region, Northwest Arctic Borough, and the North Slope Borough. Additionally, NMFS incorporated information from co-management partners, AK Stranding Network members, state and federal agencies, oil spill response organizations, and other stakeholders.

ABSG Consulting Inc. (2018). BOEM OCS Spill Statistics Report FINAL BOEM-2018-006. U.S. Dept. of Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2018-006, March 2018. 44 pp.
This report narrows the focus of fault tree analyses to petroleum spills of 50 bbls or more, which typically have more documentation, allowing for more detailed review of the causes of oil spills. This additional information enables the users to break down the overall spill frequency into component estimates, split by causal factor category.

ABSG Consulting Inc. (2018). Oil Spill Occurrence Estimators- Fault Tree Analysis for One or More Potential Future Beaufort Sea OCS Lease Sales. OCS Study BOEM 2018-048. U.S. Dept. of Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2018-048, Arlington, VA. August 2018. 85 pp.
Objective of this study was to develop oil spill occurrence estimators for Beaufort Sea OCS lease sales using fault tree methodology. A fault tree is a graphical model which shows the various combinations of equipment failures and human errors that can lead to a particular event (e.g. a pipeline spill, platform spill, or loss well control). Oils spill frequency per 1000 years and billion barrels produced, and an oil spill index were considered. Section 2 provides historical oil spill data from 1964 to 2018. Section 4 provides an overview of the exploration and development scenario for the OCS in the US waters of the Beaufort Sea. Graphics in Section 6 illustrate predicted spill frequency as a function of time, and per barrels produced.

BOEM (2019). USDOI, BOEM Oil Spill Preparedness, Prevention, and Response on the Alaska OCS. OCS Report BOEM 2019-006. U.S. Dept. of Interior, Bureau of Ocean Energy Management. Alaska OCS Region. BOEM 2019-0006, Anchorage, AK. April 2019. 41 pp.
The purpose of this document is to help readers understand oil spill preparedness, prevention, and response on the Alaska OCS. The report summarizes federal authorities and describes the National Response System, National and Local Contingency Plans, the Regional Response Teams and BOEM and BSEE authority. The report has excellent graphics. Section 6 describes industry oil spill response planning and research, including descriptions of oil spill removal organizations such as Alaska Clean Seas and Cook Inlet Spill Prevention and Response, Inc. Potential spill counter measures are described. The report has excellent graphics and is a good source of basic response planning.

Robertson, T. and Campbell, L.K. (2020). Oil Spill Occurrence Rates for Cook Inlet, Alaska Oil and Gas Exploration, Development, and Production. US Dept. of the Interior, Bureau of Ocean Energy Management. Region, A.O. BOEM 2020-51, Plymouth, MA. October 2020. 78 pp.
This report documents statistical methods to estimate oil spill occurrence based on past onshore and offshore spills in the Cook Inlet region. This information is useful for future assessment of potential oil and gas leasing, exploration or production in the OCS. A dataset of 292 spills was compiled covering 1966–2019. Spills were included in the dataset if they were larger than one barrel and could be associated with Cook Inlet oil and gas exploration, development, or production. Spills were consolidated into four types: crude oil, diesel, other refined products, and natural gas liquids. The model indicated that for every increase of one million barrels of crude oil production, the number of annual spills is expected to increase 0.36 units (number of spills) for all spill types and classes. This model explains 23% of the variation observed in the annual number of spills. The model's calculated multivariate power was 0.7199. The power is adequate but not exceptional. This is attributed to the relatively small sample size.

Robertson, T. and Campbell, L.K. (2020). Oil Spill Occurrence Rates from Alaska North Slope Oil and Gas Exploration, Development, and Production. U.S. Dept. of the Interior, Bureau of Ocean Energy Management. Alaska Region. BOEM 2020-050, Anchorage, AK. October 2020. 72 pp.
This report documents statistical methods to estimate oil spill occurrence based on past onshore and offshore spills in the North Slope region. This information is useful for future assessment of potential oil and gas leasing, exploration or production in the OCS. A dataset of 1,761 spills was compiled from a range of sources of available records covering calendar years 1971 through 2019. Spills were included in the dataset if they were larger than 1 barrel and could be associated with Alaska North Slope oil and gas exploration, development, or production. TAPS from pump station #1 downstream was not included. The model indicated that for every increase of one million barrels of oil production, the number of annual spills is expected to increase 0.12 units for all spill types and classes. This model explains 53% of the variation observed in the annual number of spills. The model's calculated multivariate power was 0.9983. The power is exceptionally good.

Appendix A
Checklists of Literature by Bin

The following checklists are provided for each topic bin as a qualitative representation of the number of information sources that discuss specific topics listed across the top of the checklist. Checklists are organized chronologically and include the author, year and title.

Bin 1. Endangered Species Act Section 7 Consultation, Biological Opinions and Letters of Concurrence

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whale	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2002	NMFS	Biological Opinion: BPXA Construction and Operation of the Liberty Oil Production Island, Beaufort Sea, Alaska	1					1	1	1	1	1	1					1	1	1		1				1	1	1																					1
2003	NMFS	Biological Opinion: MMS Lease Sales 191 and 199 Oil and Gas Exploration Activities, Cook Inlet, Alaska			1			1			1	1	1					1	1	1		1				1	1	1			1				1											1			
2003	USFWS	Biological Opinion: Steller's Eiders from Fairweather Geophysical/Veritas DGC 3D Seismic in Lower Cook Inlet, Alaska			1																																												
2006	NMFS	Biological Opinion: MMS Oil and Gas Leasing and Exploration 2006 - 2013 in Beaufort and Chukchi Seas, Alaska	1	1				1	1		1	1	1					1	1	1		1			1	1	1	1		1																			
2008	MMS	Supplement to the 2006 Biological Evaluation for MMS Oil and Gas Lease Sales in the Chukchi and Beaufort Seas on Bowhead, Fin and Humpback Whales	1	1							1	1	1					1	1	1		1			1	1	1			1	1				1														
2008	NMFS	Biological Opinion: MMS Oil and Gas Leasing and Exploration 2006 - 2013 in Beaufort and Chukchi Seas, Alaska	1	1				1	1		1	1	1					1	1	1		1			1	1	1	1		1	1				1														
2008	USFWS	73 FR 76249 Special Final Rule to Protect Polar Bears Under ESA Section 4(d)	1	1																					1	1	1																				1		
2009	USFWS	Amended Biological Opinion: BPXA Northstar and Liberty Projects	1					1			1	1	1						1	1		1			1	1	1	1																			1		
2009	USFWS	Biological Opinion: MMS Oil and Gas Lease Sales 186, 195, 202 and 193 in the Chukchi and Beaufort Seas	1	1				1	1	1	1	1	1	1				1	1	1		1			1	1	1	1																			1		
2010	NMFS	Biological Opinion: IHAs 2010 Shell and Statoil Oil and Gas Exploration Activities in Beaufort and Chukchi Seas, Alaska	1	1				1	1			1	1	1				1	1	1		1			1	1	1			1	1				1														
2011	BOEMRE	Biological Evaluation: Impacts of Oil and Gas Activities on the Beaufort and Chukchi Sea Planning Areas on Polar Bear and Polar Bear Critical Habitat, Steller's Eider, Spectacled Eider and Spectacled Eider Critical Habitat, Kittlitz's Murrelet, and Yellow-billed Loon	1	1				1	1		1		1	1				1	1	1		1			1	1	1	1																			1		
2011	NMFS	Biological Opinion: IHA ConocoPhillips and Statoil 2011 Shallow Hazards Survey in Chukchi Sea, Alaska		1				1	1		1			1	1			1	1	1		1			1	1	1	1		1	1				1														
2011	USFWS	Programmatic Biological Opinion: Issuance of Incidental Take Regulations 2016-2020 on Behalf of AOGA for Polar Bears and Pacific Walrus in the Beaufort Sea, Alaska	1					1			1		1					1	1	1		1	1		1	1	1	1														1					1		
2011	USFWS	Biological Opinion & Conference Opinion: BOEMRE Permitting for Northstar Operations Polar Bear Critical Habitat and Pacific Walrus in Beaufort Sea, Alaska	1					1					1					1	1	1		1	1		1	1	1	1														1					1		
2012	NMFS	Biological Opinion: BPXA Northstar Development Marine Mammal Protection Act Authorization 2012-2016, Beaufort Sea, Alaska	1					1	1		1	1	1					1	1	1		1			1	1	1	1		1									1					1					
2012	NMFS	Biological Opinion: IHA Shell Offshore, Inc. 2012 Exploratory Drilling in Chukchi Sea, Alaska		1				1			1	1	1					1	1	1		1			1	1	1	1		1	1								1					1					
2012	NMFS	Biological Opinion: IHA and Geological and Geophysical Permit to ION for 2012 2D Seismic Surveys in Chukchi and Beaufort Seas, Alaska	1	1							1			1				1	1	1		1			1	1	1	1		1					1				1					1					
2012	NMFS	Biological Opinion: IHA BP Offshore, Inc. 2012 Seismic Surveys in Simpson Lagoon, Beaufort Sea, Alaska	1					1			1			1				1	1	1		1			1	1	1	1		1					1				1					1					
2012	NMFS	Biological Opinion: IHA Shell Offshore, Inc. 2012 Exploratory Drilling in Beaufort Sea, Alaska	1					1			1	1	1	1				1	1	1		1			1	1	1	1		1									1					1					
2012	NMFS	Revised Biological Opinion: Apache 3D Seismic Surveys in Cook Inlet, Alaska			1			1			1							1	1	1		1				1	1	1	1																	1			
2012	NMFS	Biological Opinion: Apache 3D Seismic Surveys in Cook Inlet, Alaska			1			1			1							1	1	1		1				1	1	1	1																	1			

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			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whale	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2012	USFWS	Biological Opinion & Conference Opinion: OCS Planning Areas Beaufort & Chukchi	1	1				1			1	1	1	1				1	1	1		1	1		1	1	1	1																			1		
2012	USFWS	Biological Opinion: ExxonMobil Point Thomson Development Beaufort Sea, Alaska	1					1			1	1	1							1		1	1		1	1	1	1																			1		
2012	USFWS	Biological Opinion: LOAs Shell 2012 Exploration Activities in Chukchi Sea, Alaska		1				1			1									1	1	1			1		1															1					1		
2012	USFWS	Revised Biological Opinion & Conference: OCS Planning Areas Beaufort & Chukchi	1	1				1			1		1								1	1					1	1																			1		
2013	NMFS	Biological Opinion: BOEM and BSEE Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska	1	1				1			1	1	1	1				1	1	1	1	1	1	1	1		1	1		1	1				1			1	1					1		1			
2013	NMFS	Biological Opinion: Re-initiation of Section 7 Consultation Apache 3D Seismic Surveys of Cook Inlet, Alaska			1			1			1			1				1	1	1		1				1	1	1	1																	1			
2013	NMFS	Biological Opinion: IHA SAExploration, Inc. 2013 Marine 3D Ocean Bottom Cable Seismic Activities in Beaufort Sea, Alaska	1								1			1				1	1	1	1	1		1	1	1	1	1		1					1			1	1					1		1			
2013	NMFS	Biological Opinion: IHA 2013 Shell Geophysical Surveys, and Equipment Recovery and Maintenance Activities in Chukchi Sea, Alaska		1				1			1			1				1	1	1	1	1		1	1	1	1	1		1	1				1			1	1					1		1			
2013	NMFS	Biological Opinion: IHA TGS-NOPEC ASA (TGS) 2013 Marine 2D Seismic in Federal and International Waters, Chukchi Sea, Alaska		1			1	1			1							1	1	1	1	1		1	1	1	1	1		1	1				1			1	1					1		1			
2013	USFWS	Biological Opinion & Conference Opinion: Polar Bears & Walrus Chukchi Sea Rule and LOAs in Chukchi Seas, Alaska		1				1			1	1	1					1	1	1		1	1	1	1	1	1	1														1					1		
2013	USFWS	Biological Opinion: Pioneer Oooguruk Development 2014-2015 Modifications	1					1			1	1	1							1		1			1	1	1	1																			1		
2013	USFWS	78 FR 11766 Special Final Rule to Protect Polar Bears Under ESA Section 4(d)	1	1			1																				1																				1		
2014	NMFS	Biological Opinion: IHA BPXA Shallow Geohazard Survey in Foggy Island Bay, Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1	1		1									1					1					
2014	NMFS	Biological Opinion: IHA SAExploration2014 Marine 3D Ocean Bottom Node Seismic in Colville River Delta, Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1	1		1									1					1					
2014	NMFS	Biological Opinion: IHA BPXA 2014 Marine 3D Ocean Bottom Sensor Seismic in Prudhoe Bay, Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1	1		1									1					1					
2014	USFWS	Biological Opinion: Polar Bear and Pacific Walrus Deterrence Program	1	1							1							1		1		1				1	1																				1		
2015	AKLNG	Biological Assessment: 2015 Geophysical & Geotechnical Program in The Waters of Cook Inlet			1						1			1				1		1		1			1	1	1	1	1																	1			
2015	BOEM	Biological Assessment: BOEM Oil and Gas Activities Associated with Lease Sale 193		1							1		1	1				1	1	1		1	1		1	1	1	1																			1		
2015	NMFS	Biological Opinion: BOEM and BSEE Lease Sale 193 Oil and Gas Exploration Activities in Chukchi Sea, Alaska		1							1		1	1				1	1	1	1	1			1	1	1	1		1	1		1		1			1	1					1		1			
2015	NMFS	Biological Opinion: Proposed IHA Hilcorp Shallow Geohazard and Strudel Scour Surveys in Foggy Island Bay, Beaufort Sea, Alaska	1								1			1				1	1	1		1		1	1	1	1	1		1									1					1					
2015	NMFS	Biological Opinion: IHA SAExploration, Inc. 2015 3D Seismic in Beaufort Sea, Alaska	1								1			1				1	1	1		1		1	1	1	1	1		1									1					1					
2015	NMFS	Biological Opinion: IHA Shell 2015 Exploration Drilling Activities in Chukchi Sea, Alaska		1							1		1	1				1	1	1	1	1		1	1	1	1			1	1		1		1			1	1					1					

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			Region					Baseline		Acoustics																	Cetaceans										Pinnipeds											
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whale	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Califoma Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2015	NMFS	Biological Opinion: IHA Shell Aviation Operations Associated with Ice Condition Monitoring May 2015 - April 2016 Over the Beaufort and Chukchi Seas, Alaska	1	1							1											1			1	1	1										1					1					
2015	NMFS	Biological Opinion: IHA 2012 Shell Exploration Activities in Chukchi Sea, Alaska		1							1		1	1				1	1	1	1	1			1	1	1	1		1	1		1		1		1					1		1			
2015	USFWS	Biological Opinion: BOEM and BSEE Oil and Gas Activities Associated with Lease Sale 193		1							1		1	1				1	1	1		1	1	1	1	1	1	1													1					1		
2015	USFWS	Biological Opinion: Alaska State Preparedness Plan for Response to Oil and Hazardous Substance Discharges (referred to as the Unified Plan)						1			1									1		1					1	1														1				1	1	
2015	USFWS	Letter of Concurrence: Northern Sea Otters for Shell Offshore Support Vessels Dutch Harbor to Chukchi Sea, Alaska		1		1														1	1	1																							1	
2016	NMFS	Biological Opinion: IHA 2016 Fairweather Anchor Retrieval Activities in Chukchi and Beaufort Seas, Alaska	1	1															1	1	1	1					1			1	1				1			1	1						1			
2016	USFWS	Biological Opinion: 2016-2021 Polar Bear and Pacific Walrus Incidental Take Regulations Beaufort Sea, Alaska	1								1	1	1	1				1	1	1		1	1		1	1	1	1													1					1		
2017	Hilcorp	Biological Assessment and Request for Emergency ESA Consultation: Hilcorp Middle Ground Shoals Platform A Gasline Repairs, Cook Inlet, Alaska			1						1				1					1		1	1	1			1		1		1				1										1			
2017	NMFS	Biological Opinion: Furie's 2017-2021 Offshore Oil and Gas Exploration Drilling in the Kitchen Lights Unit of Cook Inlet, Alaska			1						1		1	1			1	1	1	1		1			1	1	1	1	1		1				1										1			
2017	NMFS	Letter of Concurrence: Emergency Consultation Hilcorp Middle Ground Shoals Platform A Gasline Repairs in Cook Inlet, Alaska			1						1				1							1					1		1		1				1										1			
2017	NMFS	Biological Opinion: BOEM and BSEE 2017-2022 Oil and Gas Lease Sale 244 in Cook Inlet, Alaska			1						1	1	1	1			1	1	1	1		1					1	1	1		1				1										1			
2017	USFWS	Biological Opinion: Proposed Oil and Gas Lease Sale 244 in Cook Inlet, Alaska			1						1	1	1	1				1	1	1		1			1	1	1	1																		1	
2018	NMFS	Biological Opinion: Issuance of U.S. Army Corps of Engineers Permit and IIHA for Harvest Cook Inlet Pipeline Cross-Inlet Extension Project			1						1	1	1	1				1		1		1		1	1	1	1	1	1						1										1			
2018	NMFS	Biological Opinion: Proposed IHA Office of Naval Research (ONR) Arctic Research Activities 2018-2021 in Beaufort Sea, Alaska	1								1								1	1		1			1	1	1			1	1			1			1	1					1		1			
2018	NMFS	Letter of Concurrence: Hilcorp 2018-2028 Simpson Lagoon Dredging and Screeding in Beaufort Sea, Alaska	1									1								1							1			1				1				1					1					
2018	NMFS	Biological Assessment: Terrestrial ESA-Listed Species: Oil Search Alaska (OSA) Nanushuk Project in North Slope, Alaska	1								1	1	1					1	1	1		1			1	1	1	1		1								1					1					
2018	NMFS	Letter of Concurrence: Ringed Seals for Eni Oliktok Production Pad and Spy Island Drillsite Ice Road Activities, Beaufort Sea, Alaska	1																			1					1																	1					
2018	United States Court of Appeals	Ringed Seal ESA Listing Opinion	1	1			1																1		1	1																	1					
2019	NMFS	Letter of Concurrence: Oil Search Alaska (OSA) Nanushuk Oliktok Dock Screeding and Module Offloading, Oliktok Point, Beaufort Sea, Alaska	1									1								1	1	1					1			1	1		1		1			1	1					1		1			
2019	NMFS	Biological Opinion: BOEM, BSEE, EPA, and USACE Authorizations for Hilcorp Liberty Oil and Gas Development and Production Activities in Beaufort Sea, Alaska	1								1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1		1	1				1			1	1					1		1			

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			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whale	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2019	NMFS	Biological Opinion: Final Rule, Hilcorp Alaska and Harvest Alaska Oil and Gas Activities, Cook Inlet Alaska			1						1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1		1				1											1			
2019	NMFS	Biological Opinion: BLM Oil and Gas Lead Sale Arctic National Wildlife Refuge Coastal Plain Beaufort Sea Coast, Alaska	1								1	1		1				1	1	1	1	1			1	1	1	1		1	1				1			1	1					1		1			
2019	NMFS	Revised Biological Opinion: Proposed IHA Office of Naval Research (ONR) Arctic Research Activities 2018-2021 in Beaufort Sea, Alaska	1													1			1	1	1	1			1	1	1	1		1	1				1			1	1					1		1			
2020	NMFS	Biological Opinion: Proposed Rule and LOAs to Hilcorp Alaska, LLC and Eni U.S. Operating Co. Inc. for 2020 to 2025 Ice Road and Trail Activities on the North Slope, Beaufort Sea, Alaska	1																			1	1		1	1	1			1				1					1					1					
		Totals	**41**	**28**	**13**	**1**	**3**	**28**	**8**	**2**	**54**	**26**	**33**	**31**	**3**	**1**	**4**	**46**	**47**	**58**	**15**	**62**	**14**	**13**	**49**	**53**	**64**	**48**	**10**	**31**	**23**	**0**	**4**	**2**	**26**	**0**	**0**	**13**	**27**	**0**	**0**	**7**	**0**	**28**	**0**	**23**	**18**	**3**	**1**

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2002	NMFS	Biological Opinion: BPXA Construction and Operation of the Liberty Oil Production Island, Beaufort Sea, Alaska	1					1	1	1	1	1	1					1	1	1		1				1	1	1																					1
2003	NMFS	Biological Opinion: MMS Lease Sales 191 and 199 Oil and Gas Exploration Activities, Cook Inlet, Alaska			1			1			1	1	1					1	1	1		1				1	1	1			1				1											1			
2003	USFWS	Biological Opinion: Steller's Eiders from Fairweather Geophysical/Veritas DGC 3D Seismic in Lower Cook Inlet, Alaska			1																																												
2006	NMFS	Biological Opinion: MMS Oil and Gas Leasing and Exploration 2006 - 2013 in Beaufort and Chukchi Seas, Alaska	1	1				1	1		1	1	1					1	1	1		1			1	1	1	1		1																			
2008	MMS	Supplement to the 2006 Biological Evaluation for MMS Oil and Gas Lease Sales in the Chukchi and Beaufort Seas on Bowhead, Fin and Humpback Whales	1	1							1	1	1					1	1	1		1			1	1	1			1	1				1														
2008	NMFS	Biological Opinion: MMS Oil and Gas Leasing and Exploration 2006 - 2013 in Beaufort and Chukchi Seas, Alaska	1	1				1	1		1	1	1					1	1	1		1			1	1	1	1		1	1				1														
2008	USFWS	73 FR 76249 Special Final Rule to Protect Polar Bears Under ESA Section 4(d)	1	1																					1	1	1																				1		
2009	USFWS	Amended Biological Opinion: BPXA Northstar and Liberty Projects	1					1			1	1	1						1	1		1			1	1	1	1																			1		
2009	USFWS	Biological Opinion: MMS Oil and Gas Lease Sales 186, 195, 202 and 193 in the Chukchi and Beaufort Seas	1	1				1	1	1	1	1	1	1				1	1	1		1			1	1	1	1																			1		
2010	NMFS	Biological Opinion: IHAs 2010 Shell and Statoil Oil and Gas Exploration Activities in Beaufort and Chukchi Seas, Alaska	1	1				1	1			1	1	1				1	1	1		1			1	1	1			1	1				1														
2011	BOEMRE	Biological Evaluation: Impacts of Oil and Gas Activities on the Beaufort and Chukchi Sea Planning Areas on Polar Bear and Polar Bear Critical Habitat, Steller's Eider, Spectacled Eider and Spectacled Eider Critical Habitat, Kittlitz's Murrelet, and Yellow-billed Loon	1	1				1	1		1		1	1				1	1	1		1			1	1	1	1																			1		
2011	NMFS	Biological Opinion: IHA ConocoPhillips and Statoil 2011 Shallow Hazards Survey in Chukchi Sea, Alaska		1				1	1		1			1	1			1	1	1		1			1	1	1	1		1	1				1														
2011	USFWS	Programmatic Biological Opinion: Issuance of Incidental Take Regulations 2016-2020 on Behalf of AOGA for Polar Bears and Pacific Walrus in the Beaufort Sea, Alaska	1					1			1		1					1	1	1		1	1		1	1	1	1														1					1		
2011	USFWS	Biological Opinion & Conference Opinion: BOEMRE Permitting for Northstar Operations Polar Bear Critical Habitat and Pacific Walrus in Beaufort Sea, Alaska	1					1					1					1	1	1		1	1		1	1	1	1														1					1		
2012	NMFS	Biological Opinion: BPXA Northstar Development Marine Mammal Protection Act Authorization 2012-2016, Beaufort Sea, Alaska	1					1	1		1	1	1					1	1	1		1			1	1	1	1		1									1					1					
2012	NMFS	Biological Opinion: IHA Shell Offshore, Inc. 2012 Exploratory Drilling in Chukchi Sea, Alaska		1				1			1	1	1					1	1	1		1			1	1	1	1		1	1								1					1					
2012	NMFS	Biological Opinion: IHA and Geological and Geophysical Permit to ION for 2012 2D Seismic Surveys in Chukchi and Beaufort Seas, Alaska	1	1							1			1				1	1	1		1			1	1	1	1		1					1				1					1					
2012	NMFS	Biological Opinion: IHA BP Offshore, Inc. 2012 Seismic Surveys in Simpson Lagoon, Beaufort Sea, Alaska	1					1			1			1				1	1	1		1			1	1	1	1		1					1				1					1					
2012	NMFS	Biological Opinion: IHA Shell Offshore, Inc. 2012 Exploratory Drilling in Beaufort Sea, Alaska	1					1			1	1	1	1				1	1	1		1			1	1	1	1		1									1					1					
2012	NMFS	Revised Biological Opinion: Apache 3D Seismic Surveys in Cook Inlet, Alaska			1			1			1							1	1	1		1				1	1	1	1																	1			
2012	NMFS	Biological Opinion: Apache 3D Seismic Surveys in Cook Inlet, Alaska			1			1			1							1	1	1		1				1	1	1	1																	1			

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2012	USFWS	Biological Opinion & Conference Opinion: OCS Planning Areas Beaufort & Chukchi	1	1				1			1	1	1	1				1	1	1		1	1		1	1	1	1																			1		
2012	USFWS	Biological Opinion: ExxonMobil Point Thomson Development Beaufort Sea, Alaska	1					1			1	1	1							1		1	1		1	1	1	1																			1		
2012	USFWS	Biological Opinion: LOAs Shell 2012 Exploration Activities in Chukchi Sea, Alaska		1				1			1									1	1	1			1		1															1					1		
2012	USFWS	Revised Biological Opinion & Conference: OCS Planning Areas Beaufort & Chukchi	1	1				1			1		1								1	1					1	1																			1		
2013	NMFS	Biological Opinion: BOEM and BSEE Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska	1	1				1			1	1	1	1				1	1	1	1	1	1	1	1		1	1		1	1				1			1	1					1		1			
2013	NMFS	Biological Opinion: Re-initiation of Section 7 Consultation Apache 3D Seismic Surveys of Cook Inlet, Alaska			1			1			1			1				1	1	1		1				1	1	1	1																	1			
2013	NMFS	Biological Opinion: IHA SAExploration, Inc. 2013 Marine 3D Ocean Bottom Cable Seismic Activities in Beaufort Sea, Alaska	1								1			1				1	1	1	1	1		1	1	1	1	1		1					1			1	1					1		1			
2013	NMFS	Biological Opinion: IHA 2013 Shell Geophysical Surveys, and Equipment Recovery and Maintenance Activities in Chukchi Sea, Alaska		1				1			1			1				1	1	1	1	1		1	1	1	1	1		1	1				1			1	1					1		1			
2013	NMFS	Biological Opinion: IHA TGS-NOPEC ASA (TGS) 2013 Marine 2D Seismic in Federal and International Waters, Chukchi Sea, Alaska		1			1	1			1							1	1	1	1	1		1	1	1	1	1		1	1				1			1	1					1		1			
2013	USFWS	Biological Opinion & Conference Opinion: Polar Bears & Walrus Chukchi Sea Rule and LOAs in Chukchi Seas, Alaska		1				1			1	1	1					1	1	1		1	1	1	1	1	1	1														1					1		
2013	USFWS	Biological Opinion: Pioneer Oooguruk Development 2014-2015 Modifications	1					1			1	1	1							1		1			1	1	1	1																			1		
2013	USFWS	78 FR 11766 Special Final Rule to Protect Polar Bears Under ESA Section 4(d)	1	1			1																				1																				1		
2014	NMFS	Biological Opinion: IHA BPXA Shallow Geohazard Survey in Foggy Island Bay, Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1	1		1									1					1					
2014	NMFS	Biological Opinion: IHA SAExploration2014 Marine 3D Ocean Bottom Node Seismic in Colville River Delta, Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1	1		1									1					1					
2014	NMFS	Biological Opinion: IHA BPXA 2014 Marine 3D Ocean Bottom Sensor Seismic in Prudhoe Bay, Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1	1		1									1					1					
2014	USFWS	Biological Opinion: Polar Bear and Pacific Walrus Deterrence Program	1	1							1							1		1		1				1	1																				1		
2015	AKLNG	Biological Assessment: 2015 Geophysical & Geotechnical Program in The Waters of Cook Inlet			1						1			1				1		1		1			1	1	1	1	1																	1			
2015	BOEM	Biological Assessment: BOEM Oil and Gas Activities Associated with Lease Sale 193		1							1		1	1				1	1	1		1	1		1	1	1	1																			1		
2015	NMFS	Biological Opinion: BOEM and BSEE Lease Sale 193 Oil and Gas Exploration Activities in Chukchi Sea, Alaska		1							1		1	1				1	1	1	1	1			1	1	1	1		1	1		1		1			1	1					1		1			
2015	NMFS	Biological Opinion: Proposed IHA Hilcorp Shallow Geohazard and Strudel Scour Surveys in Foggy Island Bay, Beaufort Sea, Alaska	1								1			1				1	1	1		1		1	1	1	1	1		1									1					1					
2015	NMFS	Biological Opinion: IHA SAExploration, Inc. 2015 3D Seismic in Beaufort Sea, Alaska	1								1			1				1	1	1		1		1	1	1	1	1		1									1					1					
2015	NMFS	Biological Opinion: IHA Shell 2015 Exploration Drilling Activities in Chukchi Sea, Alaska		1							1		1	1				1	1	1	1	1		1	1	1	1			1	1		1		1			1	1					1					

Bin 1. Endangered Species Act Section 7 Consultation, Biological Opinions and Letters of Concurrence

			Region					Baseline		Acoustics																		Cetaceans											Pinnipeds												
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whale	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Califoma Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2015	NMFS	Biological Opinion: IHA Shell Aviation Operations Associated with Ice Condition Monitoring May 2015 - April 2016 Over the Beaufort and Chukchi Seas, Alaska	1	1							1											1			1	1	1										1					1						
2015	NMFS	Biological Opinion: IHA 2012 Shell Exploration Activities in Chukchi Sea, Alaska		1							1		1	1				1	1	1	1	1			1	1	1	1		1	1		1		1		1					1		1				
2015	USFWS	Biological Opinion: BOEM and BSEE Oil and Gas Activities Associated with Lease Sale 193		1							1		1	1				1	1	1		1	1	1	1	1	1	1														1						
2015	USFWS	Biological Opinion: Alaska State Preparedness Plan for Response to Oil and Hazardous Substance Discharges (referred to as the Unified Plan)						1			1									1		1					1	1																1		1				
2015	USFWS	Letter of Concurrence: Northern Sea Otters for Shell Offshore Support Vessels Dutch Harbor to Chukchi Sea, Alaska		1		1														1	1	1																							1				
2016	NMFS	Biological Opinion: IHA 2016 Fairweather Anchor Retrieval Activities in Chukchi and Beaufort Seas, Alaska	1	1															1	1	1	1					1			1	1				1			1	1						1				
2016	USFWS	Biological Opinion: 2016-2021 Polar Bear and Pacific Walrus Incidental Take Regulations Beaufort Sea, Alaska	1								1	1	1	1				1	1	1		1	1		1	1	1	1													1					1			
2017	Hilcorp	Biological Assessment and Request for Emergency ESA Consultation: Hilcorp Middle Ground Shoals Platform A Gasline Repairs, Cook Inlet, Alaska			1						1				1					1		1	1	1			1		1		1				1										1				
2017	NMFS	Biological Opinion: Furie's 2017-2021 Offshore Oil and Gas Exploration Drilling in the Kitchen Lights Unit of Cook Inlet, Alaska			1						1		1	1			1	1	1	1		1			1	1	1	1	1		1				1										1				
2017	NMFS	Letter of Concurrence: Emergency Consultation Hilcorp Middle Ground Shoals Platform A Gasline Repairs in Cook Inlet, Alaska			1						1				1							1					1		1		1				1										1				
2017	NMFS	Biological Opinion: BOEM and BSEE 2017-2022 Oil and Gas Lease Sale 244 in Cook Inlet, Alaska			1						1	1	1	1			1	1	1	1		1					1	1	1		1				1										1				
2017	USFWS	Biological Opinion: Proposed Oil and Gas Lease Sale 244 in Cook Inlet, Alaska			1						1	1	1	1				1	1	1		1			1	1	1	1																			1		
2018	NMFS	Biological Opinion: Issuance of U.S. Army Corps of Engineers Permit and IIHA for Harvest Cook Inlet Pipeline Cross-Inlet Extension Project			1						1	1	1	1				1		1		1		1	1	1	1	1	1						1										1				
2018	NMFS	Biological Opinion: Proposed IHA Office of Naval Research (ONR) Arctic Research Activities 2018-2021 in Beaufort Sea, Alaska	1								1								1	1		1			1	1	1			1	1			1			1	1				1		1				
2018	NMFS	Letter of Concurrence: Hilcorp 2018-2028 Simpson Lagoon Dredging and Screeding in Beaufort Sea, Alaska	1									1								1							1			1				1				1					1					
2018	NMFS	Biological Assessment: Terrestrial ESA-Listed Species: Oil Search Alaska (OSA) Nanushuk Project in North Slope, Alaska	1								1	1	1					1	1	1		1			1	1	1	1		1								1					1					
2018	NMFS	Letter of Concurrence: Ringed Seals for Eni Oliktok Production Pad and Spy Island Drillsite Ice Road Activities, Beaufort Sea, Alaska	1																			1					1																1					
2018	United States Court of Appeals	Ringed Seal ESA Listing Opinion	1	1			1																1		1	1																1					
2019	NMFS	Letter of Concurrence: Oil Search Alaska (OSA) Nanushuk Oliktok Dock Screeding and Module Offloading, Oliktok Point, Beaufort Sea, Alaska	1									1								1	1	1					1		1	1		1		1			1	1				1		1				
2019	NMFS	Biological Opinion: BOEM, BSEE, EPA, and USACE Authorizations for Hilcorp Liberty Oil and Gas Development and Production Activities in Beaufort Sea, Alaska	1								1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1		1	1			1			1	1				1		1				

Bin 1. Endangered Species Act Section 7 Consultation, Biological Opinions and Letters of Concurrence

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whale	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2019	NMFS	Biological Opinion: Final Rule, Hilcorp Alaska and Harvest Alaska Oil and Gas Activities, Cook Inlet Alaska			1						1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1		1				1											1			
2019	NMFS	Biological Opinion: BLM Oil and Gas Lead Sale Arctic National Wildlife Refuge Coastal Plain Beaufort Sea Coast, Alaska	1								1	1		1				1	1	1	1	1			1	1	1	1		1	1				1			1	1					1		1			
2019	NMFS	Revised Biological Opinion: Proposed IHA Office of Naval Research (ONR) Arctic Research Activities 2018-2021 in Beaufort Sea, Alaska	1													1			1	1	1	1			1	1	1	1		1	1				1			1	1					1		1			
2020	NMFS	Biological Opinion: Proposed Rule and LOAs to Hilcorp Alaska, LLC and Eni U.S. Operating Co. Inc. for 2020 to 2025 Ice Road and Trail Activities on the North Slope, Beaufort Sea, Alaska	1																			1	1		1	1	1			1				1					1					1					
		Totals	**41**	**28**	**13**	**1**	**3**	**28**	**8**	**2**	**54**	**26**	**33**	**31**	**3**	**1**	**4**	**46**	**47**	**58**	**15**	**62**	**14**	**13**	**49**	**53**	**64**	**48**	**10**	**31**	**23**	**0**	**4**	**2**	**26**	**0**	**0**	**13**	**27**	**0**	**0**	**7**	**0**	**28**	**0**	**23**	**18**	**3**	**1**

List of Literature by Year, Author, Title & Topics

Bin 3. National Environmental Policy Act Environmental Impact Statements and Environmental Assessment

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
1999	USACE	Final Environmental Impact Statement Northstar Beaufort Sea Oil and Gas Development Project and Record of Decision	1					1	1		1	1	1	1			1	1	1	1	1	1	1	1		1	1	1	1	1	1				1			1	1			1		1	1		1		1
2002	MMS	Outer Continental Shelf Oil & Gas Leasing Program 2002-2007, Final Environmental Impact Statement	1	1			1	1			1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1	1					1	1	1	1		1
2002	MMS	Liberty Development and Production Plan, Final Environmental Impact Statement	1					1	1		1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1									1			1		1	1		1		
2003	MMS	Beaufort Sea Planning Area, Oil and Gas Lease Sales 186, 195, and 202, Final Environmental Impact Statement	1					1			1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1			1						1			1		1	1		1		
2003	MMS	Cook Inlet Planning Area Oil and Gas Lease Sales 191 and 199, Final Environmental Impact Statement		1				1			1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1			1					1		1	
2004	MMS	Proposed Oil and Gas Lease Sale 195 Beaufort Sea Planning Area, Environmental Assessment	1					1			1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1			1						1			1		1	1		1		
2006	MMS	Final Programmatic Environmental Assessment, Arctic Ocean Outer Continental Shelf Seismic Surveys 2006	1	1				1			1			1				1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		1		
2007	MMS	Outer Continental Shelf Oil & Gas Leasing Program 2007-2012, Final Environmental Impact Statement, April 2007	1	1			1	1			1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				1			1	1					1	1	1	1		1
2008	MMS	Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas lease Sales 209, 212, 217, and 221, Draft Environmental Impact Statement	1	1				1			1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1		1	1		1		1		1		1			1		1	1		1		
2010	BOEMRE	Beaufort Sea and Chukchi Sea Planning Areas, ION Geophysical, Inc., Geological and Geophysical Seismic Survey, Environmental Assessment	1	1							1			1				1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1	1	1	1		1		
2010	Harley, B., *et al.*	Environmental Assessment for a Marine Geophysical Survey of Parts of the Arctic Ocean, August-September 2010	1								1			1				1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1	1	1	1		1		
2011	BOEMRE	Beaufort Sea Planning Area, Shell Offshore Inc. 2012 Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Beaufort Sea, Alaska, Flaxman Island Blocks 6559, 6610 & 6658, Beaufort Sea Lease Sales 195 & 202, Environmental Assessment	1								1		1	1				1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1			1	1	1	1		1		
2011	DON	Gulf of Alaska Navy Training Activities, Preliminary Final Environmental Impact Statement/Overseas Environmental Impact Statement				1					1					1			1	1		1			1	1	1				1	1	1	1	1	1	1	1		1	1					1			
2011	DON	Record of Decision for Final Environmental Impact Statement/Overseas Environmental Impact Statement for the Gulf of Alaska Navy Training Activities				1					1					1			1	1		1									1	1	1	1	1	1	1	1		1	1					1			
2011	LGL Ltd. and Marine Acoustics Inc.	Environmental Assessment of Marine Vibroseis	1	1	1	1	1	1		1				1				1									1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
2011	Shell	Environmental Impact Analysis, Revised Chukchi Sea Exploration Plan OCS Lease Sale 193, Chukchi Sea, Alaska: Burger Prospect: Posey Blocks 6714, 6762, 6764, 6812, 6912, and 6915		1				1	1		1		1	1				1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1		1			1		
2012	BOEM	ION Geophysical 2012 Seismic Survey Beaufort Sea and Chukchi Sea, Alaska, Environmental Assessment		1							1			1				1	1	1		1			1	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		1		
2012	NMFS	Environmental Assessment for the Issuance of Regulations and Letters of Authorization to BP Exploration (Alaska) Inc. for the Take of Marine Mammals Incidental to Operation of Offshore Oil and Gas Facilities in the U.S. Beaufort Sea	1								1	1	1				1	1		1		1	1	1	1	1	1	1	1	1			1	1	1	1	1		1			1	1	1	1		1		1
2012	NMFS	Final Environmental Assessment for the Issuance of Incidental Harassment Authorizations for the Take of Marine Mammals by Harassment Incidental to Conducting Exploratory Drilling Programs in the U.S. Beaufort and Chukchi Seas	1	1				1	1		1		1					1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1		1			1		
2012	USACE	Point Thomson Project Final, Environmental Impact Statement	1					1	1		1	1	1				1			1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1		1	1	1	1		
2013	BOEM	TGS 2013 Geophysical Seismic Survey Chukchi Sea, Alaska, Environmental Assessment		1							1							1	1	1		1		1	1	1	1	1	1	1			1						1			1		1	1		1		
2013	NMFS	Environmental Assessment for the Issuance of Incidental Harassment Authorizations to Take Marine Mammals by Harassment Incidental to Conducting Open-Water Marine and Seismic Surveys in The Beaufort And Chukchi Seas		1							1			1				1	1	1		1			1	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		1		
2014	BOEM	SAExploration Inc. Colville River Delta 2014 3D Geophysical Seismic Survey Beaufort Sea, Alaska, Environmental Assessment	1								1							1	1	1		1		1	1	1	1		1	1			1						1			1		1	1				
2014	BOEM	SAExporation 2014 Geophysical Seismic Survey, Beaufort Sea Alaska, Environmental Assessment	1								1			1				1	1	1		1			1	1	1	1																1			1		
2014	DON	Gulf of Alaska Navy Training Activities, Draft Supplemental Draft Environmental Impact Statement/Overseas Environmental Impact Statement				1					1					1			1	1		1			1	1	1				1	1	1	1	1	1	1	1		1	1					1			

List of Literature by Year, Author, Title & Topics

Bin 3. National Environmental Policy Act Environmental Impact Statements and Environmental Assessment

Year	Author	Document Title	Region					Baseline		Acoustics														Cetaceans										Pinnipeds											
			Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	California Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2014	NMFS	Environmental Assessment for the Issuance of Incidental Harassment Authorizations to BP Exploration (Alaska) Inc. for the Take of Marine Mammals Incidental to Seismic and Geohazard Surveys in the Beaufort Sea, Alaska	1								1			1				1	1	1		1			1	1	1		1	1			1	1		1			1			1	1	1				
2015	BOEM	Chukchi Sea Planning Area Oil and Gas Lease Sale 193 In the Chukchi Sea, Alaska, Final Second Supplemental Environmental Impact Statement		1				1	1		1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		1	
2015	BOEM	SAExploration, Inc. 3D Cook Inlet 2015 Geological and Geophysical Seismic Survey, Lower Cook Inlet, Alaska, Environmental Assessment			1			1			1			1				1	1	1		1			1	1	1	1	1			1	1	1	1	1	1			1				1		1	
2015	BOEM	Shell Gulf of Mexico, Inc. Revised Outer Continental Shelf Lease Exploration Plan Chukchi Sea, Alaska Revision 2, Environmental Assessment		1				1	1		1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		1	
2015	NMFS	Final 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	1								1			1				1	1	1		1			1	1	1		1	1			1	1		1			1				1	1	1			
2015	USDOI	Chukchi Sea Outer Continental Shelf Oil and Gas Lease Sale 193, Record of Decision		1				1	1		1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		1			1	1	1	1		1	
2016	BOEM	Cook Inlet Planning Area Oil and Gas Lease Sale 244 in the Cook Inlet, Alaska Final Environmental Impact Statement			1			1			1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1			1	1	1	1	1				1					1		1	
2016	NMFS	Effects of Oil and Gas Activities in the Arctic Ocean, Final Environmental Impact Statement	1	1				1	1		1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1			1	1	1	1		1	
2016	USFWS	Environmental Assessment For a Final Rule to Authorize the Incidental Take of Small Numbers of Polar Bear and Pacific Walrus During Oil and Gas Activities in The Beaufort Sea and Adjacent Coastal Alaska.	1								1	1	1	1				1	1	1		1	1		1	1	1	1													1					1		
2017	BOEM	Eni U.S. Operating Company Inc. Outer Continental Shelf Lease Exploration Plan Harrison Bay Block 6423 Unit - Leases OCS-Y-1753, OCS-Y-1754, and OCS-Y-1757, Environmental Assessment	1								1	1	1	1				1	1	1		1	1	1	1	1	1	1	1	1			1						1			1			1	1		1		
2018	BLM	ConocoPhillips Alaska, Inc. Exploration 2018-2019, Northeast National Petroleum Reserve in Alaska, Environmental Assessment	1								1		1									1	1	1	1	1	1	1																	1		
2018	BOEM	Liberty Development and Production Plan, Final Environmental Impact Statement	1					1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		1		1	1	1			1	1	1	1	1	
2019	BLM	Coastal Plain of the Arctic National Wildlife Refuge Oil and Gas Leasing Program, Final Environmental Impact Statement and Record of Decision	1					1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	
2019	FERC	Alaska LNG Project, Draft Environmental Impact Statement	1		1			1			1	1		1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	
2020	BLM	National Petroleum Reserve in Alaska, Integrated Activity Plan and Final Environmental Impact Statement	1								1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	
2020	BLM	Willow Master Development Plan, Final Environmental Impact Statement	1								1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	
			28	**16**	**4**	**4**	**3**	**22**	**11**	**1**	**40**	**22**	**25**	**32**	**0**	**3**	**20**	**36**	**37**	**39**	**10**	**40**	**29**	**30**	**38**	**39**	**40**	**34**	**34**	**32**	**27**	**15**	**33**	**27**	**30**	**27**	**27**	**14**	**31**	**5**	**10**	**28**	**18**	**33**	**30**	**16**	**31**	**10**	**4**

List of Literature by Year, Author, Title & Topics

Bin 4. Mitigation and Monitoring

			Region					Baseline		Acoustics																				Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Seismic	Pile Driving	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Whales	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
1998	MacLean, S.A.	Marine Mammal Monitoring of an On-Ice Seismic Program in the Eastern Alaskan Beaufort Sea, April1998	1					1																																				1					
2000	Richardson, W.J. and Williams, M.T.	Monitoring of ringed seals during construction of ice roads for BP's Northstar oil development, Alaskan Beaufort Sea, 1999.	1					1																																				1			1		
2000	Wursig, B., *et al.*	Development of an air bubble curtain to reduce underwater noise of percussive piling					1	1	1									1									1																						
2001	Caltrans	San Francisco – Oakland Bay Bridge East Span Seismic Safety Project, Pile Installation Demonstration Project: Marine Mammal Impact Assessment					1											1									1													1	1								
2001	Richardson, W.J. and Williams, M.T.	Monitoring of industrial sounds, seals, and whale calls during construction of BP's Northstar Oil Development, Alaskan Beaufort Sea, 2000. [Draft]	1					1			1	1						1		1										1														1					
2002	Richardson, W.J. and Lawson, J.W.	Marine Mammal Monitoring of WesternGeco's Open-Water Seismic Program in the Alaskan Beaufort Sea, 2001	1					1		1	1			1			1			1										1									1					1	1				
2002	Richardson, W.J. and Williams, M.T.	Monitoring of industrial sounds, seals, and whale calls during construction of BP's Northstar Oil Development, Alaskan Beaufort Sea, 2001.	1							1	1	1	1					1		1									1	1			1						1					1	1				
2003	Moulton, V.D., *et al.*	Ringed seal densities and noise near an icebound artificial island with construction and drilling	1					1			1		1				1	1		1																									1				
2003	Richardson, W.J. and Williams, M.T.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2002.	1							1	1	1	1					1		1									1	1			1						1					1	1				
2004	Blackwell, S.B., *et al.*	Drilling and operational sounds from an oil production island in the ice-covered Beaufort Sea	1					1		1			1																															1					
2004	Blackwell, S.B., *et al.*	Tolerance by ringed seals (*Phoca hispida*) to impact pipe-driving and construction sounds at an oil production island	1					1		1		1						1																										1					
2004	Richardson, W.J. and Williams, M.T.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999–2003. [Annual and Comprehensive Report, December 2004.]	1							1		1	1					1		1										1									1					1	1				
2005	Miller, G.W., *et al.*	Monitoring seismic effects on marine mammals-southeastern Beaufort Sea, 2001-2002	1					1		1						1				1																													1
2005	Richardson, W.J. and Williams, M.T.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2004: Summary Report; Appendix H in Richardson 2008	1					1		1	1		1							1										1														1					
2006	Blackwell, S.B. and Greene, C.R., Jr.	Sounds from an oil production island in the Beaufort Sea in summer: characteristics and contribution of vessels	1							1										1																													
2006	Richardson, W.J.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2005: Annual Summary Report.	1					1		1	1		1							1										1														1					
2007	Blackwell, S., *et al.*	Bowhead whale (*Balaena mysticetus*) migration and calling behaviour in the Alaskan Beaufort Sea, autumn 2001– 04: an acoustic localization study	1					1																						1																			
2007	Gailey, G., *et al.*	Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia					1	1									1																1																
2007	Greene, C.R., Jr., *et al.*	Sounds and vibrations in the frozen Beaufort Sea during gravel island construction	1					1		1		1			1			1																															
2007	Illinworth & Rodkin	Compendium of Pile Driving Sound Data					1	1		1								1																															
2007	Johnson, S.R., *et al.*	A western gray whale mitigation and monitoring program for a 3-D seismic survey, Sakhalin Island, Russia					1	1									1																1																
2007	MacGillivray, A., *et al.*	Underwater Acoustic Measurements from Washington State Ferries 2006 Mukilteo Ferry Terminal Test Pile Project					1	1		1								1																															
2007	Marine Mammal Commission	Marine Mammals and Noise, A Sound Approach to Research And Management: A Report to Congress from the Marine Mammal Commission					1	1		1																																							1
2007	MMS	Outer Continental Shelf Oil & Gas Leasing Program: Draft EIS Appendix C Mitigation Measures	1	1		1	1																				1																						1
2007	Patterson, H., *et al.*	Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort Seas, July–September 2006: 90-day report.	1	1				1		1	1			1			1			1		1					1		1	1			1						1					1	1		1		
2007	Richardson, W.J.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2006: Annual Summary Report	1							1	1	1					1	1		1										1														1					

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2007	URS	Final Underwater Noise Report: Port of Anchorage Marine Terminal Development Project Underwater Noise Survey, Test Pile Driving Program, Anchorage Alaska			1					1		1	1					1		1							1		1					1		1					1								
2008	Aerts, L., *et al.*	Marine mammal monitoring and mitigation during BP Liberty OBC seismic survey in Foggy Island Bay, Beaufort Sea, July-August 2008: 90-day report.	1					1			1						1			1	1						1			1		1	1	1	1	1			1		1	1		1	1	1	1		
2008	Aerts, L.A.M. and Richardson, W.J.	Monitoring of Industrial Sounds, Seals, and Bowhead Whales Near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2007: Annual Summary Report	1							1	1	1					1	1		1										1														1					
2008	Hauser, D.D.W., *et al.*	Marine mammal and acoustic monitoring of the Eni/PGS open-water seismic program near Thetis, Spy and Leavitt islands, Alaskan Beaufort Sea, 2008: 90-day report.	1					1		1	1						1		1	1		1					1		1	1			1	1					1					1	1				
2008	Moulton, V.D., *et al.*	Zone of displacement for ringed seals (*Pusa hispida*) wintering around offshore oil-industry operations in the Alaskan Beaufort Sea	1								1	1	1					1		1		1																						1					
2008	Richardson, W.J.	Table of Contents: Monitoring of Industrial Sounds, Seals and Bowhead Whales Near BP's Northstar Oil Development, Alaskan Beaufort Sea, 1999 - 2004	1							1	1	1					1	1		1										1														1					
2008	Scientific Fishery Systems Inc and Alaska Native Technologies LLC	Port of Anchorage Marine Terminal Redevelopment Project: 2008 Underwater Noise Survey During Construction Pile Driving			1			1		1								1																															
2008	Streever, B., *et al.*	Managing Marine Mammal Issues: Corporate Policy, Stakeholder Engagement, Applied Research, and Training					1	1		1																																							1
2009	Aerts, L.A.M. and Richardson, W.J.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2008: Annual Summary Report	1					1		1	1	1	1				1	1	1	1								1		1									1					1					
2009	Integrated Concepts & Research Corporation	Construction and Scientific Marine Mammal Monitoring Associated with the Port of Anchorage Marine Terminal Redevelopment Project			1			1		1		1						1									1		1					1		1					1								
2009	Koski, W.R., *et al.*	Evaluation of an Unmanned Airborne System for Monitoring Marine Mammals					1	1																			1																						1
2010	Aerts, L.A.M. and Richardson, W.J.	Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2009: Annual Summary Report	1					1		1	1	1	1				1	1	1	1								1		1									1					1					
2010	Beland, J. and Ireland, D.	Marine Mammal Monitoring and Mitigation During a Marine Geophysical Survey in the Arctic Ocean, August - September 2010: 90-Day Report	1				1	1		1	1						1			1							1			1			1						1					1			1		
2010	Funk, D.W., *et al.*	Joint Monitoring Program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008	1	1				1			1	1	1				1		1	1							1		1	1	1		1		1		1		1			1	1	1	1	1	1		
2010	JNCC	JNCC Guidelines for Minimising the Risk of Injury and Disturbance to Marine Mammals from Seismic Surveys					1	1		1							1		1	1							1																						1
2010	Neff & Associates LLC and Battelle	Continuation of the Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA): Synthesis, 1999 - 2007	1					1		1		1	1				1	1		1							1	1	1	1														1			1		
2010	Reiser, C.M., *et al.*	90-Day Report Shell Chukchi Open water Seismic Exploration Marine Mammal Monitoring		1				1						1			1			1							1			1			1						1			1		1					
2010	Statoil	Marine Mammal Monitoring and Mitigation Plan for 2010 Marine Seismic Surveys of Selected Lease Areas in Chukchi Sea, Alaska		1													1			1							1																						
2011	Erbe, C. and JASCO Applied Sciences Inc.	Underwater Acoustics: Noise and the Effects on Marine Mammals						1		1																																							1
2011	Genesis Oil and Gas Consultants Ltd.	Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive					1			1		1	1	1				1		1																													1
2011	Hartin, K.G., *et al.*	90-Day Report: Marine mammal monitoring and mitigation during site clearance and geotechnical surveys by Statoil USA E&P Inc. in the Chukchi Sea, August–October 2011		1				1		1				1			1		1	1							1			1			1						1			1		1	1		1		
2011	International Association of Oil & Gas Producers	Model based assessment of underwater noise from an airgun array soft-start operation					1	1		1							1										1																						1
2011	Parente, C.L. and de Araújo, M.E.	Effectiveness of Monitoring Marine Mammals during Marine Seismic Surveys off Northeast Brazil					1	1		1							1			1																													1

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2011	Shell Gulf of Mexico Inc.	2011 Marine Mammal Monitoring and Mitigation Plan for Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea		1							1		1							1							1																						
2011	Shell Offshore Inc.	Polar Bear, Pacific Walrus, and Grizzly Bear Avoidance and Human Encounter/Interaction Plan Revised Outer Continental Shelf Lease Exploration Plan Camden Bay, Alaska	1								1		1	1			1		1	1		1					1	1														1					1		
2012	Bisson, L.N., *et al.*	Marine Mammal Monitoring and Mitigation During Exploratory Drilling by Shell in the Alaskan Chukchi and Beaufort seas, July – November 2012: Draft 90-Day Report.	1	1				1		1	1	1	1	1			1	1	1	1		1					1		1	1			1						1			1		1	1		1		
2012	BP Exploration Inc.	14th(+) Open Water Meeting Report on Marine Mammal and Acoustic Monitoring of the Northstar Offshore Production Facility	1								1		1							1		1					1			1									1					1	1				
2012	Emmerson, C. and Lahn, G.	Arctic Opening: Opportunity and Risk in the High North	1	1		1	1													1		1			1	1	1	1																					1
2012	Gadd, P.E., *et al.*	The History of Artificial Islands for Oil Exploration and Development in the Alaskan Arctic	1																																														
2012	MMOA	Position Statements: The Key Issues That Should Be Addressed When Developing Mitigation Plans To Minimise The Effects of Anthropogenic Sound On Species Of Concern					1																				1																						1
2012	Normandeau Associates Inc.	Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities. Workshop Report.	1	1		1	1	1		1																1	1																						
2012	SAExploration	Apache Cook Inlet 3D Seismic Protected Species Monitoring Program			1						1						1			1		1					1		1				1	1							1								
2012	Smultea, M.A., *et al.*	Summary of Systematic Bowhead Surveys Conducted in the U.S. Beaufort and Chukchi Seas, 1975-2009	1	1				1																			1			1																			
2013	ACCOBAMS Permanent Secretariat	Guidelines to Address the Impact of Anthropogenic Noise on Cetaceans in the ACCOBAMS Area					1	1		1		1	1	1		1	1		1	1		1					1																						1
2013	Aerts, L.A.M., *et al.*	Marine Mammal Distribution and Abundance in the Northeastern Chukchi Sea During Summer and Early Fall, 2008-2012.		1				1																						1			1						1			1		1			1		
2013	Baker, K., *et al.*	National Standards for a Protected Species Observer and Data Management Program: A Model Using Geological and Geophysical Surveys				1	1																				1																						1
2013	HDR Alaska Inc.	NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during BPXA Simpson Lagoon OBC Seismic Survey, Beaufort Sea, Alaska July to September 2012	1								1						1			1							1		1	1			1						1					1	1				
2013	Lammers, M.O., *et al.*	Passive acoustic monitoring of Cook Inlet beluga whales (*Delphinapterus leucas*)			1			1		1						1				1									1	1									1					1	1				
2013	Streever, B.	Case study: A look at the Simpson Lagoon seismic operation's estimated distance to 120dB re 1uPa	1					1		1							1										1																						
2013	Zitterbart, D.P., *et al.*	Automatic Round-the-Clock Detection of Whales for Mitigation from Underwater Noise Impacts					1			1				1			1		1			1					1																						1
2014	BOEM	Quieting Technologies for Reducing Noise During Seismic Surveying and Pile Driving Workshop Summary Report						1		1							1			1							1																						1
2014	Hemmera Envirochem Inc., *et al.*	Roberts Bank Terminal 2 Technical Data Report Underwater Noise Ship Sound Signature Analysis Study					1	1		1										1																													
2014	LGL Alaska Research Associates Inc., *et al.*	Joint Monitoring Program in the Chukchi and Beaufort Seas, 2012. LGL Alaska Final Report P1272-2 for Shell Offshore, Inc. ION Geophysical, Inc., and Other Industry Contributors	1	1						1	1		1	1		1	1		1	1							1		1	1	1		1	1	1	1	1		1				1	1	1				
2014	NMFS	NMFS Whale Deterrence Workshop: Assessment Report	1	1	1	1																1					1	1	1	1																			
2014	Shell Gulf of Mexico Inc.	Marine Mammal Monitoring and Mitigation Plan Exploration Drilling of Selected Lease Areas in the Alaskan Chukchi Sea		1							1		1				1			1		1					1																						
2014	Smultea, M.A., *et al.*	NMFS 90-Day Report for Marine Mammal Monitoring and Mitigation during BPXA's Liberty Shallow Geohazard Seismic and Seabed Mapping Survey Beaufort Sea, Alaska	1					1		1				1			1		1	1		1					1		1										1					1	1				
2015	Azzara, A., *et al.*	A 10-Year Projection Of Maritime Activity in the U.S. Arctic Region	1	1		1		1		1										1																													
2015	BSEE and BOEM	Arctic Nearshore Impact Monitoring in Development Area - III (ANIMIDA III)	1					1																																									

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2015	Cate, J.R., *et al.*	Marine Mammal Monitoring 90-Day Report: Shallow geohazard survey Hilcorp in Foggy Island Bay, Alaska, July 2015.	1					1						1			1		1	1		1					1		1															1	1				
2015	Frouin-Mouy, H., *et al.*	Passive Acoustic Monitoring Study: Hilcorp's 2015 Geohazard Survey in Foggy Island Bay, AK.	1					1						1		1	1		1	1		1					1		1	1									1					1	1				
2015	Olgoonik Fairweather LLC	Arctic Nearshore Impact Monitoring in Development Area – III (ANIMIDA III): 2015 Field Report	1					1																																									
2015	Smith, C.E., *et al.*	Assessment of known impacts of unmanned aerial systems (UAS) on marine mammals: data gaps and recommendations for researchers in the United States					1	1		1	1																																						1
2016	Angliss, R., *et al.*	Manned vs unmanned aerial surveys of cetaceans in the Arctic: Operations and preliminary results					1	1		1	1																																						1
2016	Bishop, S.C. and Streever, B.	Long-Term Ecological Monitoring in BP's North Slope Oil Fields Through 2014								1						1				1					1					1									1					1	1		1		
2016	CH2M Engineers Inc.	Anchorage Port Modernization Program Test Pile Program Report of Findings			1			1		1				1			1	1	1	1		1					1		1												1					1			
2016	Cooley, H., *et al.*	Polar Bear Program Annual Report	1	1				1																																							1		
2016	Denes, S.L., *et al.*	Hydroacoustic Pile Driving Noise Study – Comprehensive Report.				1				1								1																															1
2016	Durner, G.M., *et al.*	Proceedings of the18th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, 7–11 June 2016, Anchorage, Alaska	1	1			1			1													1		1																						1		
2016	Gailey, G., *et al.*	Behavioural responses of western gray whales to a 4-D seismic survey off northeastern Sakhalin Island, Russia					1			1							1			1		1					1						1																
2016	Ireland, D.S., *et al.*	Comprehensive Report of Marine Mammal Monitoring and Mitigation in the Chukchi and Beaufort Seas, 2006–2015.	1	1						1	1		1		1		1			1							1		1	1			1	1					1			1	1	1	1		1		
2016	McPherson, C., *et al.*	Passive Acoustic Monitoring of Ambient Noise and Marine Mammals—Barossa Field					1			1			1			1	1		1	1																													1
2016	NMFS	Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing Underwater Acoustic Thresholds for Onset of Permanent and Temporary Threshold Shifts						1																			1																						1
2016	Olgoonik Fairweather LLC	Walrus Disturbance Workshop Notes		1				1			1		1				1			1							1															1							
2016	USFWS	Endangered and Threatened Wildlife and Plants; Endangered Species Act Compensatory Mitigation Policy																									1															1					1		1
2017	BOEM	Alaska Annual Studies Plan: 2017						1	1																		1	1		1									1					1					1
2017	Greeneridge Sciences Inc.	Northstar Near-island Sound Levels, 2001–2016	1					1		1	1	1	1							1																													
2017	MacCracken, J.G., *et al.*	Final Species Status Assessment for the Pacific Walrus (*Odobenus rosmarus divergens*)		1			1	1															1		1																	1							
2017	NMFS	National Marine Fisheries Service (NMFS) Alaska Region Statewide Marine Mammal Spill Preparedness and Response Structure; Expectations for Responsible Parties	1	1	1	1																						1																					
2018	Exxon Neftegas Ltd. and Sakhalin Energy Investment Company Ltd.	Report on Gray Whale Monitoring Program off Northeast Sakhalin Island in 2017					1																				1						1																
2018	Fairweather Science LLC	CIPL Extension Project: Marine Mammal Monitoring and Mitigation Plan (Revised)			1						1	1								1		1					1		1																				1
2018	Ferguson, M.C., *et al.*	Performance of Manned and Unmanned Aerial Surveys to Collect Visual Data and Imagery for Estimating Arctic Cetacean Density and Associated Uncertainty (DRAFT)					1			1	1																1																						1
2018	Green, G.A., *et al.*	Quintillion 2017 Subsea Cable System Phase 1 Installation Program Marine Mammal Monitoring 90-Day Report	1	1		1														1	1						1			1	1	1	1	1	1		1		1			1		1	1	1	1		
2018	Sitkiewicz, S., *et al.*	2018 Harvest Alaska Cook Inlet Pipeline Project Monitoring Program Marine Mammal Monitoring and Mitigation Report.			1															1							1		1					1	1						1					1			
2018	Verfuss, U.K., *et al.*	Comparing methods suitable for monitoring marine mammals in low visibility conditions during seismic surveys						1		1						1	1		1	1																													1
2019	Alaska Fisheries Science Center	ASAMM polar bear sightings, 16-30 September 2019	1	1				1																																							1		

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2019	Castellote, M.	Harvest’s Cook Inlet Pipeline (CIPL) Extension Project Acoustic Monitoring: Final Report			1			1		1	1					1			1	1																													
2019	Trefry, J.H. and Neff, J.M.	Effects of offshore oil exploration and development in the Alaskan Beaufort Sea: A three-decade record for sediment metals	1					1																																									
		Totals	**54**	**24**	**11**	**9**	**30**	**64**	**2**	**57**	**34**	**21**	**25**	**14**	**2**	**9**	**40**	**25**	**18**	**58**	**2**	**18**	**2**	**0**	**4**	**2**	**50**	**8**	**21**	**34**	**3**	**2**	**20**	**9**	**5**	**4**	**3**	**0**	**25**	**1**	**7**	**12**	**3**	**38**	**21**	**5**	**17**	**0**	**26**

List of Literature by Year, Author, Title & Topics

Bin 5. Subsistence and Traditional Knowledge

Year	Author	Document Title	Region					Baseline		Acoustics												Cetaceans															Pinnipeds												
			Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Eccol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall'sPorpoise	Gray Whales	Humpback Whales	Harbor Porpoise	Killer Whales	Minke Whales	North Pacific Right Whales	Bearded Seal	Califorra Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2000	Brower, H.K., et al.	North Slope Borough Subsistence Harvest Documentation Project; Data for Kaktovik, Alaska for the Period December 1, 1994 to November 30, 1995	1						1																																					1
2000	Huntington, H.P.	Traditional knowledge of the ecology of belugas, *Delphinapterus lecuas*, in Cook Inlet, Alaska			1				1	1																		1																		
2000	MMS	Beaufort Sea Information Update Meeting	1						1				1														1		1													1			1		1
2001	BP Exploration Inc.	BP Exploration Inc. Good Neighbor Policy: Northstar Project	1						1				1																1																		1
2002	Richardson, J.W. and Thomson, D.H.	Bowhead Whale Feeding in the Eastern Alaskan Beaufort Sea - Update of Scientific and Traditional Information Vol 2	1					1	1																				1																		
2004	Galginaitis, M. and Funk, D.W.	Annual Assessment of Subsistence Bowhead Whaling Near Cross Island, 2001 and 2002- ANIMIDA Task 4 Final Report	1					1	1																				1																		
2006	Ice Seal Committee	Agreement between the Ice Seal Committee (ISC) and the National Marine Fisheries Service (NMFS) for the Co-Management of Alaskan Ice Seal Populations	1	1		1			1																		1										1				1	1	1				
2007	Noongwook, G., *et al.*	Traditional Knowledge of the Bowhead Whale (*Balaena Mysticetus*) around St. Lawrence Island, Alaska																																												
2008	EDAW Inc., *et al.*	Quantitative description of potential impacts of OCS activities on bowhead whale hunting activities in the Beaufort Sea	1			1			1				1														1			1																1
2008	Hovelsrud, G.K., *et al.*	Marine Mammal Harvests and Other Interactions with Humans	1	1			1	1	1											1		1			1			1	1											1	1				1		1
2008	Nielsen, J.B.	Inupiat Whaling and Oil Industry in North Alaska	1	1					1																				1																		
2009	Braund, S.R. and Kruse, J.	Synthesis: Three Decades of Research on Socioeconomic Effects Related to Offshore Petroleum Development in Coastal Alaska																																											
2009	Galginaitis, M.	Annual Assessment of Subsistence Bowhead Whaling Near Cross Island, 2001-2007: Final Report	1						1																				1																		
2009	Huntington, H.P.	A preliminary assessment of threats to arctic marine mammals and their conservation in the coming decades																																											
2009	Huntington, H.P. and Quakenbush, L.	Traditional Knowledge of Bowhead Whale Migratory Patterns near Kaktovik and Barrow, Alaska	1						1	1																			1																		
2009	Palmer, A.C.	Under what conditions can oil and gas developments in the Arctic be acceptable, and to whom?					1																					1																		
2009	Stephen R. Braund & Associates	Impacts and benefits of oil and gas development to Barrow, Nuiqsut, Wainwright, and Atqasuk harvesters	1	1			1		1																			1																		1
2010	Quakenbush, L. and Huntington, H.	Traditional Knowledge Regarding Bowhead Whales in the Chukchi Sea near Wainwright, Alaska		1					1													1		1					1	1																
2010	Stephen R. Braund & Associates	Literature review of North Slope Marine Traditional Knowledge	1	1					1													1	1	1	1			1																		
2010	Stephen R. Braund & Associates	Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow	1	1			1		1																				1										1		1					
2010	Suydam, R., et al.	Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Eskimos during 2010	1	1		1	1		1																		1			1															
2010	Suydam, R., et al.	Subsistence Harvest Bowhead Whales by Alaska Eskimos during 2006	1	1		1			1																		1			1															
2011	Alaska Eskimo Whaling Commission	AEWC Conflict Avoidance Agreement 2011 Open Water Season Programmatic Conflict Avoidance Agreement	1	1							1									1							1			1															
2011	Alaska Eskimo Whaling Commission	AEWC Comments Revised Draft SEIS Chukchi Lease Sale 193		1																								1	1		1															
2011	Cannon, C.	Native Village Point Hope Comments Chukchi Lease Sale 193 Draft SEIS		1																								1																		
2011	Itta, E.S.	North Slope Borough Comments on the Chukchi Lease Sale 193 Draft SEIS		1																1	1							1	1																	
2011	Kishigami, N.	Climate change, oil and gas development, and Inupiat whaling in northwest Alaska	1	1					1				1							1			1		1		1	1		1																1
2011	Powers, C.	Koniag Corporation Comments Chukchi Lease Sale 193 Revised Draft SEIS		1																							1																		
2011	Rexford, D.J.	Whaling crew lands Point Lay's second whale after decades- long shutout		1					1																				1																		
2011	Shell Offshore Inc.	Plan of Cooperation Addendum Revised Outer Continental Shelf Lease Exploration Plan Camden Bay Beaufort Sea, Alaska	1										1														1																		1

List of Literature by Year, Author, Title & Topics

Bin 5. Subsistence and Traditional Knowledge

Year	Author	Document Title	Region					Baseline		Acoustics														Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Cetaceans											Pinnipeds												Sea Otter	Marine Mammals General
			Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Eccol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels										Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Humpback Whales	Harbor Porpoise	Killer Whales	Minke Whales	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear			
2011	Shell Offshore Inc.	Plan of Cooperation Addendum Revised Chukchi Sea Exploration Plan OCS Lease Sale 193 Chukchi Sea, Alaska	1	1									1																1																					1
2011	Stephen R. Braund & Associates	Chukchi and Beaufort Seas National Pollutant Discharge Elimination System Exploration General Permits Reissuance Report of Traditional Knowledge Workshops – Point Lay, Barrow, Nuiqsut, and Kaktovik	1	1					1																				1	1		1																		
2011	Whiting, A. and Naylor, N.	Native Village Kotzebue Comments Chukchi Lease Sale 193 Revised Draft SEIS		1																									1	1									1												
2011	Whiting, S.M.	Northwest Arctic Borough Comments on the Chukchi Lease Sale 193 Draft SEIS		1																										1																				
2012	Alaska Eskimo Whaling Commission	AEWC Comments BOEM 2012-2017 5-Yr Lease Plan	1	1		1	1																						1	1																				
2012	BOEM	Special Issue on Traditional Knowledge	1	1		1	1		1																						1																				1
2012	Edwardson, G.	Inpuiat Community of the Arctic Slope (ICAS) Comments on BOEM 2012-2017 5-Yr Lease Plan	1	1			1																							1																				
2012	Huntington, H.P., *et al.*	Traditional Knowledge Regarding Walrus Near Point Lay and Wainwright, Alaska		1					1																															1										
2012	Whiting, A.	Native Village Kotzebue Comments on BOEM 5-Yr Lease Plan 2012-2017		1																										1																				
2013	Huntington, H.P.	Traditional Knowledge Regarding Bowhead Whales and Camden Bay, Beaufort Sea, Alaska	1						1	1																			1		1																				
2013	Stephen R. Braund & Associates	Aggregate effects of oil industry operations on Inupiaq subsistence activities, Nuiqsut, Alaska: A history and analysis of mitigation and monitoring	1						1		1		1				1		1										1	1									1								1		1		1
2013	Stephen R. Braund & Associates	COMIDA: Impact Monitoring for Offshore Subsistence Hunting, Wainwright and Point Lay, Alaska		1					1				1																1		1	1									1			1							
2014	Alaska Eskimo Whaling	AEWC Mini Convention Whaling Captains Meeting Minutes	1						1											1	1										1																				
2014	Alaska Eskimo Whaling	AEWC and Harry Brower Comments Chukchi Lease Sale 193		1																									1		1																				
2014	Alaska Eskimo Whaling	AEWC Comments Chukchi Lease Sale 193 SEIS		1																											1																				
2014	Awalin, M.	Cully Corp Comments on Chukchi Lease Sale 193 Draft SEIS		1																										1																				
2014	BP Exploration Inc., et al.	2014 Programmatic Conflict Avoidance Agreement Beaufort & Chukchi Seas, Alaska	1	1					1				1				1		1										1																					1
2014	Brower, C.	NSB Comments Chukchi Lease Sale 193		1																									1	1																				
2014	Collier, C.	Seldovia Village Tribe Comments on Cook Inlet Lease Sale 244 EIS			1																																														1
2014	Fagnani, M.	Aleut Corp Comments on Chukchi Lease Sale 193 Draft SEIS		1																																														
2014	Galginaitis, M.	Monitoring Cross Island Whaling	1					1	1																					1																					
2014	Oceana and Kawerak Inc	Bering Strait Marine Life and Subsistence Use Data Synthesis		1		1		1	1	1			1							1									1	1	1																					1
2014	Patkotak, H.	Olgoonik Corp Comments on the Chukchi Lease Sale 193 Draft SEIS		1																										1																				
2014	Rasmuson, E.B.	Comments Chukchi Lease Sale 193 SEIS		1																																														
2014	Whiting, A. and Okleasik, U.T.	Native Village Kotzebue Comments Chukchi Lease Sale 193 Draft SEIS		1																										1																				1
2015	Alaska Eskimo Whaling Commission	AEWC Comments Liberty Development and Production Plan (DPP) and EIS	1										1							1		1	1							1		1																				
2015	Brower, C.	NSB Comments on the Liberty Development and Production Plan (DPP) and EIS	1								1		1							1										1	1																				
2015	Fagnani, M.	Aleut Corporation Comments on Liberty Development and Production Plan (DPP)	1																																															
2015	Gadamus, L., et al.	Building an indigenous evidence-base for tribally-led habitat conservation policies		1		1			1															1		1											1			1	1	1	1							
2015	Hilcorp Alaska LLC	Plan of Cooperation: Liberty Unit Shallow Geohazard Surveys, Beaufort Sea, Alaska, 2015	1											1		1				1										1																					x
2015	Nukapigak, I.	Kuukpik Corp Corporation Comments on Liberty Development and Production Plan (DPP) and EIS	1										1																	1																				

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall'sPorpoise	Gray Whales	Humpback Wahles	Harbor Porpoise	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	California Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2016	Huntington, H.P., et al.	Traditional Knowledge Regarding Ringed Seals, Bearded Seals, Walrus, and Bowhead Whales near Kivalina, Alaska		1					1																					1									1			1		1					
2016	Huntington, H.P., et al.	Effects of changing sea ice on marine mammals and subsistence hunters in northern Alaska from traditional knowledge interviews	1	1		1			1	1																	1																						1
2016	Kofinas, G., *et al.*	Subsistence Sharing Networks and Cooperation- Kaktovik, Wainwright, and Venetie, Alaska	1	1					1																																								
2016	Opheim, M.	Seldovia Village Tribe Comments Cook Inlet LS 244 EIS			1																																												
2016	Owl Ridge Natural Resource Consultants Inc.	Plan of Cooperation: Quintillion Subsea Operations Cable Project Bering, Chukchi, and Beaufort Seas, Alaska	1	1		1									1												1																						1
2017	Martinez-Levasseur, L.M., et al.	Challenges and strategies when mapping local ecological knowledge in the Canadian Arctic: the importance of defining the geographic limits of participants' common areas of observations					1		1																																	1							1
2017	Nasgovitz, M.	Antrhopogenic noise in the Alaskan Arctic	1	1		1				1			1					1		1						1	1																						1
2017	Stephen R. Braund & Associates	Social Indicators in Coastal Alaska-Arctic Communities	1	1				1	1																																								
2018	McWhinnie, L.H., et al.	Vessel traffic in the Canadian Arctic: Management solutions for minimizing impacts on whales in a changing northern region					1													1		1					1		1	1																			
2018	Robards, M.D., *et al.*	Understanding and adapting to observed changes in the Alaskan Arctic: Actionable knowledge co-production with Alaska Native communities	1	1			1		1																		1																						
2018	Suydam, R.S. and George, J.C.	Subsistence harvest of bowhead whales (*Balaena mysticetus*) taken by Alaskan Natives, 1974 to 2016	1	1		1																					1			1																			
2019	Galginaitis, M.	Summary of the 2018 Subsistence Whaling Season at Cross Island. Report prepared for Hilcorp Alaska, LLC																																															
2019	Holen, D.	Coastal Community Vulnerability index and Visualizations of Change in Cook Inlet, Alaska			1																						1																						
2019	Stevenson, T.C., et al.	An examination of trans-Arctic vessel routing in the central Arctic Ocean	1	1		1	1													1							1																						1
2020	Collier, C.	Seldovia Village Tribe Comments on Propsed Cook Inlet Lease Sale 258			1																								1																			1	
2020	Stinchcomb, T.R., et al.	Extensive aircraft activity impacts subsistence areas: Acoustic evidence from Arctic Alaska	1							1										1																													
TOTAL			**43**	**46**	**5**	**13**	**12**	**6**	**37**	**7**	**3**	**0**	**14**	**1**	**1**	**1**	**0**	**3**	**0**	**15**	**2**	**4**	**4**	**1**	**6**	**2**	**34**	**19**	**7**	**30**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7**	**0**	**0**	**7**	**3**	**5**	**2**	**0**	**3**	**1**	**20**

List of Literature by Year, Author, Title & Topics

Bin 6. Climate Change

			Other Region?					Baseline		Acoustics																			Cetaceans										Pinipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	BelugaWhales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	California Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2010	Ashjian, C.J., et al.	Climate Variability, Oceanography, Bowhead Whale Distribution, and Iñupiat Subsistence Whaling near Barrow, Alaska	1						1																1					1																				
2016	Atwood, T.C., et al.	Rapid Environmental Change Drives Increased Land Use by an Arctic Marine Predator	1																				1	1	1																						1		
2013	BOEM, et al.	Biogeochemical Assessment of OCS Arctic Water: Current Status and Vulnerability to Climate Change	1	1																					1																								
2015	Bromaghin, J.F., et al.	Polar bear population dynamics in the southern Beaufort Sea during a period of sea ice decline	1																						1																						1		
2018	Druckenmiller, M.L., et al.	Trends in sea-ice cover within bowhead whale habitats in the Pacific Arctic	1	1																					1					1																				
2017	Ferrara, G.A.	Assessing the Vulnerability of Marine Mammal Subsistence Species in the Bering Sea to Climate Change				1																	1	1	1				1	1									1			1	1	1	1		1		
2003	George, C., et al.	Observations on Shorefast Ice Dynamics in Arctic Alaska and the Responses of the Iñupiat Hunting Community	1						1																					1																				
2018	Hauser, D.D.W., et al.	Vulnerability of Arctic marine mammals to vessel traffic in the increasingly ice-free Northwest Passage and Northern Sea Route	1	1		1	1													1							1																							1
2008	Hopcroft, R., et al.	Arctic Ocean Synthesis: Analysis of Climate Change Impacts in the Chukchi and Beaufort Seas with Strategies for Future Research	1	1				1												1					1																									1
2008	Laidre, K.L., et al.	Quantifying the Sensitivity of Arctic Marine Mammals to Climate-Induced Habitat Change	1	1		1	1																1	1	1		1		1	1									1			1	1	1	1		1		
2018	Lone, K., et al.	Aquatic behaviour of polar bears (*Ursus maritimus*) in an increasingly ice-free Arctic				1		1															1		1																						1		
2018	Mioduszewski, J., et al.	Diminishing Arctic Sea Ice Promotes Stronger Surface Winds	1	1		1	1																		1		1																						
2018	Moore, S.E. and Reeves, R.R.	Tracking arctic marine mammal resilience in an era of rapid ecosystem alteration	1	1		1	1																		1		1																						1
2019	Niemi, A., et al.	State of Canada's Arctic Seas					1		1																1				1																				1
2011	Quinn, P.K., et al.	The Impact of Black Carbon on Arctic Climate					1																		1																								
2019	Tempel, J.L.	Life Without Ice: Climate Change and the Subsistence Communities of St. Lawrence Island		1		1			1																1														1			1	1	1	1				
1997	Tynan, C.T. and Demaster, D.P.	Observations and Predictions of Arctic Climatic Change: Potential Effects on Marine Mammals	1	1		1	1																1	1	1																								1
2017	Udevitz, M.S., et al.	Forecasting Consequences of Changing Sea Ice Availability for Pacific Walruses		1																			1		1																1							
2012	USGS	Changing Arctic Ecosystems: Polar Bear and Walrus Response to the Rapid Decline in Arctic Sea Ice	1	1																			1	1	1																1					1		
2019	VanWormer, E., et al.	Viral emergence in marine mammals in the North Pacific may be linked to Arctic sea ice reduction	1	1		1	1																		1																							1
		Totals	14	12	0	9	8	2	4	0	0	0	0	0	0	0	0	0	0	2	0	0	7	5	18	0	4	0	3	5	0	0	0	0	0	0	0	0	3	0	0	5	3	3	3	0	6	0	6

List of Literature by Year, Author, Title & Topics

Bin 7. Scientific Studies

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline or sound Source Levels	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Polar Bear	Steller Sea Lion	Sea Otter	Marine Mammal General
1995	Richardson, W.J., et al.	Marine Mammals and Noise																																													1
1998	Miller, G.W., et al.	Ringed seal distribution and abundance near potential oil development sites in the central Alaskan Beaufort Sea, spring 1997; Appendix A in Richardson 2008	1					1																																			1					
1999	Lesage, V., et al.	The effect of vessel noise on the vocal behavior of belugas in the St. Lawrence River Estuary, Canada					1													1									1																				
1999	Link, M.R., et al.	Ringed seal distribution and abundance near potential oil development sites in the central Alaskan Beaufort Sea, spring 1998; Appendix B in Richardson 2008	1					1																																			1					
2000	Moore, S.E., D. P. DeMaster and P. K. Dayton	Cetacean habitat selection in the Alaskan Arctic in the summer and autumn	1	1				1																			1		1	1			1																
2000	Moore, S.E.	Variability of cetacean distribution and habitat selection in the Alaskan Arctic, Autumn 1982-91	1	1				1																			1		1	1			1																
2001	Harris, R.E., et al.	Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea	1															1									1												1					1	1				
2002	Moulton, V.D., et al.	Factors influencing local abundance and haulout behaviour of ringed seals (*Phoca hispida)* on landfast ice of the Alaskan Beaufort Sea; Appendix K in Richardson 2008	1					1																																			1					
2002	Patenaude, N.J., et al.	Aircraft Sound and Disturbance to Bowhead and Beluga Whales During Spring Migration in the Alaskan Beaufort Sea	1								1																		1	1																			
2002	Richardson, J.W.	Marine Mammals Versus Seismic and Other Acoustic Surveys: Introduction to the Noise Issues						1										1																															1
2003	Blackwell, S.B. and Greene Jr., C.R.	Acoustic Measurements in Cook Inlet, Alaska, during August 2001			1						1				1		1			1									1																				
2003	NRC	Cumulative environmental effects of oil and gas activities on Alaska's North Slope	1						1	1	1	1	1	1	1		1	1	1	1						1	1		1	1			1	1					1			1	1	1	1	1			1
2005	Moulton, V.D., et al.	Effects of an Offshore Oil Development on Local Abundance and Distribution of Ringed Seals (*Phoca hispida*) of the Alaskan Beaufort Sea	1										1														1																	1					
2005	NRC	Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects					1			1					1	1											1																						1
2006	HDR Alaska Inc., et al.	Final Underwater Measurements of Pile- Driving Sounds During the Port MacKenzie Dock Modifications,13–16 August, 2004			1					1							1																																
2006	Williams, M.T., et al.	Ringed Seal (*Phoca hispida*) Use of Subnivean Structures in the Alaskan Beaufort Sea During Development of an Oil Production Facility	1							1			1														1																	1					
2007	Nowacek, D.P., et al	Responses of cetaceans to anthropogenic noise									1	1	1	1				1		1									1	1					1														
2007	Southall, B., et al.	Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations						1								1										1	1																						1
2007	URS	Port of Anchorage Marine Terminal Development Project Underwater Noise Survey Test Pile Driving Program Anchorage, Alaska			1					1							1										1																						
2008	Greene, C.R., Jr., et al.	Sounds and vibrations in the frozen Beaufort Sea during gravel island construction	1							1					1		1										1																						1
2008	Hatch, L., et al.	Characterizing the relative contributions of large vessels to total ocean noise fields: a case study using the Gerry E. Studds Stellwagen Bank National Marine Sanctuary					1													1						1	1																						1
2008	Koski, W.R., *et al.*	Feeding by Bowhead Whales Near Offshore Seismic in Central Beaufort Sea	1															1												1																			
2008	Laidre, K.L., et al.	Quantifying the sensitivity of Arctic marine mammals to climate-induced habitat change	1	1			1	1																	1		1		1	1			1						1			1	1	1	1	1			
2008	Moore, S.E. and Huntington, H.P.	Arctic marine mammals and climate change: Impacts and resilience	1	1		1		1																	1		1		1	1			1	1					1			1	1	1	1	1			
2008	Southall, B. and Hatch, L.	Preliminary Comprehensive Overview of the Impacts of Anthropogenic Underwater Sound in the Marine Environment, Module 5: Shipping					1													1							1																						1
2008	Tyack, P.L.	Implications for Marine Mammals of Large-Scale Changes in the Marine Acoustic Environment						1								1										1	1																						1

List of Literature by Year, Author, Title & Topics

Bin 7. Scientific Studies

Year	Author	Document Title	Region					Baseline		Acoustics																Cetaceans												Pinnipeds											
			Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline or sound Source Levels	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	California Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Polar Bear	Steller Sea Lion	Sea Otter	Marine Mammal General
2008	Weir, C.R.	Overt Responses of Humpback Whales (*Megaptera novaeangliae*), Sperm Whales (P*hyseter macrocephalus*), and Atlantic Spotted Dolphins (*Stenella frontalis*) to Seismic Exploration off Angola					1											1									1																				1
2008	Wyatt, R., et al.	Joint Industry Programme on Sound and Marine Life: Review of Existing Data on Underwater Sounds Produced by the Oil and Gas Industry, Issue 1								1			1		1		1	1		1							1																				1
2009	Huntington, H.P.	A preliminary assessment of threats to arctic marine mammals and their conservation in the coming decades											1							1					1																						1
2009	Lucke, K., et al.	Temporary shift in masked hearing thresholds in a harbor porpoise (*Phocoena phocoena*) after exposure to seismic airgun stimuli																									1						1													
2009	Mann, D., et al.	Under-ice noise generated from diamond exploration in a Canadian sub-arctic lake and potential impacts on fishes					1						1		1																															
2010	Di Iorio, L. and Clark, C.W.	Exposure to seismic survey alters blue whale acoustic communication					1											1									1																				
2010	Landro, M. and Amundsen, L.	Marine Seismic Sources Part V: The Hearing Of Marine Mammals						1								1												1																			1
2010	Moulton, V.D. and Holst, M.	Effects of Seismic Survey Sound on Cetaceans in the Northwest Atlantic					1											1									1																			1
2011	Guerra, M., et al.	Quantifying seismic survey reverberation off the Alaskan North Slope	1															1									1																			1
2011	Hammay, D., *et al.*	Model based assessment of underwater noise from an airgun array soft-start operation								1								1																												1
2011	McQuinn, I.H., et al.	A threatened beluga (*Delphinapterus leucas*) population in the traffic lane: vessel-generated noise characteristics of the Saguenay-St. Lawrence Marine Park, Canada					1													1							1		1																
2011	Small, R.J., et al.	Chukchi Sea Acoustics Workshop: Final Report		1				1	1							1										1	1																			1
2012	Ellison, W.T., et al.	A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds								1																1	1																			1
2012	Gervaise, C., et al.	Shipping noise in whale habitat: characteristics, sources, budget, and impact on belugas in Saguenay-St. Lawrence Marine Park hub					1													1							1		1																
2012	Guy, L.S., et al.	Synthesis of Arctic research (SOAR) science workshop report	1	1				1																																					1
2012	Hoffman, C.A.	Mitigating impacts of underwater noise from dredging on beluga whales in Cook Inlet, Alaska			1							1			1											1		1																		
2012	Moore, S.E., et al.	A New Framework for Assessing the Effects of Anthropogenic Sound on Marine Mammals in a Rapidly Changing Arctic	1	1			1																		1	1	1																		1
2012	Quakenbush, L., et al.	Seasonal Movements of the Bering-Chukchi-Beaufort Stock of Bowhead Whales: 2006–2011 Satellite Telemetry Results	1	1		1																					1			1															
2012	Reine, K., et al.	Characterization of Underwater Sounds Produced by a Backhoe Dredge Excavating Rock and Gravel					1					1																																		
2012	Stewart, B.	Interactions between beluga whales (*Delphinapterus leucas*) and boats in Knik Arm, upper Cook Inlet, Alaska: Behavior and Bioacoustics			1			1																	1		1		1																
2013	Aerts, L.A.M. and Streever, B.	Modeled and Measured Underwater Sound Isopleths and Implications for Marine Mammal Mitigation in Alaska																1									1																			1
2013	Erbe, C., et al.	Underwater noise from offshore oil production vessels					1			1			1																																		1
2013	Heinis, F., et al.	Monitoring Programme for the Maasvlakte 2, Part III - The Effects of Underwater Sound				1									1					1							1							1												1
2013	Marine Environment Protection Committee	Noise From Commercial Shipping and its Adverse Impacts on Marine Life					1			1										1							1																			x
2013	Robertson, F.C., et al.	Seismic operations have variable effects on dive-cycle behavior of bowhead whales in the Beaufort Sea	1															1												1																
2013	Stafford, K.	Anthropogenic Sound and Marine Mammals in the Arctic: Increases in Man-Made Noises Pose New Challenges	1	1		1	1	1								1		1	1	1							1																			1
2014	CSA Ocean Sciences Inc.	Quieting Technologies for Reducing Noise During Seismic Surveying and Pile Driving Workshop: Summary Report								1							1	1		1							1																			1

List of Literature by Year, Author, Title & Topics

Bin 7. Scientific Studies

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline or sound Source Levels	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	California Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Polar Bear	Steller Sea Lion	Sea Otter	Marine Mammal General
2014	MacGillivray, A.O., et al.	Marine mammal audibility of selected shallow-water survey sources												1	1		1	1	1								1		1					1															1
2014	Moore, S.E. and Gulland, F.M.D.	Linking marine mammal and ocean health in the 'New Normal' arctic																							1																								1
2014	Reeves, R.R., et al.	Distribution of endemic cetaceans in relation to hydrocarbon development and commercial shipping in a warming Arctic	1	1		1	1						1							1			1	1	1		1	1	1	1																			
2014	Robertson, F.C.	Effects of Seismic Operations on Bowhead Whale Behaviour: Implications for Distribution and Abundance Assessments	1															1												1																			
2014	Vedenev, A. and Shatravin, A.	Safety zones and noise exposure criteria for marine mammals exposed to anthropogenic noise	1	1		1	1											1									1																						1
2014	Williams, R., et al.	Marine mammals and ocean noise: future directions and information needs with respect to science, policy and law in Canada					1												1	1						1	1																						1
2015	Blackwell, S.B., et al.	Effects of airgun sounds on bowhead whale calling rates: evidence for two behavioral thresholds	1															1												1																			
2015	Finneran, J.J.	Noise-induced hearing loss in marine mammals: A review of temporary threshold shift studies from 1996 to 2015						1																			1		1																				1
2015	Grebmeier, J.M., *et al.*	Pacific Marine Arctic Regional Synthesis (PacMARS) Final Report. North Pacific Research Board	1	1		1	1	1														1																											1
2015	Hamilton, C.D., et al.	Predictions replaced by facts: a keystone species' behavioural responses to declining arctic sea-ice					1	1															1	1	1																			1					
2015	Laidre, K.L., et al.	Arctic marine mammal population status, sea ice habitat loss, and conservation recommendations for the 21st century	1	1			1	1															1		1	1	1		1	1			1						1			1	1	1	1	1			
2015	Miller, J.H.	Ocean Noise Variability and Noise Budgets													1											1	1																						1
2015	Moore, S.E. and Stabeno, P.J.	Synthesis of Arctic Research (SOAR) in marine ecosystems of the Pacific Arctic	1	1				1																			1																						1
2015	Nowacek, D.P., et al.	Marine seismic surveys and ocean noise: time for coodrinated and prudent planning																1									1																						1
2016	Aguilar de Soto, N., et al.	From physiology to policy: A review of physiological noise effects on marine fauna with implications for mitigation												1			1	1	1								1																						1
2016	Costa, D.P., et al.	Assessing the exposure of animals to acoustic disturbance: Towards an understanding of the population consequences of disturbance				1	1											1								1	1																						1
2016	Ellison, W.T., et al.	Modeling the aggregated exposure and responses of bowhead whales Balaena mysticetus to multiple sources of anthropogenic underwater sound	1										1					1		1							1			1																			
2016	Erbe, C., *et al.*	Communication masking in marine mammals: A review and research strategy								1						1										1	1																						1
2016	Ireland, D.S., et al.	Adaptive Management Approach to Mitigating Oil and Gas Activities in Areas Occupied by Pacific Walrus		1									1														1															1							
2016	Moore, S.E.	Is it 'boom times' for baleen whales in the Pacific Arctic region?	1	1			1																		1						1				1		1												
2017	Atwood, T.C., et al.	Environmental and behavioral changes may influence the exposure of an Arctic apex predator to pathogens and contaminants	1																						1																					1			
2017	Boveng, P.L., et al.	Abundance Estimates of Ice- Associated Seals: Bering Sea Populations that Inhabit the Chukchi Sea During the Open-Water Period		1		1		1																															1				1	1	1				
2017	Erbe, C. and McPherson, C.	Underwater noise from geotechnical drilling and standard penetration testing					1			1			1				1			1							1																						1
2017	Liu, M., et al.	Broadband ship noise and its potential impacts on Indo-Pacific humpback dolphins: Implications for conservation and management					1													1							1																						1
2017	Shelden, K.E.W., et al.	Aerial Surveys, Abundance, and Distribution of Beluga Whales (*Delphinapterus leucas*) in Cook Inlet, Alaska, June 2016			1			1																			1		1																				
2017	Silber, G.K., et al.	Projecting Marine Mammal Distribution in a Changing Climate	1																						1																								1
2018	Ellison, W.T., et al.	An Acoustic Scene Perspective on Spatial, Temporal, and Spectral Aspects of Marine Mammal Behavioral Responses to Noise								1																1	1																						1
2018	Hauri, C., et al.	From sea ice to seals: a moored marine ecosystem observatory in the Arctic		1				1								1									1		1																						1

List of Literature by Year, Author, Title & Topics

Bin 7. Scientific Studies

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline or sound Source Levels	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Harbor Porpoise	Humpback Wahles	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	California Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Polar Bear	Steller Sea Lion	Sea Otter	Marine Mammal General
2018	Haver, S.M., et al.	Monitoring long-term soundscape trends in U.S. waters: The NOAA/NPS Ocean Noise Reference Station Network					1	1		1																																								
2018	Kuşku, H., et al.	Acoustic Noise Pollution from Marine Industrial Activities: Exposure and Impacts										1	1		1		1	1		1							1		1																					
2018	O'Corry-Crowe, G., et al.	Migratory culture, population structure and stock identity in North Pacific beluga whales (*Delphinapterus leucas*)	1	1	1	1		1																			1		1																					
2018	Quakenbush, L., et al.	Bering-Chukchi-Beaufort Stock of Bowhead Whales: 2006–2017 Satellite Telemetry Results with Some Observations on Stock Sub- Structure	1	1		1																					1			1																				
2018	Shelden, K.E.W., et al.	Beluga Whale, *Delphinapterus leucas*, Satellite-Tagging and Health Assessments in Cook Inlet, Alaska, 1999 to 2002			1			1																			1		1																					
2018	Taylor, R.L., et al.	Demography of the Pacific walrus (*Odobenus rosmarus divergens*) in a changing Arctic		1		1	1	1																			1															1							
2018	Wilson, R.R., et al.	Potential Impacts of Offshore Oil Spills on Polar Bears in the Chukchi Sea	1	1			1																				1	1																		1			
2019	Castellote, M., et al.	Anthropogenic Noise and the Endangered Cook Inlet Beluga Whale, *Delphinapterus leucas*: Acoustic Considerations for Management			1			1			1	1		1	1	1	1			1						1			1																			
2019	Erbe, C., et al.	Managing the Effects of Noise From Ship Traffic, Seismic Surveying and Construction on Marine Mammals in Antarctica					1			1								1		1						1	1																					1
2019	Miller, J.H.	Pile Driving: Near Field Characteristics/Considerations															1									1	1																					1
2019	Protection of the Arctic Marine Environment (PAME) and Arctic Council	Underwater Noise in the Arctic: A State of Knowledge Report	1	1			1			1								1		1									1	1														1					1
2019	Southall, B.L., et al.	Errata: Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects						1								1		1	1	1						1	1																					1
2019	Southall, B.L., et al.	Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects						1								1		1	1	1						1	1																					1
2020	Delean, B.J., et al.	Human-Caused Mortality and Injury of NMFS-Managed Alaska Marine Mammal Stocks 2013-2017						1																																								1
2020	Frankel, A.S. and Stein, P.J.	Gray whales hear and respond to signals from a 21-25 kHz active sonar					1												1								1						1																
2020	Halliday, W.D., et al.	Underwater noise and Arctic marine mammals: review and policy recommendations	1	1			1	1																																								1
2020	McGuire, T.L., et al.	Reproductive natural history of endangered Cook Inlet Beluga whales: insights from a long-term photo-identification study			1			1																					1																					
2020	Reichmuth, C., et al.	Behavioral assessment of in-air hearing range for the Pacific walrus (*Odobenus rosmarus divergens*)						1																																		1							
2020	USGS	Analyses on Subpopulation Abundance and AnnualNumber of Maternal Dens for the U.S. Fish and Wildlife Service on Polar Bears (*Ursus maritimus*) in the Southern Beaufort Sea, Alaska	1					1																																						1			
2020	Willoughby, A.L., et al.	Bowhead whale (*Balaena mysticetus*) and killer whale (*Orcinus orca*) co-occurrence in the U.S. Pacific Arctic, 2009–2018: evidence from bowhead whale carcasses	1	1				1																						1						1													
		Totals	**38**	**25**	**10**	**12**	**33**	**36**	**2**	**18**	**5**	**6**	**13**	**5**	**12**	**11**	**13**	**28**	**8**	**25**	**0**	**1**	**3**	**2**	**13**	**18**	**64**	**2**	**25**	**18**	**1**	**0**	**7**	**5**	**2**	**1**	**1**		**6**	**0**	**0**	**7**	**5**	**13**	**6**	**7**	**0**	**0**	**49**

List of Literature by Year, Author, Title & Topics

Bin 8. Oil Spill Incidents, Preparation and Response

			Region					Baseline		Acoustics																			Cetaceans										Pinnipeds										
Year	Author	Document Title	Beaufort Sea	Chukchi Sea	Cook Inlet	Other Alaska Region	Other (International or US)	Scientific Baseline	Traditional Ecol. Knowledge	Baseline	Aircraft	Dredging	Drilling & Production	Geophysical Surveys (echosounders, sub-bottom prof.)	Other (i.e., underwater tools)	Passive Acoustics	Pile Driving	Seismic	Sonar	Vessels	Marine Transit Route	Physical Disturbance	Changes to Habitat	Changes in Prey	Climate Change	Cumulative Impacts	Mitigation & Monitoring	Oil Spills and Response	Beluga Whales	Bowhead Whales	Fin Whales	Dall's Porpoise	Gray Whales	Humpback Wahles	Harbor Porpoise	Killer Whales	Minke Wahles	North Pacific Right Whales	Bearded Seal	Californa Sea Lion	Harbor Seals	Pacific Walrus	Ribbon Seal	Ringed Seal	Spotted Seal	Steller Sea Lion	Polar Bear	Sea Otter	Marine Mammals General
2017	Wright, S.K., *et al.*	Arctic marine mammal disaster response guidelines: National Marine Fisheries Service guidance report	1	1		1																						1																					1
2018	ABSG Consulting Inc.	BOEM OCS Spill Statistics Report FINAL BOEM-2018-006					1																					1																					
2018	ABSG Consulting Inc.	Oil Spill Occurrence Estimators- Fault Tree Analysis for One or More Potential Future Beaufort Sea OCS Lease Sales. OCS Study BOEM 2018-048	1																									1																					
2019	BOEM	USDOI, BOEM Oil Spill Preparedness, Prevention, and Response on the Alaska OCS. OCS Report BOEM 2019-006	1	1	1	1																						1																					
2020	Robertson, T. and Campbell, L.K.	Oil Spill Occurrence Rates for Cook Inlet, Alaska Oil and Gas Exploration, Development, and Production			1																							1																					
2020	Robertson, T. and Campbell, L.K.	Oil spill occurrence rates from Alaska North Slope oil and gas exploration, development, and production	1																									1																					
		Totals	**4**	**2**	**2**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**