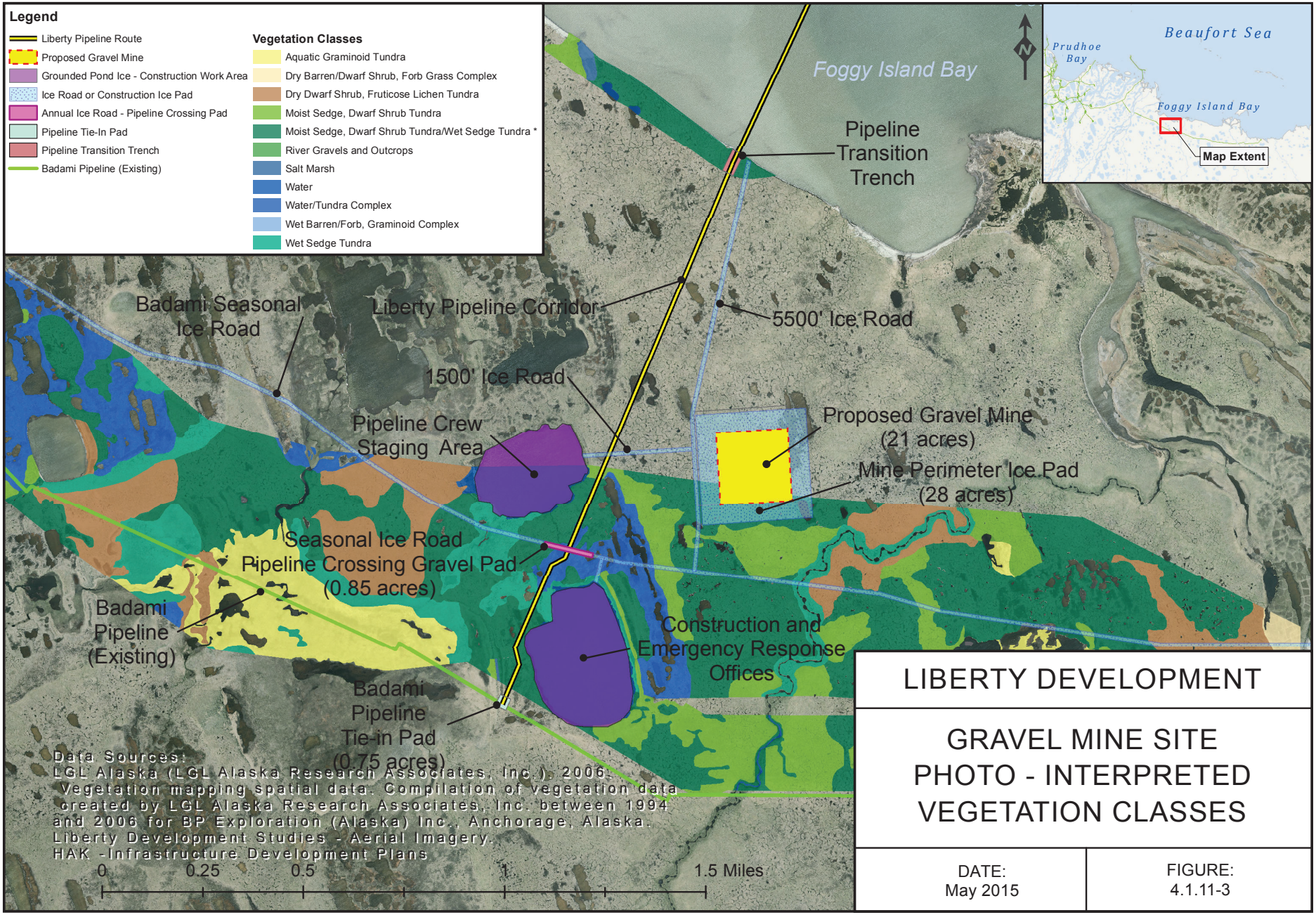
Table 4.1.11-3. Photo Interpreted Vegetation Classes Potentially Affected by the Proposed Pipeline and Gravel Source for the Liberty Drilling Island

COVER CLASS	LEVEL C UNIT MAP CODE	DESCRIPTION OF LEVEL C PHOTO INTERPRETED MAP UNITS	PIPELINE TRANSITION TRENCH[3] (ACRES)	PIPELINE SEASONAL CROSSING GRAVEL ICE PAD[4] (ACRES)	PIPELINE TIE-IN PAD[1]	GRAVEL MINE SITE (ACRES)[1]	TEMPORARY ICE ROADS AND PADS (ACRES)[1,5]
Water	Ia	Water (ponds, lakes, rivers, streams, saltwater)	--	--	--	--	
Water/Tundra Complex	IId	Water/Tundra Complex (interconnected ponds with emergent vegetation)	--	0.45	--	--	
Wet Tundra	IIIa	Wet Sedge Tundra	--	--	--	--	
	IIId	Wet Sedge/Moist Sedge, Dwarf Shrub Tundra Complex (wet patterned ground complex)	--	--	--	1.1	
Moist/Wet Tundra	IVa	Moist Sedge, Dwarf Shrub/Wet Graminoid Complex (moist patterned ground complex)	1.0	0.4	--	2.8	
Moist Tundra	Va	Moist Sedge, Dwarf Shrub Tundra	--	--	--	--	
Mapped Area Total			1.0	0.85	Area not mapped	3.9 out of 21 acres (18%) mapped	

Notes:

1. Only a portion of the study area has been mapped for photo-interpreted vegetation classes. Portions of the gravel mine site, pipeline route, and the pipeline tie-in pad are not included in the vegetation class mapping.
2. 200-foot-wide corridor centered on estimated route, digitized from MMS 2002c with pad locations from Noel and McKendrick 2000. Of the area mapped, the pipeline crosses primarily wet tundra and moist/wet tundra. Along this corridor, the pipeline will be elevated on VSMs, directly impacting only a small area of vegetation (0.01 to 0.03 acres depending upon terrain, exact placement of VSMs, and installation method), which is not included in this tabulation.
3. Trench area calculated as 300 feet long and 150 feet wide or 1.0 acres.
4. Pad impacts based on estimated size of tie-in pad = 170 feet by 155 feet, or 0.6 acres, with 0.75-acre gravel footprint.
5. Gravel pad to allow annual ice road to cross pipeline corridor (i.e., ice road crossing pad) estimated to have approximately 0.85 acre footprint; location is estimated.
6. Ice roads and pads have minimal impact on tundra vegetation. Ice roads and pads impacts based on estimated 17.4 acres of construction ice roads and an 28-acre mine site perimeter ice-pad over tundra habitat (45.4 acres total).

Source: LGL Alaska 2006; Vegetation mapping spatial database provided by Liberty design team, supplemented with additional data digitized from the Point Thomson EIS Appendix J (USACE 2012a).



LIBERTY DEVELOPMENT

GRAVEL MINE SITE PHOTO - INTERPRETED VEGETATION CLASSES

DATE:	FIGURE:
May 2015	4.1.11-3

Table 4.1.11-4. Potential Effects of Project Components on Wetland Functions

WETLAND FUNCTION	PIPELINE	GRAVEL PAD	GRAVEL MINE	ICE ROADS AND PAD[1]	WINTER WATER WITHDRAWAL[2]
Flood Flow Moderation and Conveyance *Indicators:* Floodplains of streams Wetlands, ponds, lakes, and lake basins	Minimal effects provided trenching at shoreline and VSM placement in floodplains is minimized.	Gravel fill on tundra and nearshore waters eliminate areas where floodwaters are stored and conveyed, can redirect water flow, and eliminates the absorptive capacity of the underlying vegetation and soil. The net effect of gravel fill is an incremental increase in the height and flashiness of stream flow peaks. Fill placement in floodplains could also change the locations and duration of flooding. Most project area wetlands absorb snowmelt and rainfall.	No effect. The gravel mine would retain water during snowmelt.	Ice roads and pads running cross-gradient would alter sheet flow during spring snowmelt, impounding water upgradient, or re-routing water more directly toward streams. Ice roads could concentrate snowmelt waters into streams at the stream crossings and could dam water upstream within the floodplain delaying outflow until the road is breached.	No effect. Lakes used as water sources with reduction in total water volume may have an increase in capacity to store snowmelt waters.
Shoreline and Bank Stabilization *Indicators:* Emergent vegetation (IIb and IId) in and next to lakes >20 acres Well vegetation areas II, (III, IV, V) within and next to lakes >20 acres and stream channels Estuarine meadows (IIIb, IXh) Coastal beaches (Xa)	Potential effects due to trenching at shoreline approach; minimal effect for VSMs provided placement in floodplains is minimized.	Gravel fill on tundra and nearshore waters would eliminate this function where fill is placed next to moving water or lake shorelines. Placement of an embankment in a stream or floodplain could focus erosive forces in new locations that could erode the vegetation and reduce its ability to perform the function.	The gravel mine would eliminate features performing this function within its footprint. When the mine fills with water and becomes a lake, shore-protecting vegetation may be re-established.	Concentration of snowmelt waters into streams at ice road and pad crossings, damming of streams, and concentration of flow across the ice road could increase erosive potential, removing vegetation and reducing their shoreline and bank stability function.	This function would remain unchanged in lakes that recharge with snowmelt waters. If water-source lakes did not refill during snowmelt, aquatic and shoreline vegetation may temporarily lose vigor and the capacity to stabilize shorelines by intercepting wave energy and protect banks from wave erosion.
Maintenance of Natural Sediment Transport Processes *Indicators:* Floodplains of large and small streams	Negligible effects unless the overfilled pipeline trench at the shoreline and in nearshore water intercepts long-shore currents.	Gravel fill on tundra and nearshore waters would eliminate or alter this function with fill embankments potentially changing sediment transport and deposition patterns. No changes in sediment retention at lakes anticipated.	This function would be eliminated within the mine footprint, which would retain sediment it receives.	Where ice roads and pads cross streams and floodplains, sediment transport during snowmelt could be altered. Sediments would tend to settle upstream of the ice road crossing, and erosion would tend to increase downstream if flows were concentrated. Slotting ice roads prior to snowmelt at appropriate locations would allow for more natural downstream transport of suspended sediments.	No effect. Lakes receiving sediment would still retain the sediment.
Production and Export of Organic Matter *Indicators:* Vegetated wetland with surface water connection to other wetlands or streams Flooded wetlands (II, III) in or next to stream floodplain Streams and vegetated wetlands (II, III, IV, V) within floodplains Vegetated estuarine wetlands (IIIb, IXh) Large topographic basins with surface water outlets	The vegetation performing this function within the trench footprint would be eliminated and would be altered or remain reduced when vegetation cover is restored. Disturbance from VSM installation would have negligible effects.	Gravel fill on tundra would eliminate this function with fill effects such as release of dust, impoundment of water, and changes in downgradient site moisture potentially changing production of organic matter in adjacent wetlands. Changes in flow patterns could also alter export to downstream ecosystems with either beneficial or detrimental effects.	Production of organic matter would be eliminated within the mine footprint until the pit is closed and would be substantially reduced thereafter, relative to the preconstruction vegetation communities.	Ice roads and pads may alter snowmelt water overland flows, but the net alteration of export would likely be negligible. Production of organic matter under and next to ice roads and pads would be changed by altered hydrology and phenology, but direction of change is uncertain.	Lake drawdown could adversely affect productivity of lakeshore vegetation during years that the lake does not refill completely with snowmelt waters. Because the flow out from the lake would likely be reduced, export of organic matter may also be reduced.
Maintenance of Soil Thermal Regime *Indicators:* Wet tundra (III) and moist tundra (IVa, Va, Vb)	Removal and disturbance of the vegetation and peat cover by trenching at the shoreline, combined with the operational temperature of the pipeline, may compromise the thermal stability in the	Gravel fill on tundra would replace this function provided the fill is sufficiently thick to replace the insulating vegetation cover. This function may be degraded at fill edges by drifting snow, dust and gravel spray,	This function would be eliminated within the mine footprint by removal of the vegetative cover.	Ice roads located on tussocks or high-centered polygons or ice roads that are not moved from year to year could result in damage to the vegetation structure and the vegetation mat that would decrease its	No effect.

Table 4.1.11-4. Potential Effects of Project Components on Wetland Functions

WETLAND FUNCTION	PIPELINE	GRAVEL PAD	GRAVEL MINE	ICE ROADS AND PAD[1]	WINTER WATER WITHDRAWAL[2]
	trenched section. Removal of vegetation by VSM installation would have little to no effect.	impoundment of runoff, and changes to surface flow patterns that may alter the thermal regime and accelerate thermokarst.		ability to maintain normal soil temperatures leading to thermokarst.	
Waterbird Support *Indicators:* Coastal wet sedge-grass marsh (IIIb, IXh) and barrens (IXi, Xa) Emergent marsh (IIb, IId; *Arctophila* – grass marsh) Basin wetland complexes Patterned wet sedge/low-center polygon wetlands (IIId) and adjacent ponds Wet sedge wetlands (IIIa, IIIc, IIId) and adjacent ponds High-center polygon wetlands (Vd) Lakes Nearshore waters	Minimal loss and change in habitat resulting from trenching, installation of VSM, and snow drifts. Potential minor changes in behavior of waterbirds and predators resulting from presence of the aboveground pipeline and pipeline monitoring.	Gravel fill on tundra and nearshore waters would eliminate this function within fill footprints. Adjacent habitats may be altered by changes in drainage, changes in snow accumulation, deposition of dust and gravel, and resulting changes in plant types and phenology.	Waterbird habitats present before gravel mining would be eliminated and open water habitat would be created, which would represent a conversion of habitat that may also be used by waterbirds. Habitats adjacent to the gravel mine may become drier because of altered hydrology as they drain into the mine basin.	Ice roads and pads would delay availability, change the moisture regime, and alter plant phenology in habitats under and next to the ice roads and pads, altering nesting and feeding site availability. The habitats supporting waterbirds are generally wetter habitats that are less likely to be adversely affected by ice roads. Waterbirds could be exposed to fuel and oil spills or leaks from vehicles on ice roads or pads that are undetected or incompletely removed.	Lake drawdown could reduce open-water habitat and suitability of shoreline and island habitats in the years the lake did not completely recharge during snowmelt.
Terrestrial Mammal Support *Indicators:* Brown bear den habitat (polar bear denning habitat buffered by 50 feet excluding areas within a mile from the coast). Riparian corridors/floodplains of large rivers including gravel bars (Xa) Tussock tundra (Vb) Coastal spits and coastal barrens (coastal Xa)	Minimal loss and change in habitat from trenching, VSM installation, and snow drifts. Potential behavioral changes resulting from presence of bermed trench location and aboveground pipeline.	Gravel fill on tundra would eliminate tundra habitats and would potentially slightly degrade habitats near fill edges as a result of changes in snow accumulation, changes in site moisture, and deposition of dust and gravel.	This function would be eliminated within the mine footprint by removal of vegetation cover.	Ice roads and pads tend to melt later and delay sprouting of vegetation compared to the surrounding tundra; habitat covered by ice roads would not be available for grazing by small mammals, bears, muskoxen, or caribou early in the summer. Assuming FLIR surveys identified active brown bear dens and ice road routes were altered to avoid dens, there would be no effect on bear dens. Some individuals could be disturbed or exposed to fuel and oil spills or leaks from vehicles on ice roads or pads that are undetected or incompletely removed.	No effect on the evaluated habitats.
Resident and Diadromous Fish Support *Indicators:* Streams, ponds, lakes, coastal and river gravel bars, wetlands within floodplains of either fish-bearing streams Marine and nearshore EFH and intertidal areas, and coastal beaches	Minimal effects, temporary increase in suspended sediments in nearshore EFH.	Gravel fill on tundra and nearshore waters would eliminate fish habitat and could alter travel routes. Adjacent habitat could be degraded by deposition of dust and gravel, changes in drainage patterns and flooding regime, and changes of vegetation and invertebrate communities.	This function, if present prior to gravel mine construction, would be eliminated or altered within the mine footprint as the pit is converted to aquatic habitat.	Ice roads and pads crossing streams and along the coast could affect fish movements, spawning, and access to habitat. The sea ice road is unlikely to affect fish use of nearshore marine habitats because these areas are naturally frozen to the bottom during winter. Slotting ice roads at stream crossings minimizes potential effects on fish movements. Fish could be exposed to fuel and oil spills or leaks from vehicles using ice roads or pads that are undetected or incompletely removed and reach streams during snowmelt.	No effect assuming water withdrawal from lakes with overwintering fish was restricted to ensure maintenance of fish habitat.

Table 4.1.11-4. Potential Effects of Project Components on Wetland Functions

WETLAND FUNCTION	PIPELINE	GRAVEL PAD	GRAVEL MINE	ICE ROADS AND PAD[1]	WINTER WATER WITHDRAWAL[2]
Threatened or Endangered Species Support ***Spectacled Eider*** *Indicators:* *Arctophila* and *Carex* wetlands (II, III) Basin wetland complexes Open water in complex with islands or patterned margins Patterned wet sedge/low-center polygon wetlands (IIId) Deep open lakes Nearshore marine waters Salt-killed tundra (IXi)	Minimal loss or alteration of habitat and behavior changes resulting from presence of the aboveground pipeline and pipeline monitoring.	For spectacled eider, effects would be the same as for waterbird support.	For spectacled eider, effects would be the same as for waterbird support.	For spectacled eider, effects would be the same as for waterbird support.	For spectacled eider, effects would be the same as for waterbird support.
Threatened or Endangered Species Support ***Polar Bear*** *Indicators:* Polar bear denning habitat buffered by 50 feet Potential characteristics of future critical habitat designation (sea ice, barrier island, no-disturbance zones)	Negligible loss of habitat and behavior changes resulting from presence of the aboveground pipeline.	For polar bear, loss of potential denning habitat and disturbance of individual bears by human activity.	Alteration of habitats for polar bear denning support would depend on occurrence of potentially suitable den habitat within the mine footprint.	No effect on polar bear habitat assuming ice roads and pads would be sited after FLIR survey. Possible disturbance of individual female bears by activity on ice roads and pads between emergence from den and cessation of ice road use. Some individual male bears could be disturbed. Polar bears could be exposed to fuel and oil spills or leaks from vehicles using ice roads or pads that are undetected or incompletely removed.	No effect on polar bear habitat.
Scarce and Valued Habitats *Indicators:* *Arctophila fulva* wetlands (IIb, IId) Salt-marsh communities (IIIb, IXh, IXi)	Minimal loss and change in habitat resulting from trenching, installation of VSM, and snow drifts. Potential minor changes in behavior of waterbirds, and predators.	This function would be eliminated and potentially degraded in areas next to fill because of changes in hydrology and deposition of dust and gravel.	This function would be eliminated within the mine footprint with removal of vegetation cover.	These highly valued habitat types are not among habitats that are most vulnerable to damage by ice roads and pads, and *Arctophila* marshes are least likely to be damaged by ice roads.	Lakes that support *Arctophila* marshes that do not fully recharge during snowmelt may be temporarily degraded.

1. Proposed ice road and ice pad locations are shown in the DPP Figures 5-1, 5-2, 10-1 (ice roads), and 10-2 (mine overburden storage ice pad). Exact locations may change due to site specific circumstances at the time of construction.
2. Water withdrawal locations are currently under consideration. Water withdrawal is permitted by ADNR and ADF&G, with conditions for environmental protection.

Key: EFH = Essential Fish Habitat; FLIR = Forward Looking Infrared Radar; VSM = vertical support member.

Source: Adapted from Table 5.8-3, and Appendix K in the Point Thomson Final EIS (USACE 2012a). Photo interpreted vegetation classes as defined in Table 4.1.11-3 and USACE 2012a.

Page intentionally left blank

Rare Plants

Rare plants, as defined in Section 3.11, that may occur at the pipeline landing based on preferred habitats could include *Draba micropetala*, fewflower draba (*Draba pauciflora*), hairy lousewort (*Pedicularis hirsuta*), and Alaskan bluegrass (*Poa hartzii alaskana*) (Table 3.11-2). No *Draba* species were found at the pipeline landing on August 7, 1998; one commonly occurring lousewort was found (*Pedicularis sudetica*), and an associate of Alaskan bluegrass, the wormwood (*Artemisia borealis*), was found (Noel and McKendrick 2000). The Badami pipeline tie-in pad would be in an area that could cross a mixture of habitats, from the dry lake basin terrace to low-centered polygons. Rare plants that may occur at the pipeline tie-in based on preferred habitats could include *Draba micropetala*, fewflower draba (*Draba pauciflora*), and hairy lousewort (*Pedicularis hirsuta*) on the lake basin terrace (Table 3.11-2). No *Draba* species were found at the tie-in location on August 7, 1998, and one commonly occurring lousewort (*Peducularis sudetica*) was found (Noel and McKendrick 2000). No rare plant surveys have been completed for Liberty Development, although based on preferred habitats, rare plants with potential to occur at the proposed gravel mine site could include false semaphoregrass (*Pleuropogon sabinei*) near pond shorelines (Table 3.11-2).

Water Withdrawal

Water withdrawal from freshwater sources would be necessary for ice roads and ice pads for pipeline and gravel mine construction. Ice roads would be used for winter access to the LDPI throughout the life of the project. Water withdrawal from freshwater sources is regulated by permits with conditions and stipulations that are intended to ensure protection of fish habitats and allow for recharge the following spring. Because freshwater withdrawal would be regulated, negligible impacts to shoreline vegetation are anticipated. If incomplete recharge were to occur, the lowered water levels of ponds and lakes could adversely affect aquatic and shoreline vegetation and their functions until the pond refilled the following season (Table 4.1.11-4; USACE 2012a).

Oil Spills

The most likely spills would be small oil leaks and fuel transfer spills during ice-road and ice-pad construction and use. These spills and leaks would most likely be detected and cleaned up before damage to vegetation or wetlands occurred. Spills that reach vegetation could damage or kill tundra. Oil can affect tundra by killing vegetation, with vegetation in upland habitats typically being more sensitive to damage than vegetation in wetter tundra communities (USACE 2012a). Fuels such as diesel are generally more damaging than crude oil to tundra vegetation (Walker et al. 1978). Oiled tundra habitats are difficult to remediate without causing further disturbance to the vegetative mat and soils; prevention of oil or fuels from reaching tundra should be a priority to minimize impacts to vegetation and wetlands.

Oil spills on tundra, or spills that wash ashore and onto coastal salt marshes constitute the greatest potential adverse effect to wetlands and terrestrial vegetation (**Figure 4.1.11-4**). The most likely scenario for oil reaching tundra or coastal salt marshes would be a leak or break of the aboveground or subsea portions of the pipeline. If the spill would occur during winter or break-up, little oil would be likely to reach the tundra or shoreline because of ice cover or river flow. If an aboveground pipeline spill occurred, it would most likely occur at the tie-in pad and would likely be contained on the pad. A spill from the pipeline on the tundra during summer would most likely occur within seasonally flooded/saturated wetlands or water. Small crude oil spills (255 bbls/acre or less) on wet tundra dominated by sedges and willows can recover naturally without any cleanup (McKendrick 1999). Crude oil spills on wet tundra are not as damaging as spills on dry tundra and may respond better to remediation (McKendrick 1999; Cater 2010). If the spill would occur during summer from the subsea portion of the pipeline, the prevailing winds from the northeast and the prevailing long-shore current to the west would likely transport the oil to inundated low-lying tundra and sheltered tidal flats around East Sagavanirktok Creek and the East Channel

Sagavanirktok River Delta. Winds from the west would push oil from a subsea pipeline spill into inundated low-lying tundra and salt- and brackish-water marshes near the Kadleroshilik River delta (Figure 4.1.11-4). Summer cleanup tactics from a pipeline spill would involve placement of booms, transportation across and along the tundra and shorelines, and removal of oil that could potentially damage tundra and coastal salt marsh habitats.

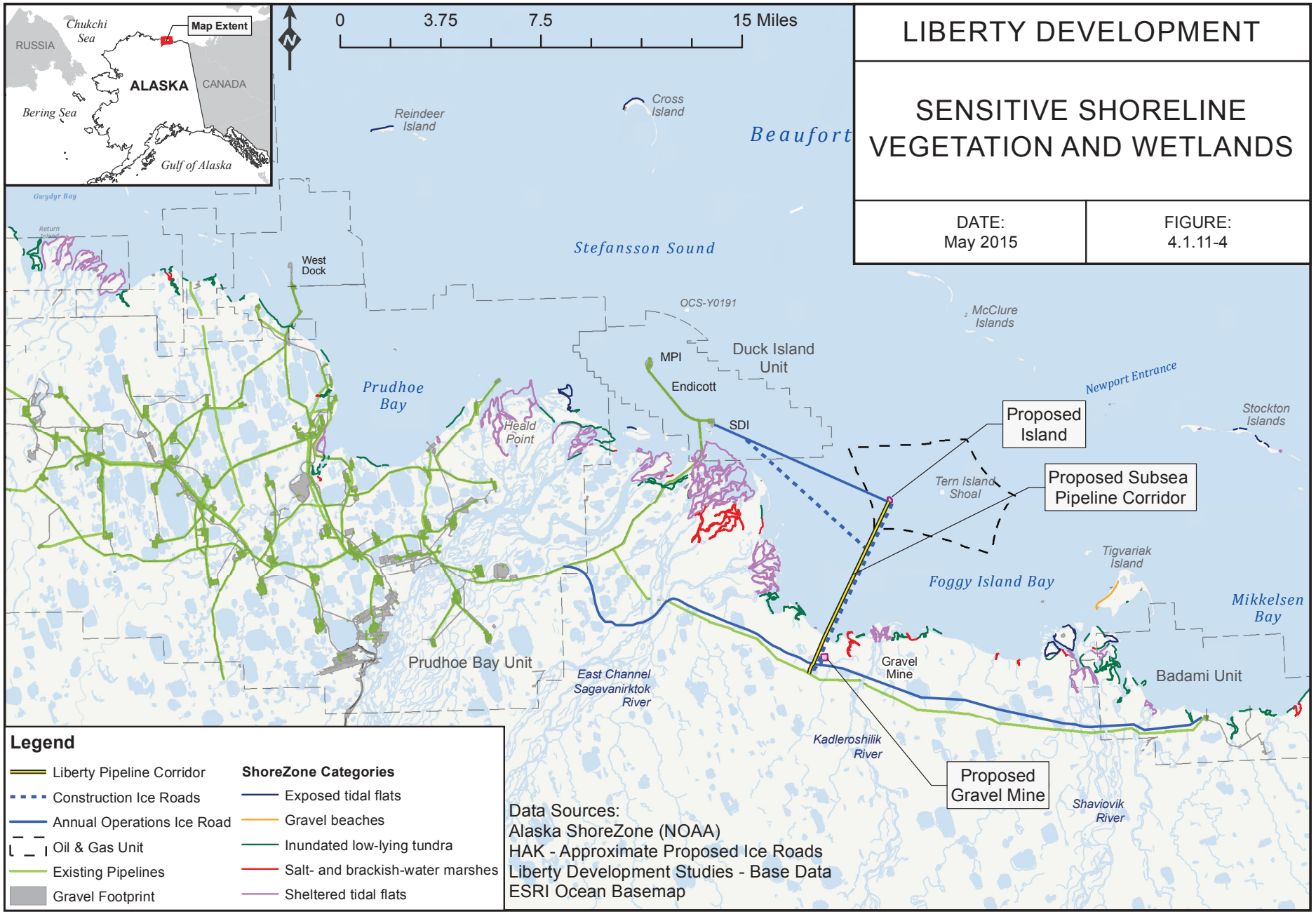
Because the oil-bearing reservoir would be drilled from the LDPI during the summer and winter months, potential oil spill impacts to vegetation and wetlands would be unlikely. Open water conditions would allow deployment of booms around the island and to protect sensitive coastal shorelines, and cleanup would be possible with skimmers. Snow and ice cover would prevent spilled oil from dispersing over large areas, and cleanup would be possible using loaders to scrape the oil off the ice and load it into trucks.

Under the WCD for an oil spill resulting from a well blowout during open water, minimal amounts of oil (microns thick) would be expected to reach the tundra from the air and small amounts may reach coastal shorelines. Under the WCD for an oil spill resulting from a well blowout during winter, minimal amounts of oil (microns thick) would be expected to reach the tundra. Most of the oil would fall onto the water or ice and would subsequently be burned for cleanup. The burning of oil would create an ash/soot residue that may be dispersed by wind. Most ash would be recovered from the ice, but some may remain on the ice and tundra when overflood and break-up occur. Deflection boom and skimmers would be placed along the mainland shoreline, and vessel-based reconnaissance and skimming would continue during the following open-water season if oil were present. Collectively, these measures would minimize the likelihood of oil reaching the shoreline, and minimal impacts to vegetation and wetlands would be expected.

Lease stipulations and mitigation measures for the pipeline, gravel pad, gravel mine, ice roads and pads described in Section 5 of this EIA and Section 13 of the DPP as well as spill prevention and response plans would be implemented to avoid or minimize potential adverse effects on tundra, coastal habitats, and wetlands.

Conclusion

Construction and operation of the proposed Liberty Development would result in loss of about 24 acres of tundra vegetation, wetland, and water habitats associated with the proposed pipeline facilities and gravel mine, as well as minor visible effects to an estimated 22 acres of tundra along the pipeline. Construction of ice roads and pads would result in potential temporary to long-term vegetation and wetland impacts from construction and water withdrawal. BOEM (2012) considered the consequences of allowing oil leasing and potential oilfield exploration and development in the Alaskan Arctic to range from minor to moderate with overall routine activities expected to result in direct loss from construction and damage during maintenance with secondary impacts from water and air quality degradation, ice roads, fugitive dust, and altered drainage caused by pipelines and roads. It is expected that the proposed Liberty Development will have a minor consequence consistent with BOEM's determination. MMS (2002c) also considered the consequences of the Liberty Island project proposed in 2000 and concluded that the gravel mine site would have a minimal effect on vegetation and wetland habitats. Both BOEM (2012) and MMS (2002c) concluded that the federal and state permit and approval processes would minimize potential adverse effects on wetlands. It is expected that the proposed Liberty Development would have a consequence for vegetation, wetlands, and waters similar to the MMS (2002c) determination.


LIBERTY DEVELOPMENT
SENSITIVE SHORELINE VEGETATION AND WETLANDS
DATE: May 2015
FIGURE: 4.1.11-4
Map Extent
RUSSIA
Chukchi Sea
ALASKA
CANADA
Bering Sea
Gulf of Alaska
0 3.75 7.5 15 Miles
N
Reindeer Island
Cross Island
Beaufort
Stefansson Sound
Gwydyr Bay
Return Island
West Dock
OCS-Y0191
McClure Islands
Duck Island Unit
MPI
Endicott
SDI
Prudhoe Bay
Heald Point
Newport Entrance
Stockton Islands
Proposed Island
Proposed Subsea Pipeline Corridor
Tern Island Shoal
Tigvariak Island
Foggy Island Bay
Mikkelsen Bay
Prudhoe Bay Unit
East Channel Sagavanirktok River
Gravel Mine
Badami Unit
Kadleroshilik River
Proposed Gravel Mine
Shaviovik River
Legend
Liberty Pipeline Corridor
Construction Ice Roads
Annual Operations Ice Road
Oil & Gas Unit
Existing Pipelines
Gravel Footprint
ShoreZone Categories
Exposed tidal flats
Gravel beaches
Inundated low-lying tundra
Salt- and brackish-water marshes
Sheltered tidal flats
Data Sources:
Alaska ShoreZone (NOAA)
HAK - Approximate Proposed Ice Roads
Liberty Development Studies - Base Data
ESRI Ocean Basemap

4.1.11.2 Terrestrial Mammals

Caribou, muskoxen, brown bear, arctic fox, red fox, and arctic ground squirrel, discussed below, are the terrestrial mammals of most concern that are likely to be affected by the Liberty Development (BOEM 2012; MMS 2007b; MMS 2002c). Typical oil and gas development habitat, disturbance, mortality, and productivity impacts on terrestrial mammals were recently described in the Point Thomson Final EIS (USACE 2012a, Section 5.10); the 2007 Liberty DPP EA (MMS 2007b; BPXA 2007, Sections 3.1.9; 3.2.6; and 3.3.9); and the Liberty DPP FEIS (MMS 2002c, Section III.A.1 and III.A.2.d). These discussions are incorporated by reference and are updated with recent information.

Project-related direct and indirect effects on terrestrial mammals and their dens, burrows, foraging, insect-relief habitats, and resting habitats could include:

- Habitat loss and alteration,
- Habitat fragmentation,
- Mortality, and
- Altered survival or productivity.

While these effect categories may appear distinct on the surface, they are interrelated. For example, habitat alteration, especially related to displacement caused by disturbance, may lead to habitat fragmentation and/or altered survival or productivity. Onshore activities would include construction of an aboveground pipeline with a landfall trench, tie-in pad, annual ice road crossing pad, a new gravel mine, an onshore ice pad, and ice access roads to the mine site, to freshwater sources, and to the LDPI. Onshore activities would also include transportation and storage of project-related construction modules, materials, equipment, and personnel on existing roads within the Prudhoe Bay and Endicott oil fields. Construction of the LDPI, installation of the pipeline, and the onshore gravel mining would occur primarily during winter when many terrestrial mammals would not occur on the ACP, although foxes are likely to be present.

Habitat Loss and Alteration

Habitat loss and alteration may be due to physical habitat changes, displacement from or attraction to altered habitats, or disturbance from noise or activity. Construction of the gravel mine would convert approximately 21 acres of tundra to aquatic habitat. Trenching and construction of the gravel tie-in pad and seasonal ice road crossing pad for the aboveground portion of the pipeline would disturb and cover about 2.6 acres of tundra habitat. Construction of the pipeline and mine site are not likely to remove habitat that may be suitable for brown bear dens. Most brown bears usually den further inland from the shoreline (see Figure 5.10-1 in USACE 2012a). Construction of the tie-in pad may affect some habitat that would be suitable for fox dens or small mammal burrows (USACE 2012a). Based on the map presented in the Point Thomson EIS, it does not appear that there are documented fox dens along the proposed pipeline route, ice road routes, or gravel mine site (see Figure 5.10-1 in USACE 2012a; Perham 2000, 2001). **Figure 4.1.11-5** also shows the documented locations of arctic fox dens.

Initial clearing and piling of snow for ice-road construction may collapse subnivean or soil-based tunnel systems, causing temporary habitat loss or alteration for small mammals. Construction of ice roads or pads over fox den sites or ground squirrel burrow sites may damage these structures. Ice roads typically compress standing dead vegetation altering the vegetation structure of the habitat for small mammals and reduce available winter foraging habitat for large and small herbivores. In addition, ice roads and pads delay availability of some tundra habitats for spring foraging until after the ice roads and pads and associated snow drifts have melted.

New infrastructure would be constructed on the LDPI and at the Endicott SDI. A new pipeline would be constructed between LDPI and the Badami pipeline. Caribou, brown bear, arctic fox, and red fox are occasionally reported at Endicott (Streever and Cargill Bishop 2013), although this facility is not generally considered terrestrial habitat. The existing Badami pipeline would be used to transport Liberty oil to the Endicott sales pipeline and to TAPS Pump Station 1; a new 1.5-mile cross-country pipeline would be required. Caribou, muskoxen, and brown bears normally occur in the Sagavanirktok River Delta area and coastal areas of Foggy Island Bay during summer when they use riparian foraging habitat and riparian and coastal insect-relief habitats, such as coastal spits, mud flats, and river bars. The proposed aboveground portion of the pipeline and the gravel mine site are located near the coast in Foggy Island Bay just west of the Kadleroshilik River delta. This area is used by terrestrial mammals for foraging, movements, and insect-relief habitat (USACE 2012a).

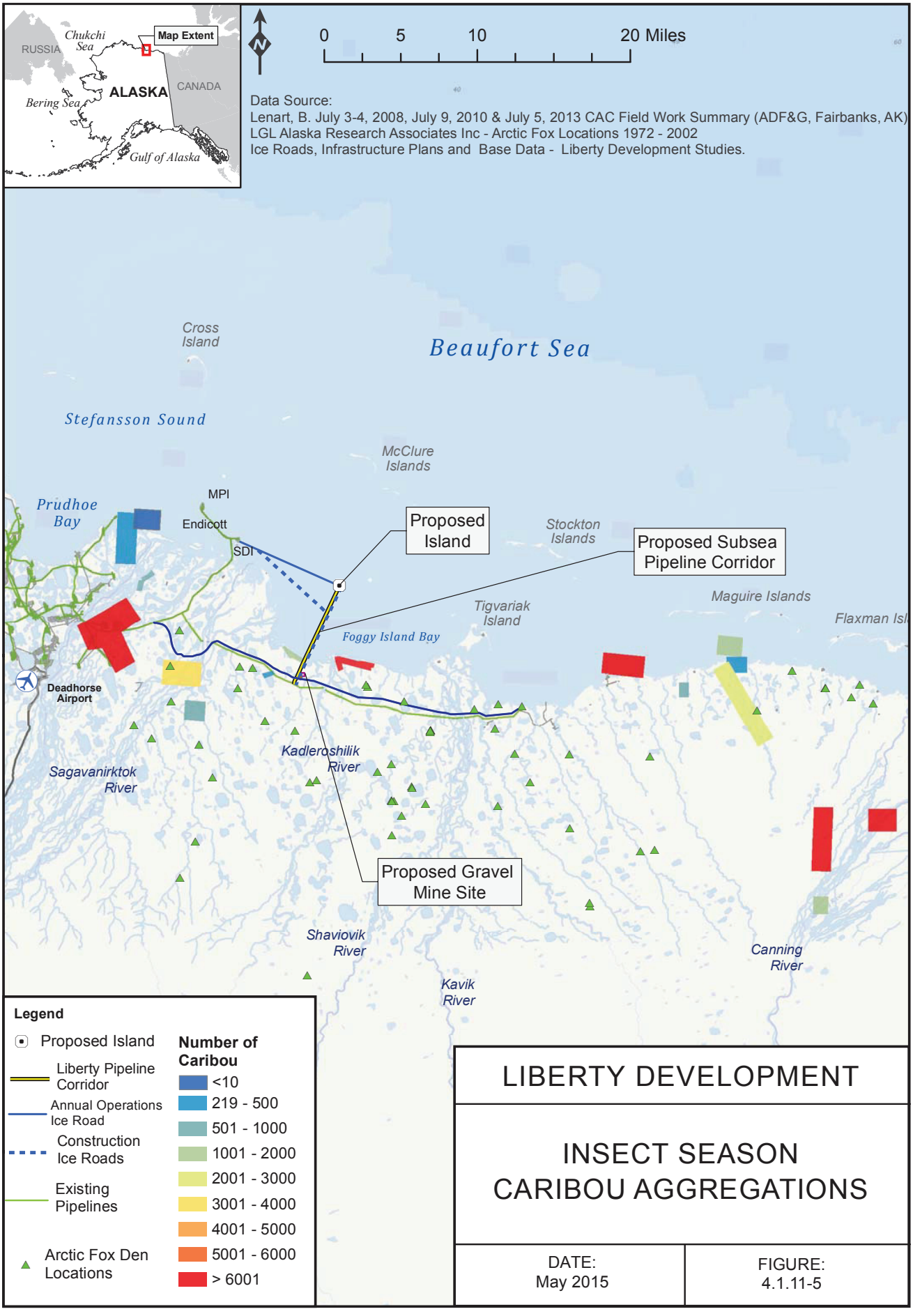
Lease stipulations and mitigation measures for the pipeline, gravel pad, gravel mine, ice roads, and pads described in Section 5 of this EIA and Section 13 of the DPP and spill prevention and response planning would be implemented to avoid or minimize potential adverse effects on terrestrial habitats.

Habitat Fragmentation

Habitat fragmentation may cause reduced patch sizes or increased habitat edge and barriers to movement. The offshore development would not be likely to contribute to increased habitat fragmentation in the project region. Placement of the gravel mine site would have a potential to alter caribou, brown bear, and muskoxen movements along the coast and in and around riparian habitats in the Kadleroshilik River delta. Increased traffic on the Endicott Road may temporarily increase habitat fragmentation in the Sagavanirktok River Delta through delay in caribou or other mammal movements across the road.

The proposed aboveground portion of the pipeline and the gravel mine site would potentially block or delay east-west caribou movements during the insect season between insect-relief habitats. One large caribou aggregation (Group 14 – 1,925 caribou) was photographed near and extended west of the proposed pipeline landing site on July 4, 2008 (Lenart 2008; Figure 4.1.11-5).

No road would be associated with the proposed pipeline, and the pipeline landing would be trenched from the shoreline inland for about 300 feet before it transitions to an aboveground pipeline. The proposed aboveground pipeline height (7 feet minimum) would be greater than the minimum 5-foot height that has been recommended to prevent blockage of caribou movements during summer or winter (Cronin et al. 1994; Lawhead et al. 2006). An evaluation of potential caribou movement density in the vicinity of the proposed aboveground pipeline and gravel mine indicates that crossings were not high, with 1 to 5 or 6 to 10 caribou crossings per square mile (mi^2) based on available telemetry data (see Figure 5.10-3 in USACE 2012a).



LIBERTY DEVELOPMENT

INSECT SEASON CARIBOU AGGREGATIONS

DATE: May 2015

FIGURE: 4.1.11-5

Disturbance

Human disturbance may alter habitat suitability depending on the timing and type of animal. Often the area affected by noise and human activity is much larger than the actual facility. Disturbance can displace animals away from habitats that would normally be used. Construction of the gravel mine, LDPI, and installation of the subsea and aboveground pipeline during winter would minimize potential disturbance impacts because fewer terrestrial mammals are present or active in the project area at this time. Noise disturbance would be greatest during gravel mine construction with blasting occurring over one winter. Most caribou and muskoxen leave the ACP by late September to migrate to wintering areas in or south of the Brooks Range. Brown bears would be hibernating during gravel mine excavation. Brown bears hibernate in dens that would typically be located further inland than the proposed gravel mine site. Prior to ice road and gravel mine construction, the standard practice is to survey the area using techniques like Forward Looking Infrared Radar (FLIR) to identify polar bear dens near the construction sites. Similar surveys and other tracking tools (e.g., ADF&G tracking data) would also be used to identify brown bear dens near the construction area, and disturbance to these sites could be avoided.

Air, land, and marine traffic are described in Section 5 of the DPP. During winter, transportation would be vehicles over ice roads or helicopters. Trucks would use ice roads to access Foggy Island Bay, the pipeline, the gravel mine site, freshwater sources, and the LDPI. Approximately 400 trips by vehicles of various types and function would be used during the winter construction season to haul gravel and construct the LDPI. Construction of the pipeline tie-in pad and installation of the VSMs and aboveground portion of the pipeline would create onshore winter traffic. These activities could potentially cause short-term noise disturbance and displacement, or collisions with arctic and red foxes, and small numbers of caribou and muskoxen wintering on the ACP. Disturbance may cause flight reactions and decreased foraging for caribou and muskoxen, resulting in increased energy expenditures and decreased energy acquisition. These increased energy expenditures would be expected to be minor and would not be expected to affect overwinter survival. Some arctic and red fox are expected to be disturbed during construction of the onshore ice roads and pad.

Helicopters and hovercraft can access the LDPI year-round. Estimated traffic levels could include 1-2 helicopter round-trips and 3 hovercraft round-trips per day during construction; 2 helicopter round-trips per day and 2 hovercraft round-trips per day during drilling and operations; and 1-2 helicopter round-trips per day and 2 hovercraft round-trips per day during operations. During open water, between freeze-up and break-up, operation traffic would include small boats and barges traveling between SDI or West Dock and LDPI. Helicopter traffic would occur between Deadhorse or Prudhoe Bay and the LDPI.

The greatest potential for project-related disturbance to terrestrial mammals would be the increase in air and vehicle traffic from Deadhorse and on the Endicott Road. Low-level helicopter overflights for routine maintenance and surveillance of the pipelines may cause flight responses, especially for maternal caribou, large groups of caribou, and brown bears that would cause the animals to expend extra energy (USACE 2012a). Potential summer construction activity at the SDI would create an increased level of traffic along the Endicott Road during gravel hauling. Increased summer traffic may lead to an increase in disturbance to caribou moving through the Sagavanirktok River Delta. If unmitigated, there is a potential for vehicle collision mortality for foxes and arctic ground squirrels. Traffic increases to more than 15 vehicles or more per hour could result in delays or deflection of caribou groups crossing the Endicott Road (USACE 2012a).

Most ground and air traffic from Deadhorse to LDPI would cross through the middle of the Sagavanirktok River Delta; the potential for disturbance to animals using the delta would be present during all seasons, but it would be

greatest during spring and summer. Caribou are most sensitive to disturbance and displacement from preferred habitats early during the calving period. Helicopter over flights could but are unlikely to cross over traditional caribou calving concentrations between the Sagavanirktok and Canning rivers. No caribou are expected to use the Sagavanirktok River Delta area near the Endicott Road during calving (USACE 2012a, Section 5.10), as most calving locations would be expected to be east of this area (**Figure 4.1.11-6**). Cows and calves may move closer to the coast and the delta during post-calving in late June (**Figure 4.1.11-7**).

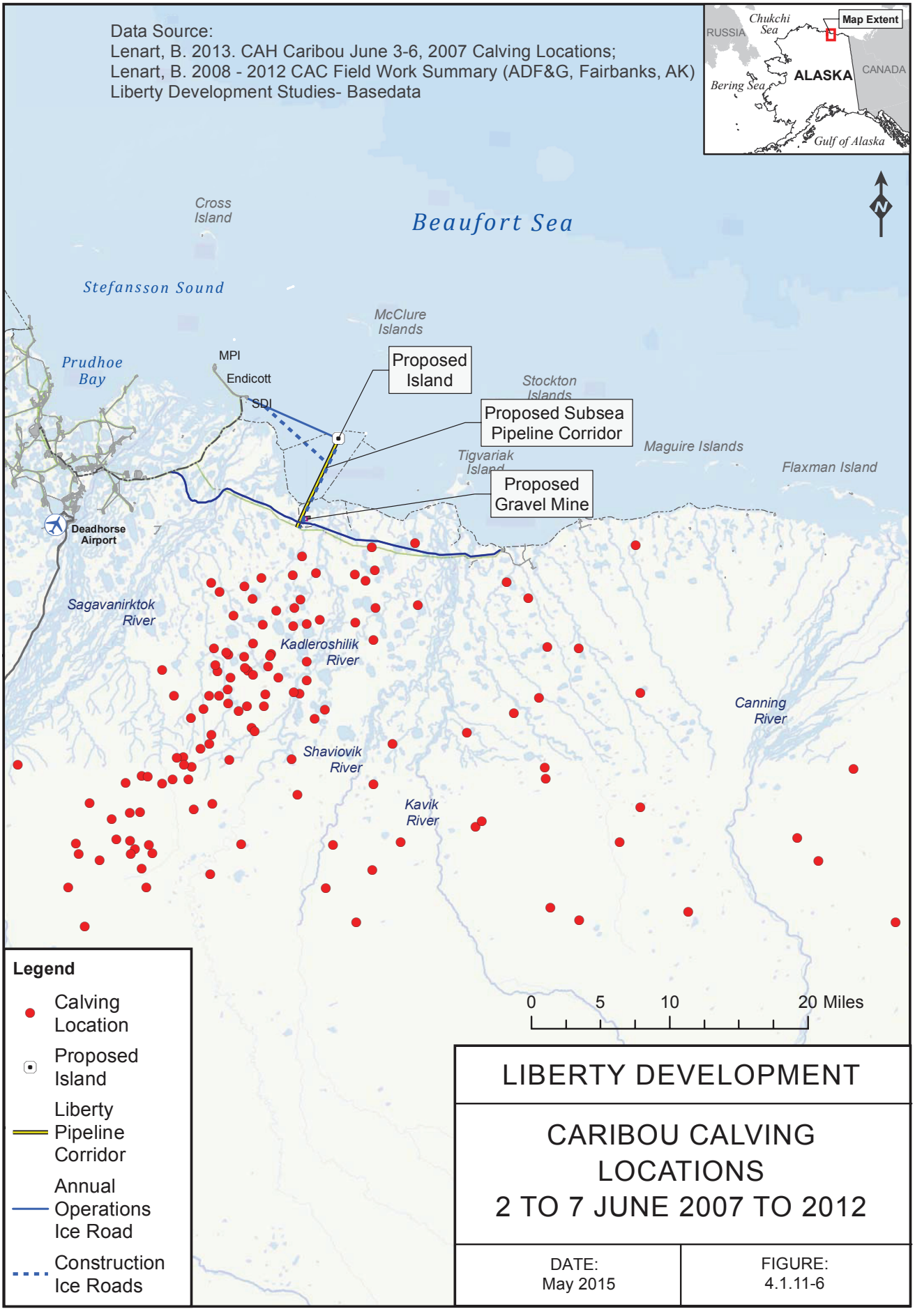
Lease stipulations and mitigation measures for the aboveground pipeline, aircraft flight altitudes and routing, gravel mines, and ice roads described in Section 5 of this EIA and Section 13 of the DPP would be implemented to avoid or minimize potential adverse effects from habitat fragmentation and disturbance on terrestrial mammals.

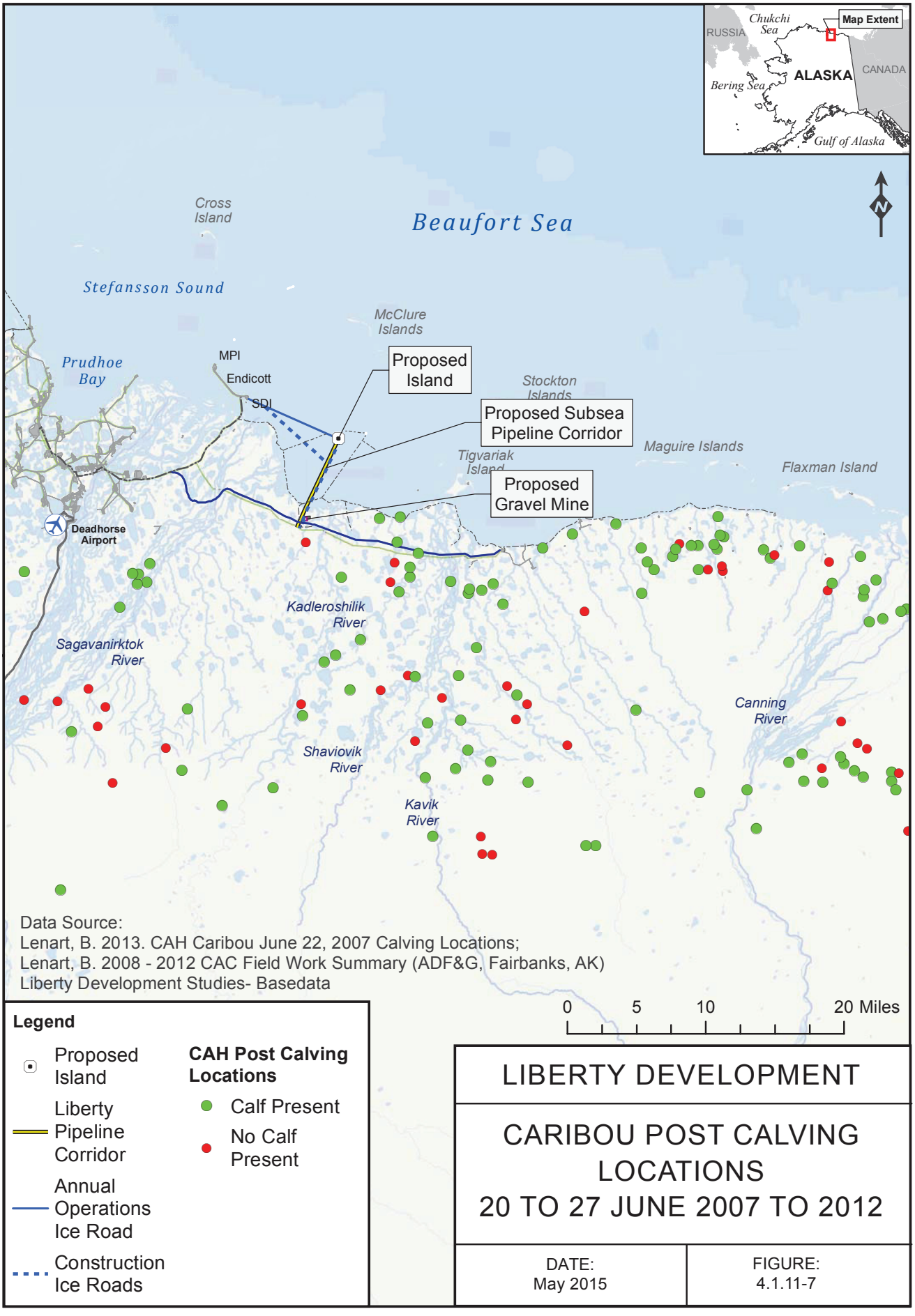
Mortality

Mortality may be associated with gravel or ice construction, vehicle collisions, and other causes. Construction of ice roads across tundra habitats would likely result in some small mammal mortality, especially if ice roads are constructed across burrows with hibernating arctic ground squirrels. Darkness limits human vision during the winter construction seasons, and vehicle collisions with terrestrial mammals may occur. The most likely cause of project-related mortality to terrestrial mammals would be vehicle collisions on gravel and ice roads. Vehicle collision mortality is not comprehensively monitored in the North Slope oil fields, although caribou mortalities occur sporadically (Streever et al. 2007; Streever and Cargill Bishop 2013).

A few animals may also be killed because of aggression towards people. Causes of aggression are most often related to food-conditioned bears or foxes, or diseased animals (rabies). Because these animals can become a threat to human safety, they may be killed to defend human life. Five red foxes and an ermine were killed because of aggression towards people between 2010 and 2012 (Streever and Cargill Bishop 2013). While these types of mortalities are uncommon, a few can be expected.

Lease stipulations and mitigation measures for vehicle traffic and food waste described in Section 5 of this EIA and Section 13 of the DPP would be implemented to avoid or minimize potential adverse effects from vehicle collisions and aggression towards humans on terrestrial mammals.


Data Source:
Lenart, B. 2013. CAH Caribou June 3-6, 2007 Calving Locations;
Lenart, B. 2008 - 2012 CAC Field Work Summary (ADF&G, Fairbanks, AK)
Liberty Development Studies- Basedata
Map Extent
RUSSIA
Chukchi Sea
ALASKA
CANADA
Bering Sea
Gulf of Alaska
N
Beaufort Sea
Cross Island
Stefansson Sound
McClure Islands
Prudhoe Bay
MPI
Endicott
SDI
Proposed Island
Stockton Islands
Proposed Subsea Pipeline Corridor
Maguire Islands
Tigvariak Island
Flaxman Island
Proposed Gravel Mine
Deadhorse Airport
Sagavanirktok River
Kadleroshilik River
Canning River
Shaviovik River
Kavik River
Legend
Calving Location
Proposed Island
Liberty Pipeline Corridor
Annual Operations Ice Road
Construction Ice Roads
0 5 10 20 Miles
LIBERTY DEVELOPMENT
CARIBOU CALVING LOCATIONS
2 TO 7 JUNE 2007 TO 2012
DATE: May 2015
FIGURE: 4.1.11-6



LIBERTY DEVELOPMENT

CARIBOU POST CALVING LOCATIONS 20 TO 27 JUNE 2007 TO 2012

DATE:	FIGURE:
May 2015	4.1.11-7

Altered Survival or Productivity

Survival or productivity may be affected through changes in predator abundance, distribution or predation risk, and exposure to spills and leaks of toxic materials. Disturbance and displacement of terrestrial mammals from preferred habitats can lead to reduced survival and productivity. Low-level aircraft overflights may cause reactions that reduce productivity of caribou (Wolfe et al. 2000). Potential disturbance effects on caribou productivity may be greatest during the calving period; although overflights between Deadhorse and LDPI would not be expected to occur at low altitudes and are unlikely to cross calving concentration areas or post-calving aggregations (Figure 4.1.11-6 and 4.1.11-7; Lenart 2007, 2008, 2009, 2010, 2011d, 2012, 2013). Disturbance from traffic on the Endicott Road is also not likely to affect calving caribou (Figure 4.1.11-6).

Foxes in search of food are often attracted to construction sites and humans. Red and arctic foxes are common on the North Slope, and human-fox interactions are not uncommon (Streever and Cargill Bishop 2013). Although prevention of scavenging at oilfield facilities and construction sites is a goal of industry, at least some form of feeding and scavenging will most likely continue to occur. Access to human food or garbage may increase their survival rate during the winter, which can ultimately negatively affect prey species (Sovada et al. 2001). Access to artificial nutrition during winter that has altered red fox survival has been described as a likely cause for the displacement of arctic foxes from den sites near camps in the Prudhoe Bay Oil Field (Stickney et al. 2014). Foxes attracted to oilfield facilities may also consume toxic substances, potentially resulting in serious illness or death.

Lease stipulations and mitigation measures for aircraft flight altitudes and routing and food waste control described in Section 5 of this EIA and Section 13 of the DPP would be implemented to avoid or minimize potential adverse effects on terrestrial mammal survival or productivity.

Oil Spill Analysis

The most likely spills would be small oil leaks and fuel transfer spills during ice-road construction and use. These spills and leaks would most likely be detected and cleaned up, and are unlikely to injure terrestrial mammals. Spills that reach vegetation could damage or kill tundra, reducing available habitat for terrestrial mammals. Oil can affect mammals by reducing foraging habitats and would injure or kill terrestrial mammals that ingest oil through grooming, foraging on contaminated vegetation, or foraging on contaminated prey. Oiled tundra habitats are difficult to remediate without causing further disturbance to the vegetative mat and soils (Cater 2010); prevention of oil from reaching vegetation or the shoreline should be a priority to minimize impacts to vegetation and wetlands.

BOEM (2012) describes consequences for expected accidental spills on Arctic coastal habitats for small spills (less than 1,000 bbl) as negligible to moderate, and for large spills (greater than 1,000 bbl) as moderate to major. Oil spills from the aboveground pipeline or that cause oil to wash ashore constitute the greatest potential adverse effect to terrestrial habitats and mammals. The most likely scenario for oil reaching the tundra or shoreline would be a leak or break of the pipeline. If the spill would occur during winter or break-up, little oil would be likely to reach the tundra or shoreline because of ice cover or river flow, and effected terrestrial mammals would likely be small mammals and foxes. If an aboveground pipeline spill occurred, it would most likely occur at the tie-in pad and would likely be contained on the pad. If a subsea pipeline spill occurred during summer, the prevailing winds from the northeast and the prevailing long-shore current to the west would likely transport the oil into the Sagavanirktok River Delta.

Summer cleanup tactics would involve placement of booms, transportation across and along shorelines, and removal of oil that could result in displacement of terrestrial mammals away from contaminated tundra and shorelines, reducing the likelihood of exposure. An oil spill could affect terrestrial mammals on tundra and at

shorelines from scavenging carcasses washed ashore. Oiled carcasses could be scavenged by foxes and bears. Caribou have been observed using sea ice as a salt lick, and it is possible that they may ingest oil from contaminated sea ice during the spring (MMS 1999). Ingestion of oil can result in lethal and sublethal effects to arctic fox, such as changes in the liver and brain, bone marrow depletion, gastrointestinal tract ulcers, inflammation of lungs and nasal passages, and kidney failure (MMS 1999). Terrestrial mammals that get oil in their fur or hair may lose the insulating properties, resulting in severe cold stress that may result in death (MMS 1999).

A few foxes may be attracted to the increased activity during cleanup on the ice and may be vulnerable to collision mortality or exposure to oil. Deflection boom and skimmers would be placed along the mainland shoreline, and vessel-based reconnaissance and skimming would continue during the following open-water season if oil were present. These activities may result in a few terrestrial mammals being displaced from the cleanup area, which would reduce their risk of exposure to spilled oil. Collectively, these measures would minimize the likelihood of oil reaching the shoreline, and minimal impacts to terrestrial mammals would be expected.

Lease stipulations and mitigation measures for spill prevention and response planning described in Section 5 of this EIA and Section 13 of the DPP would be implemented to avoid or minimize potential adverse effects from small and large spills on coastal habitats and terrestrial mammals.

Conclusion

Construction and operation of the proposed Liberty Development would likely result in moderate short-term disturbance, minor to moderate long-term loss of about 24 acres of tundra habitat, potential minor alteration of 5 acres of habitat, and potential minor construction and collision mortality for local terrestrial mammals. The pipeline landing trench would require long-term annual onsite monitoring for erosion that would create disturbance. BOEM (2012) considered the consequences of allowing oil leasing and potential oilfield exploration and development in the Alaskan Arctic to range from negligible to moderate with overall routine activities not expected to have long-term major impacts on terrestrial mammals on the North Slope. It is expected that the current Liberty Development will have a consequence consistent with BOEM's determination. MMS (2002c) also considered the consequences of the Liberty Island project proposed in 2000 and concluded that the project would result in short-term effects on individual animals but would not affect the overall distribution and abundance of terrestrial mammal populations. It is expected that the current Liberty Development would have a similar, although potentially increased consequence for terrestrial mammals than the MMS (2002c) determination because of increased traffic along the Endicott Road and the larger and more coastal gravel mine site.

No road would be associated with the proposed pipeline, and the pipeline landing would be trenched from the shoreline inland for about 300 feet before it transitions to an aboveground pipeline. The proposed aboveground pipeline height (7 feet minimum) would be greater than the minimum 5-foot height that has been recommended to prevent blockage of caribou movements during summer or winter (Cronin et al. 1994; Lawhead et al. 2006). An evaluation of potential caribou movement density in the vicinity of the proposed aboveground pipeline and gravel mine indicates that crossings were not high with 1 to 5 or 6 to 10 caribou crossings per mi^2 based on available telemetry data (see Figure 5.10-3 in USACE 2012a).

4.1.12 Threatened and Endangered Species

Under Section 7(a)(2) of the ESA, BOEM would be required to consult with NMFS and the USFWS for proposed actions in the Liberty Development that may "take" listed species or affect critical habitat. Under the ESA, "take" is defined as to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct" a species listed as threatened or endangered (16 U.S.C. Section 1532[19]). The previous ESA consultations for the offshore processing Liberty Development island (NMFS 2001; USFWS 2002) evaluated bowhead whales, Steller's eiders, and spectacled eiders and identified potential adverse effects from the project. These consultations concluded that the project was not likely to jeopardize the continued existence of these species. The incidental take of bowhead whales was authorized in accordance with take provisions under the MMPA. Incidental take of 17 spectacled eiders was estimated for the life of the project from oil spills (2) and collisions (5 over 5 years for total of 15) associated with the project. USFWS concluded that Steller's eiders were unlikely to occur in the vicinity of the Liberty Development, and that no take of Steller's eiders was anticipated (USFWS 2002). As discussed in Section 3.12, two marine mammal species have been listed as threatened[3] (ringed seal and polar bear), and one marine mammal (Pacific walrus) species has become a candidate[4] for listing since consultations for the previous Liberty projects were completed.

When an ESA-listed species or its designated critical habitat is likely to be affected by a project authorized by a federal action, the responsible regulatory agency must provide the appropriate wildlife management agency (NMFS and/or USFWS, depending on species in question) with an evaluation of whether the Proposed Project would be likely to affect the listed species or critical habitat. The NMFS and/or USFWS then would use this documentation to determine whether formal consultation would be required. If the federal action is anticipated to have any adverse effects, the NMFS or USFWS would prepare their Biological Opinions (BO) on whether the action would be likely to jeopardize the continued existence of the listed species or whether the action would destroy or adversely modify critical habitat. When the take of a species is anticipated and the impact of the take is not likely to cause jeopardy to the species, the NMFS or USFWS would estimate the type and amount of take and issue an Incidental Take Statement, which could include terms and conditions and reasonable and prudent measures to minimize the impact of any incidental take.

Of the four currently listed and one candidate marine mammal species with potential to occur in the vicinity of the Liberty Development, ringed seals, polar bears, and bowhead whales are expected to occur regularly and were analyzed for potential consequences (**Table 4.1.12-1**). Potential project-related effects on Pacific walruses and humpback whales are not expected. Of the two currently listed species of coastal birds with potential to occur in the vicinity of the Liberty Development, spectacled eiders are expected to occur regularly and Steller's eiders are expected to occur irregularly; hence, both species were analyzed for potential consequences (Table 4.1.12-1). Both of these coastal bird species nest in higher densities west of the Liberty Development.

[3] The rule listing the bearded seal Beringia Distinct Population Segment (DPS) as threatened under the Endangered Species Act (ESA) was vacated in July 2014 and remanded back to National Marine Fisheries Service (NMFS). As a result, for purposes of this EIS, potential effects on the bearded seal are evaluated with other non ESA-listed marine mammals in Section 4.1.8.

[4] In 2009, the yellow-billed loon was found to be a candidate for listing under the ESA, subject to annual review of that status (74 FR 12932). On October 1, 2014, the USFWS announced their finding that listing the yellow-billed loon as an Endangered or Threatened Species under the ESA is not warranted (79 FR 59195). As a result, for purposes of this EIA, potential effects on the yellow-billed loon are evaluated with other non ESA-lsted coastal birds in Section 4.1.9.

Table 4.1.12-1. Liberty Development Threatened and Endangered Species Evaluations

COMMON NAME	SCIENTIFIC NAME	FEDERAL STATUS[1]	DETAILED ANALYSIS	PRELIMINARY FINDINGS
Marine Mammals				
Pacific walrus	*Odobenus rosmarus divergens*	Candidate	No	No Effect
Ringed seal	*Pusa (Phoca) hispida*	Threatened	Yes	MA-LAA
Polar bear	*Ursus maritimus*	Threatened	Yes	MA-LAA
Bowhead whale	*Balaena mysticetus*	Endangered	Yes	MA-LAA
Humpback whale	*Megaptera novaeangliae*	Endangered	No	No Effect
Marine and Coastal Birds				
Steller's eider	*Polysticta stelleri*	Threatened	Yes	MA-LAA
Spectacled eider	*Somateria fischeri*	Threatened	Yes	MA-LAA

Note:

1. USFWS manages the Steller's eider, spectacled eider, Pacific walrus, and polar bear; NMFS manages the other marine mammals listed.

Key: MA-LAA = May affect, likely to adversely affect.

HAK would work in coordination with BOEM, NMFS, and USFWS to develop reasonable and prudent measures to minimize the potential take of listed species and adverse modification of designated critical habitat resulting from the currently proposed Liberty Development. Lease stipulations and mitigation measures protective of marine mammals, coastal and marine birds, and ESA-listed species described in Section 5.2.12 would be implemented to avoid or minimize potential adverse effects on listed species or designated critical habitats.

4.1.12.1 Marine Mammals

Ringed seals, polar bears, and bowhead whales are expected to occur with sufficient regularity in the Beaufort Sea and were analyzed for environmental consequences. Potential impacts to Pacific walruses and humpback whales from project-related activities are expected to be negligible because these species are extralimital to the central Alaska Beaufort Sea and would occur only rarely during the open-water season (Table 3.12-1). The northernmost distribution of Pacific walruses in Alaska waters generally is limited to the Chukchi Sea near Barrow in the summer and fall, although some individuals may wander farther east. Although these individuals could be exposed to effects of the project, those effects are not likely to result in more than transitory disturbance of those few individuals.

In recent years and perhaps in conjunction with climate change, a few humpback whales have ventured through the Bering Strait into the Chukchi Sea and western Beaufort Sea, which has led to speculation that they are extending their range or perhaps reoccupying ancient habitat (Clarke et al. 2013). Whether this change truly is a range expansion and whether this species will continue expanding its range into the Beaufort Sea is unknown. In the near term, the species are not likely to be affected by the project because they are not likely to occur near the Liberty Development. In the longer term, some individuals may move farther into the Beaufort Sea. Because humpback whales tend to be associated with shelf or basin habitats, they likely would stay offshore of the project and would not be disturbed by noise from the project. Consequently, impacts to this extralimital species are not discussed further.

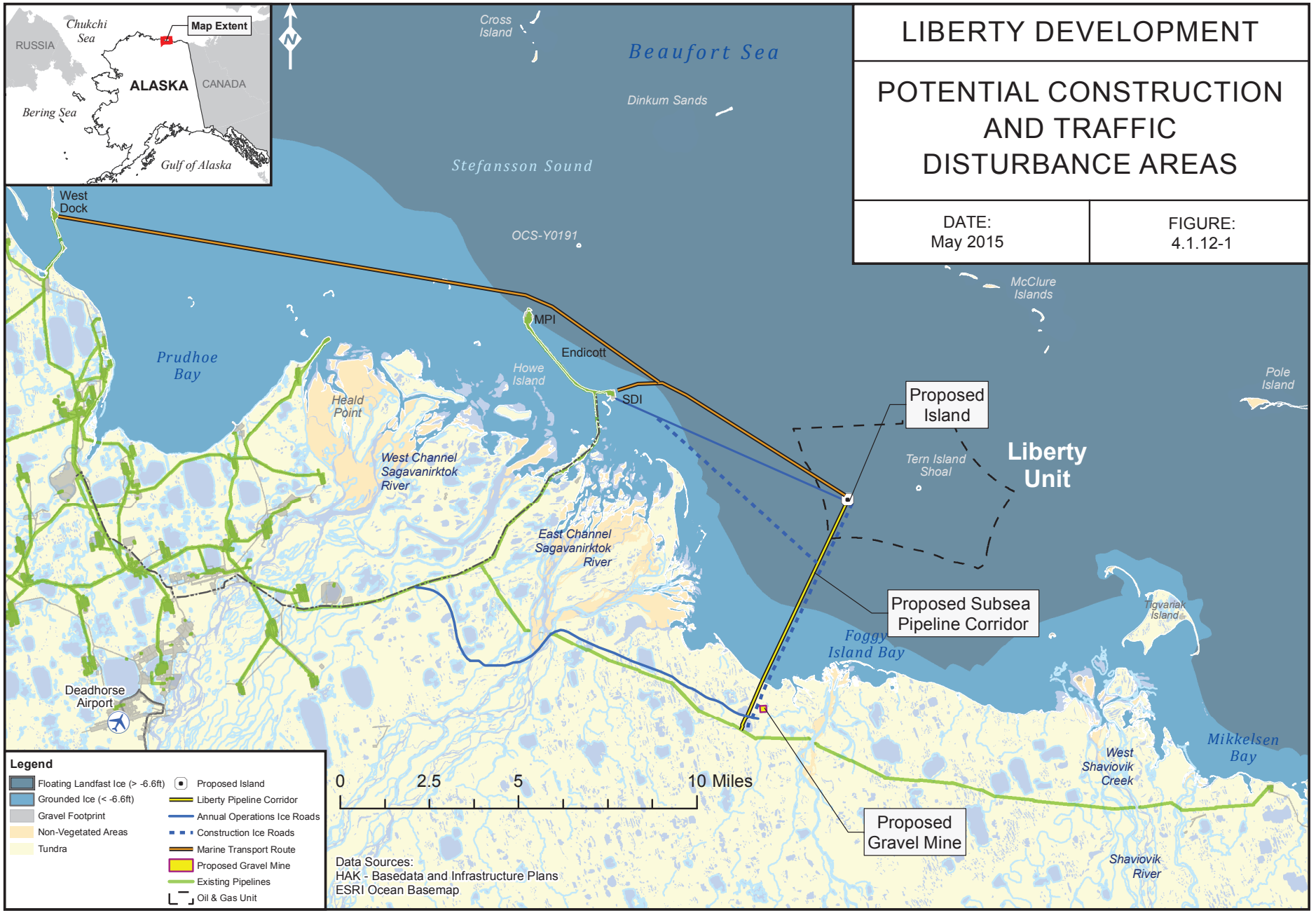
As described in Section 3.12, authorization of incidental "take" of threatened and endangered marine mammals is managed under both Section 7 of the ESA and Section 101(a)(5) of the MMPA. Under Section 7(a)(2) of the ESA,

federal agencies are obligated, in consultation with USFWS and/or NMFS, to ensure that their actions are not likely to jeopardize the continued existence of a threatened or endangered species or to destroy or adversely modify a species' critical habitat. The results of this consultation are documented in a BO. If USFWS and/or NMFS are satisfied that the federal action is consistent with the requirements of Section 7(a)(2), based on information provided by the federal action agency (usually in the form of a biological assessment), they will issue an incidental take statement. The incidental take statement specifies the impact of the anticipated incidental take and any measure that may be necessary to minimize such impact. These measures usually are consistent with the provisions of the authorization issued under Section 101(a)(5) of the MMPA. HAK, working in conjunction with federal agencies, expects to obtain an incidental take authorization and to follow required mitigation measures detailed in Letters of Authorization (LOAs), Incidental Harassment Authorizations (IHAs), and incidental-take statements from NMFS and USFWS.

Potential impacts of the Liberty Development on listed marine mammals include potential displacement by noise and activities from construction, drilling, transportation, and operating activities; loss or alteration of marine and terrestrial habitats; and possible contamination of marine mammals and/or their prey from spills or leaks of fuel or oil from vehicles or facilities (**Figure 4.1.12-1**). Although marine mammals could experience widespread impacts from a WCD or CDE, the probability of such an event is extremely low (NOAA 2013a). The potential impacts on marine mammals from a WCD are discussed in Section 4.3.

The Liberty Development Project ER (LGL Alaska et al. 1998, Sections 5.1.7, 5.2.7, 5.3.4, 5.4.7, and 5.6), the Liberty DPP FEIS (MMS 2002c, Sections IIIA2a and IIIC3a[1]), the BOEM OCS Oil and Gas Leasing Program: 2012–2017 Final Programmatic EIS (Section 4.4.7.1.3, BOEM 2012), the Revised OCS Lease Exploration Plan: Camden Bay, Beaufort Sea, Alaska EA (BOEMRE 2011c, Section 4.2.7.1), and the Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft EIS (NOAA 2013a, Sections 4.5.2.4.1, 4.5.2.4.5, 4.5.2.4.6, 4.5.2.4.7, 4.5.2.4.9, 4.5.2.4.10, 4.5.2.4.12, 4.5.2.4.14) describe in detail potential impacts to marine mammals from oil-development activities that are anticipated to occur during the Liberty Development. These documents are summarized here and incorporated by reference. In addition the NMFS and USFWS recently completed BOs for the Northstar Development (a drilling facility located on an artificial island in the Beaufort Sea) and the Point Thomson Project, respectively, which evaluate many of the same types of activities that would be used to construct and operate the Liberty Development. In each of these BOs, the agencies determined that operation of the respective facilities were not likely to jeopardize the continued existence of populations of listed marine mammals (NMFS 2014; USFWS 2012).

The Liberty Development would use both impact and vibratory pile driving during construction to install support piles, surface casings, and similar structural components. Impact pile-driving produces higher sound levels than vibratory pile-driving, and therefore can have greater potential impacts to wildlife (acoustic effects to marine mammals are discussed in detail in Section 4.1.8.1). HAK would complete all construction activities within two years and may drill into the oil reservoir year-round. The potential impacts of the Proposed Project are summarized in the following subsections.


LIBERTY DEVELOPMENT
POTENTIAL CONSTRUCTION AND TRAFFIC DISTURBANCE AREAS
DATE: May 2015
FIGURE: 4.1.12-1
Map Extent
Chukchi Sea
RUSSIA
ALASKA
CANADA
Bering Sea
Gulf of Alaska
N
Cross Island
Beaufort Sea
Dinkum Sands
Stefansson Sound
OCS-Y0191
West Dock
MPI
Endicott
SDI
Prudhoe Bay
Howe Island
Heald Point
West Channel Sagavanirktok River
East Channel Sagavanirktok River
McClure Islands
Pole Island
Proposed Island
Liberty Unit
Tern Island Shoal
Proposed Subsea Pipeline Corridor
Foggy Island Bay
Tigvariak Island
Deadhorse Airport
Proposed Gravel Mine
West Shaviovik Creek
Mikkelsen Bay
Shaviovik River
0 2.5 5 10 Miles
Legend
Floating Landfast Ice (> -6.6ft)
Grounded Ice (< -6.6ft)
Gravel Footprint
Non-Vegetated Areas
Tundra
Proposed Island
Liberty Pipeline Corridor
Annual Operations Ice Roads
Construction Ice Roads
Marine Transport Route
Proposed Gravel Mine
Existing Pipelines
Oil & Gas Unit
Data Sources:
HAK - Basedata and Infrastructure Plans
ESRI Ocean Basemap

Ringed Seals

Project-related activities that could affect ringed seals include aircraft traffic and noise; vessel traffic and noise; construction and drilling noise; loss or alteration of marine habitat from island construction and pipeline installation; and spills or leaks of fuels or oil from vessels or facilities.

Potential Presence in the Liberty Development Area

Ringed seals are common near the Liberty Development during both the open-water season and the winter. Spring densities of molting ringed seals are variable annually, based on several environmental factors, and have ranged from 0.15 to 0.28 ringed seals/mi² between 1997 and 2002 (Moulton et al. 2005). Based on these densities, an estimated 42 to 79 ringed seals would occur in the project area during the winter. Ireland et al. (2009) reported an overall open-water season density of 0.31 ringed seals/mi² during vessel-based surveys of the Beaufort Sea in 2007, which would correspond to 90 ringed seals in the project area. Aerts et al. (2008) recorded 13 seals in Foggy Island Bay during seismic surveys for the Liberty Development (July 15 through August 25, 2008) and estimated a total of 30 seals for the 91.8-mi² area surveyed, for a rough density of 0.33 seals/mi²; this estimate is consistent with that of Ireland et al. (2009).

Impact Evaluation

Kelly et al. (2010) reviewed factors affecting the continued existence of ringed seals and concluded that compared with the far-reaching changes expected in sea ice and snow cover, potential impacts from contaminants, oil- and gas-industry activities, fisheries, and shipping are likely to pose moderate risks to ringed seals. Potential impacts of the proposed Liberty Development on ringed seals are expected to be similar to those described for the Northstar Development Project (noise disturbance, spills or leaks), although there may be fewer ringed seals near the Liberty Development because the water is shallower than that around Northstar (Moulton et al. 2005; NMFS 2014).

Disturbance

The most intense sound that ringed seals would be exposed to is pile-driving (see bearded seal discussion in Section 4.1.8.2, as well as acoustics discussion in Section 4.1.8.1). The use of safety zones and other mitigation measures would ensure that ringed seals are not subjected to noise levels that could cause PTS. Under the Proposed Project, vessel traffic would be most frequent during Year 2 of construction, when barging would support construction on the island. Responses of ringed seals hauled out on ice or land to vessel traffic primarily include entering the water at the approach of the vessel. Responses of swimming seals to the approach of vessels are more difficult to detect but may include a change in behavior, although the limited data indicate that ringed seals are tolerant of vessels (NMFS 2014). Underwater sound from vessels often were detectable as far as 18.6 miles offshore from Northstar (Richardson and Williams 2004), indicating that vessel sound may be audible to seals that enter within approximately 19 miles of the LDPI.

Green and Johnson (1983) found that intensive on-ice traffic and construction did not affect the overall winter density of ringed seals within 8 miles of traffic, although decreased use of breathing holes near traffic suggested localized displacement. Snowmachines may elicit varying responses from ringed seals in subnivean lairs. Burns et al. (1982), Kelly et al. (1986), and Kelly (1988) reported that one seal remained in its lair during passes within 0.3 miles, although other seals vacated lairs when snowmachines passed up to 1.7 miles away. Most seals returned to their lairs after the vehicles were no longer present.

Disturbance during the winter or spring may be of greater consequence to ringed seals than disturbance during the open-water season because seals could be displaced from breathing holes or be caused to abandon pups in lairs. However, Moulton et al. (2005) reported that there was no evidence that construction, drilling, or production

activities at BPXA's Northstar Island affected local distribution or abundance of ringed seals during the spring. Drilling and production sounds from Northstar Island were audible to ringed seals, at least intermittently, out to about 0.9 miles in water and 3.1 miles in air (Blackwell et al. 2004b). During construction of an island in winter 1981 to 1982, monitoring showed a slight change in the distribution of ringed seals near the island, with densities increasing with increasing distance from the island (Frost et al. 1988). Richardson and Williams (2004) reported that ice-road construction activities at Northstar caused no major disturbance of ringed seals, although they suggested that small numbers of seals could have been displaced immediately around Northstar.

Aircraft traffic would occur year-round during construction, drilling, and operations. Behavioral reactions of ringed seals to aircraft depend on the lateral distance, the flight altitude, and the type of aircraft. Ringed seals hauled out on ice may dive into their holes when approached by low-flying aircraft; 21 percent reacted to fixed-wing aircraft overflights at a lateral distance of 328 feet, 6 percent reacted at 328 to 984 feet, and 2 percent reacted at 984 to 1,640 feet (Born et al. 1999). Variables influencing the probability of escape responses included time of day and air temperature (Born et al. 1999). Reactions of ringed seals in subnivean lairs varied with aircraft altitude and lateral distance (Kelly et al. 1986), with some seals leaving lairs at the approach of helicopters at 1,000 feet flight altitude at a distance of 1.2 miles. Helicopters appear to elicit stronger responses than do fixed-wing aircraft (Kelly et al. 1986; Blackwell et al. 2004b). Behavioral responses to disturbance can increase energetic costs and could result in temporary separation of mothers and pups, although seals exposed regularly to anthropogenic noise may habituate and show little to no reaction to aircraft traffic (Johnson et al. 1989). The likelihood of impacts to ringed seals from project-related noises and traffic would decrease at the onset of the operations phase, when less anthropogenic sound would be generated and transportation needs would decrease.

Drilling Noise

Ringed seals could be displaced around the LDPI by low-frequency noises generated by drilling. The effects of offshore drilling on ringed seals in the Beaufort Sea was investigated by Frost and Lowry (1988), who concluded that local ringed seal populations were less dense within a 2-nautical mile buffer area around man-made islands and offshore wells in the Beaufort Sea in 1985 through 1987 than they were outside of the buffer. Moulton et al. (2005) found that ringed seal densities were not decreased near Northstar Island, which is more similar to the LDPI than the wells included in the study by Frost and Lowry (1988).

Noise levels associated with the Liberty Development are anticipated to be similar to levels produced during construction, drilling, and operation activities at Northstar. Underwater sounds from construction, drilling, and production reached background levels within 1.2 to 2.5 miles (2 to 4 km) from Northstar (Richardson and Williams 2004). Richardson and Williams (2004) concluded that there was little effect from the low-frequency industrial sounds produced by the Northstar facility on ringed seals during the open-water period and that the overall effects of the construction and operation of the facility were minor, short-term, and localized. Potential impacts of drilling noise from the Liberty Development on ringed seals can be expected to be similar to those at Northstar, which were minor, short-term, and localized and, therefore, would not be expected to affect the ringed seal subpopulation.

Collision-Caused Injury and Mortality

Ringed seals may be at risk to injury or death from vessel strikes. However, ringed seals are highly mobile and likely are able to detect and avoid vessels, particularly large transport vessels and dredges, which move slowly and along defined courses. Thus, the probability of a collision between a vessel and a ringed seal is quite low. The frequency of vessel traffic would be highest during Year 2 of construction, when barging would support construction on the island; however, even during years of frequent vessel traffic, the probability of injury would be low.

During travel across the sea ice in spring, there would be a potential to run over ringed seal pups in lairs. This risk would be greatest during construction and drilling, and would diminish at the onset of operations, when fewer personnel and materials would need to be transported to and from the LDPI. Restricting traffic to established ice roads that are constructed prior to seals establishing birthing lairs would minimize the potential for the fatality of seal pups.

Habitat Loss or Alteration

The proposed Liberty Development would turn approximately 24 acres of marine foraging habitat into island habitat, which may be attractive as a haulout for ringed seals. Ringed seals typically prefer deeper waters for foraging than those near the LDPI or SDI (Seaman et al. 1981; Stirling et al. 1977, 1982; Kelly et al. 2010). Marine habitat near the LDPI that remains unfrozen in the winter probably supports few arctic cod, amphipods, or shrimp for ringed seals (Link et al. 1999; Frost et al. 2004). Destruction or abandonment of breathing holes or lairs on floating landfast ice could occur along the ice roads or the pipeline route during construction (Figure 4.1.12-1). Increases in suspended sediments from trenching for pipeline installation could locally reduce prey abundance or the foraging efficiency of ringed seals. Increased turbidity from trenching could persist for several seasons and could cause a localized reduction in the quality of foraging habitats for ringed seals; however, no long-term impacts to the marine environment or ringed seals are expected from trenching.

Spills or Leaks

Potential effects of expected small spills and leaks of oil (less than 1,000 bbl) and large oil spills (greater than 1,000 bbl) on marine mammals are discussed in Section 4.1.8.1. The consequences of a WCD or CDE are addressed in Section 4.3. The types of direct affects from contact with contaminants and the indirect impacts of spills on prey species of ringed seals would be comparable to those described previously for bearded seals in Section 4.1.8.2; however, ringed seals would be at greater risk to impacts from spills or leaks because they occur in higher abundance, are more likely to use habitats inshore of the barrier islands, and are present near the Liberty Development year-round. Because ringed seals may range across large areas over a short time and probably would be displaced by disturbance during cleanup activities, the probability of exposure to small spills under either project option is low, and no population-level impacts are expected. Consequences of a WCD or CDE on ringed seals are addressed in Section 4.3.

Conservation Measures

Conservation measures to avoid or minimize the incidental take of ringed seals would be developed during ESA consultation. These measures probably would include current standard mitigation used by the oil and gas industry in the Arctic. Lease stipulations and mitigation measures described in Section 5.2.12 of this EIA and in Section 13 of the DPP are expected to avoid and minimize potential adverse effects on ringed seals.

Preliminary Effects Determination

Project construction, drilling, and operations may affect, and probably will adversely affect, ringed seals in the area of the Liberty Development. Ringed seals probably would exhibit avoidance behavior, resulting in short-term, localized displacement of a few individuals. Although unlikely, a few ringed seals in the vicinity of the Liberty Development could be exposed to injurious noise levels or other injury. Physical impacts (e.g., PTS, collision mortality, exposure to spilled or leaked materials) to ringed seals from the Liberty Development are unlikely. Activities associated with the Liberty Development are not expected to impact the overall productivity, distribution, or abundance of the arctic subspecies of ringed seal. Construction activities would occur within habitats that could be considered for designation as critical for ringed seals. The small area of temporary landfast

ice impacts and long-term impacts to marine and nearshore habitats probably would be negligible to minor and would not diminish the value of the larger area for foraging or breeding.

Polar Bears

Potential project-related effects on polar bears would include disturbance from vessel, vehicle, or aircraft traffic; incidental disturbance from construction, drilling, and operation activities; hazing; habitat loss or alteration; and potential spills or leaks from vessels, vehicles, equipment, or facilities. In addition, project-related effects on ringed seals would indirectly affect polar bears because ringed seals are their primary food source.

Potential Presence in the Liberty Development Area

MMS (2002c) estimated that 1 to 3 polar bears could occur within 0.9 miles of the originally proposed island for the Liberty Development. Polar bears are more common in the vicinity of the Liberty Development during fall and winter, although they may occur in the region year-round (Section 3.12.1.4). The winter distribution of polar bears parallels that of ringed seals, which are their primary prey. Consequently, polar bears are more abundant in areas where ringed seals are more abundant, which generally is near the flaw zone, the zone of ice in between landfast ice and drifting ice. Although polar bear sightings documented within the North Slope oil fields are an inexact indicator of the number of polar bears, they may offer an indication of long-term trends. There has been an increasing trend in the annual number of polar bear sightings between 2000 and 2012, with 5-year averages (2008-2012) of 76 at Endicott/SDI and 23 at Northstar (Streever and Cargill Bishop 2013). Bears are most commonly observed in late August and September, when pack ice is far from shore.

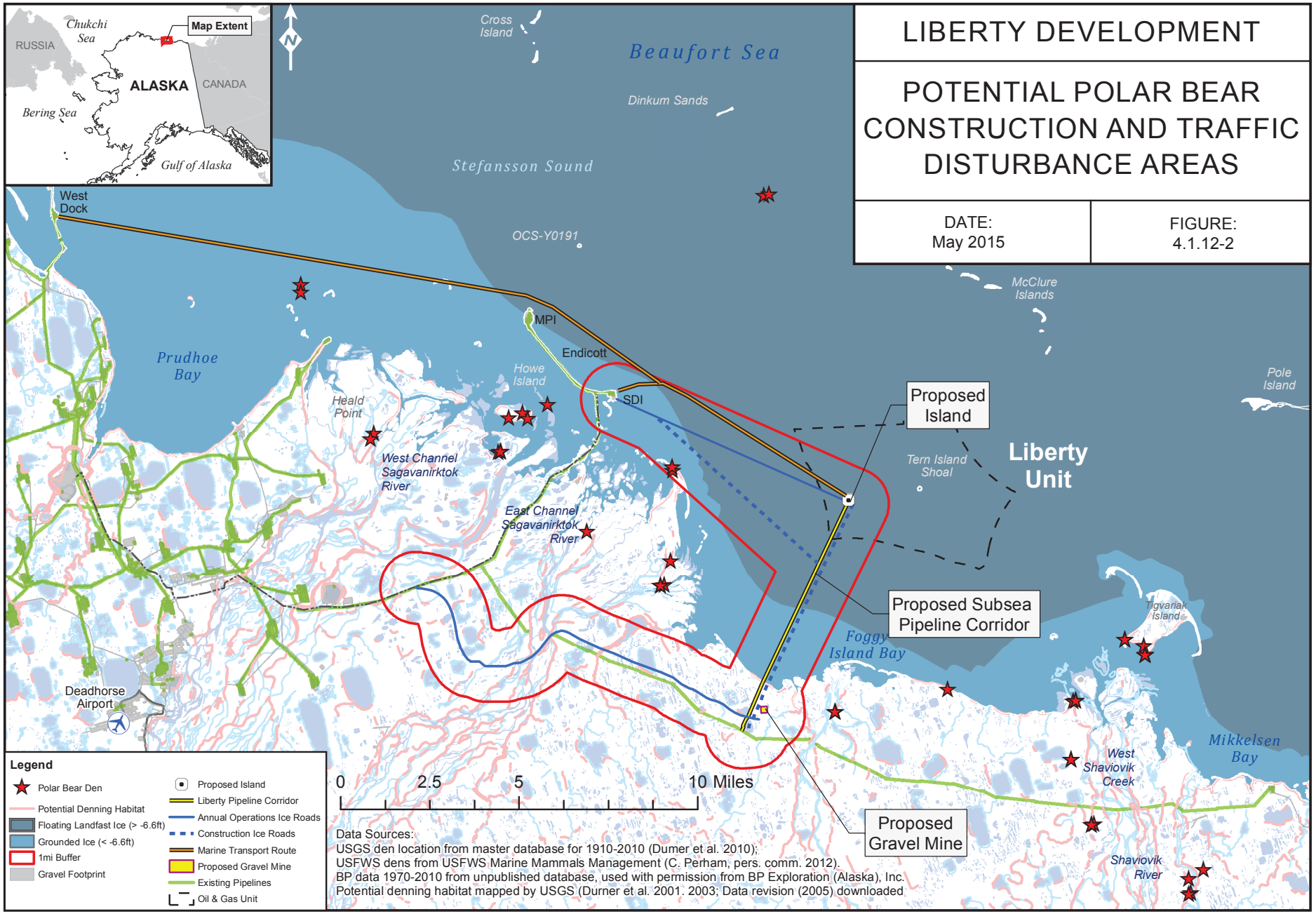
Impact Evaluation

Project-related activities that could affect polar bears include aircraft traffic and noise; vessel traffic and noise; construction and drilling noise; loss or alteration of habitat from island construction, gravel mining, and pipeline installation; and spills or leaks of fuels or oil from vessels or facilities. Liberty Development activities would be most likely to affect polar bears during construction, when more vessels, vehicles, and aircraft would be active in the area, although disturbance would continue at lower levels through operations.

Disturbance

Ship traffic could disturb a few polar bears during the summer and fall, with the likelihood of disturbance being highest during the construction phase of the project (Years 1 and 2). Barge traffic is common during the open-water season, and barges generally move at slow speeds along designated routes. Vessel traffic is expected to be most frequent during construction and drilling, and would decrease substantially during operations. Polar bears may either move away from approaching ships and boats, or they may approach boats to investigate them (Richardson et al. 1995). Polar bears typically swim with their heads above the water's surface and would hear and see nearby vessels. Polar bears on land or ice do not appear to be affected by vessels (Richardson et al. 1995).

Disturbances of greatest consequences to polar bears probably would involve winter construction activities and hibernating females and cubs in dens. Vehicular traffic and equipment operation associated with island construction and pipeline trenching would occur over two winters, primarily along ice-roads that access the gravel mine site, the island location and along the pipeline route (**Figure 4.1.12-2**). The presence of vehicular traffic in Year 2 is expected to be less than that during Year 1 because all gravel mining and hauling would be completed in Year 1. Vehicle traffic would decrease during operations.


LIBERTY DEVELOPMENT
POTENTIAL POLAR BEAR CONSTRUCTION AND TRAFFIC DISTURBANCE AREAS
DATE: May 2015
FIGURE: 4.1.12-2
Map Extent
Chukchi Sea
RUSSIA
ALASKA
CANADA
Bering Sea
Gulf of Alaska
N
Cross Island
Beaufort Sea
Dinkum Sands
Stefansson Sound
OCS-Y0191
West Dock
MPI
Endicott
SDI
Howe Island
Heald Point
Prudhoe Bay
West Channel Sagavanirktok River
East Channel Sagavanirktok River
McClure Islands
Pole Island
Proposed Island
Liberty Unit
Tern Island Shoal
Proposed Subsea Pipeline Corridor
Foggy Island Bay
Tigvariak Island
Deadhorse Airport
Mikkelsen Bay
West Shaviovik Creek
Shaviovik River
Proposed Gravel Mine
Legend
Polar Bear Den
Potential Denning Habitat
Floating Landfast Ice (> -6.6ft)
Grounded Ice (< -6.6ft)
1mi Buffer
Gravel Footprint
Proposed Island
Liberty Pipeline Corridor
Annual Operations Ice Roads
Construction Ice Roads
Marine Transport Route
Proposed Gravel Mine
Existing Pipelines
Oil & Gas Unit
0 2.5 5 10 Miles
Data Sources:
USGS den location from master database for 1910-2010 (Durner et al. 2010);
USFWS dens from USFWS Marine Mammals Management (C. Perham, pers. comm. 2012).
BP data 1970-2010 from unpublished database, used with permission from BP Exploration (Alaska), Inc.
Potential denning habitat mapped by USGS (Durner et al. 2001. 2003; Data revision (2005) downloaded

Most of the year, polar bears do not appear to be particularly sensitive to vehicle traffic or other human disturbances (Amstrup 1993; Richardson et al. 1995). If exposed to vehicle traffic and construction noises, reactions of polar bears likely would be brief and behavioral in nature. In contrast, females in maternity dens may be sensitive to noise and vehicle traffic (Amstrup and Gardner 1994) and may be more likely to be displaced by disturbance in the early part of a denning season (early winter), before the birth of cubs (Amstrup 1993; Linnell et al. 2000) than later in the winter. Pregnant females or females with young that abandon dens in mid-winter may perish, although Amstrup (1993) noted that polar bears were tolerant of ground traffic near maternal dens in the winter and spring. Snow cover on dens also serves as an insulator, reducing noise propagation into the den.

Noise from the Liberty Development also could be audible to polar bears at close ranges, with airborne sounds being more relevant than those generated underwater, particularly if polar bear dens are situated close to Liberty Development activities. In 2003, MacGillivray et al. (2003) measured airborne sounds from construction activities inside artificial polar bear dens on Flaxman Island. These researchers found that the den walls attenuated sounds from vehicles travelling on ice roads by 30 to 40 dB, and that the dens were most effective at attenuating sounds at frequencies between 70 and 170 Hz. Industrial sounds inside the dens were near background levels when noise sources were at ranges between 0.2 and 0.6 miles from the dens. These studies concluded that vibrations from traffic and noise were unlikely to be felt by denning bears unless the source was nearby (MacGillivray et al. 2003, 2009).

Movements of non-denning polar bears along the coastline during the winter and across tundra habitats year-round could be altered because of the construction of gravel and man-made ice infrastructure, barge facilities, and other activities. Construction activities and unfamiliar structures could cause individuals to avoid or detour around new construction. However, polar bears likely would habituate to the new structures, given their tolerance to human activities (Richardson et al. 1995).

Aircraft traffic would occur year-round during construction, drilling, and operations. Behavioral reactions of polar bears to aircraft depend on the lateral distance, flight altitude, and the type of aircraft. Reactions range from no detectable response to running away from aircraft traveling less than 660 feet agl at a lateral distance of less than 1,300 feet (Amstrup 1993). HAK will comply with standard flight mitigations as outlined in authorizations and lease stipulations.

Drilling Noise

Low-frequency noises from drilling at the Liberty Development could cause some behavioral disturbances to polar bears. These behavioral responses would be comparable to those described for vessel, aircraft, and ground traffic, although polar bears often quickly habituate to anthropogenic sounds (Amstrup 1993). Denning bears are unlikely to be disturbed by noise unless it occurs immediately nearby, because sound propagates poorly through snow, ice, and gravel (Richardson et al. 1995). Potential impacts of drilling noise from the Liberty Development on polar bears can be expected to be similar to those at Northstar, which were minor, short-term, and localized.

Collision-Caused Injury and Mortality

Polar bears can be at risk of injury or death from vessel strikes; however, the probability of a collision between a vessel and a polar bear is quite low because polar bears tend to forage in dense ice cover and probably would not use vessel traffic corridors. Bears could collide with vehicles traveling to and from facilities on ice or gravel roads, although this scenario is unlikely because polar bears are quick enough to avoid collisions with vehicles. The frequency of vessel and vehicle traffic would be greatest during construction and would decrease substantially during operations. HAK will comply with standard vessel operation mitigation to avoid collisions.

Hazing and Defense of Life

The attraction of polar bears to developments by food smells or human activities would increase the potential for human–polar bear interactions and would increase the probability of a bear being hazed or killed in defense of human life. The potential for hazing will be greatest during construction because more workers will be present during the construction phase and project-related activities will cover a larger area (due to gravel mining), increasing the likelihood of a bear encounter.

The attraction of polar bears to developments by food smells or human activities would increase the potential for human–polar bear interactions and would increase the probability of a bear being hazed or killed in defense of human life. The potential for hazing will be greatest during construction because more workers will be present during the construction phase and project-related activities will cover a larger area (due to gravel mining), increasing the likelihood of a bear encounter. Of the 5-year average of 76 bears/year recorded at Endicott and SDI during operations, an average of 37 bears/year required deterrent action. The majority of bears (27/year average) were deterred by vehicle positioning. Sound (horn, siren, airhorn, loudspeaker, yelling/clapping) was the second most common deterrent type, following by lighting (headlights, spotlights; 13/year average). Often multiple types of deterrents were employed. Projectiles (cracker shells, pellets) were the least likely kind of deterrent used (>4 hazing incidents/year average), and only when other deterrent methods were unsuccessful. Some bears were not deterred at all, some were deterred multiple times (BPXA 2009, 2010, 2011, 2012, 2013). HAK will implement a project-specific Polar Bear Interaction Plan that would emphasize management practices that minimize attractants and maximize bear and human safety.

Habitat Loss or Alteration

The Liberty Development would turn a small area of aquatic habitat into terrestrial habitat (approximately 24 acres of sea floor at the LDPI) that could be attractive as a haulout to ringed seals and, therefore, polar bears, especially as sea ice retreats northward in late summer and early fall. Snow drifting along the sheetpile wall at the LDPI, and possibly along the SDI hovercraft landing area, may create snow drifts of sufficient size for polar bears to den. Snow-handling plans may be necessary to avoid creation of a possible attractant for polar bears. About 74 acres of terrestrial habitat would be converted to gravel mine. The mine site will not alter potentially suitable denning habitat (Figure 4.1.12-2). Most impacts to potentially suitable denning habitat (mapped as linear bank features that collect sufficient snow drifts for polar bear den construction; Durner et al. 2001) would primarily be related to disturbance during gravel mining and hauling for construction. Potentially suitable terrestrial denning habitat within 1 mile of ice roads and construction areas could be disturbed (Figure 4.1.12-2). Construction of the gravel mine would involve blasting that could also disturb potentially suitable terrestrial den habitats within 1 mile of the gravel source area (Figure 4.1.12-2). Prior to initiating any winter project-related activity such as ice-road construction or gravel mining, surveys would be conducted for polar bear dens, and no activity would be allowed within 1 mile of occupied den sites without approval from USFWS. During all phases of the project, the ice road between SDI and LDPI would avoid the disturbance of potentially suitable terrestrial denning habitat (Figure 4.1.12-2). Ice features may seasonably develop that contain primary elements for denning.

Alteration of sea ice habitat also could affect a few bears indirectly if these alterations result in changes in the distribution or abundance of ringed seals. A lack of prey can have energetic consequences for individual mammals, including declines in health and reproductive success (Barboza et al. 2009). However, this scenario is unlikely because ringed seals do not occur in high densities on the landfast ice in Stefansson Sound, and localized and short-term displacement of a few ringed seals would likely have negligible nutritional consequences for polar bears.

Spills or Leaks

Potential effects of expected small spills and leaks of oil (less than 1,000 bbl) and large oil spills (greater than 1,000 bbl) on marine mammals are discussed in Section 4.1.8.1. Trajectories of small and large oil spills from the previous Liberty Development overlaid on polar bear density surfaces resulted in an average of 3.4 and 4.2 and a maximum of 16.3 and 22.9 polar bears that would be oiled by a 1,600-bbl and a 6,000-bbl spill during September, respectively (Amstrup et al. 2006). An average of 6.6 and 8.0 and a maximum of 46.1 and 55.2 polar bears potentially would be exposed to a 1,600-bbl and a 6,000-bbl oil spill during October, respectively (Amstrup et al. 2006).

The exposure of polar bears to spills and leaks of oil, fuel, or chemicals could result in acute irritation or damage to eyes, nostrils, and skin and could cause respiratory distress from the inhalation of vapors (Geraci and St. Aubin 1990). Exposure to contaminants could damage or decrease the insulative qualities of polar bear fur and could lead to long-term impacts to the endocrine system (Geraci and St. Aubin 1990). The ingestion of toxic chemicals, either directly or through grooming of contaminated fur, can cause acute irritation to the digestive tract, vomiting, and the aspiration of vomit into the lungs, potentially resulting in pneumonia and death (Geraci and St. Aubin 1990). Indirect effects could result in a reduced abundance of ringed seals or the consumption of contaminated ringed seals. Because polar bears may range across large areas over short periods (Amstrup et al. 2006) and because their ringed seal prey also may range widely, impacts from consuming contaminated seals could affect multiple individuals. Polar bears also would probably be displaced by disturbance during cleanup activities. Consequences of the WCD or CDE on polar bears are addressed in Section 4.3.

Conservation Measures

Conservation measures to avoid or minimize the incidental and intentional take of polar bears would be developed during ESA consultation. These measures probably would include pre-construction den surveys and 1-mile buffers around all known dens; speed restrictions; pre-determined transportation routes; food waste management planning; the use of operational closures; OSRP and other material-management plans; and adherence to a Polar Bear Interaction Plan. Lease stipulations and mitigation measures described in Section 5.2.12 of this EIA and Section 13 of the DPP are expected to avoid and minimize adverse effects on polar bears.

Preliminary Effects Determination

Project construction, drilling, and operations may affect, and would probably adversely affect a few polar bears in the vicinity of the Liberty Development. Potential impacts from the Liberty Development are not expected to alter the overall productivity, distribution, or abundance of the Southern Beaufort Sea (SBS) and Chukchi/Bering seas (CBS) polar bear stocks.

Construction activities would occur within areas with potential polar bear denning habitat, with potentially suitable denning habitat temporarily exposed to disturbance, and no potentially suitable denning habitat would be altered within the gravel source area. This small area of impact would be negligible. In expanding the SDI, a small area of aquatic habitat would be converted to terrestrial and nearshore benthic habitat. This new terrestrial habitat could attract bears looking for a location to rest or den. Mitigation measures and monitoring programs would reduce the potential use of the SDI by polar bears.

Bowhead Whale

Project-related activities that could affect bowhead whales include aircraft traffic and noise; vessel traffic and noise; construction and drilling noise; loss or alteration of marine habitat from island construction and pipeline installation; and spills or leaks of fuels or oil from aircraft, vessels, or facilities. Traffic on ice roads and noise

associated with winter construction and operation activities would not impact bowhead whales because they are absent from the Beaufort Sea in the winter.

Potential Presence in the Liberty Development Area

Bowhead whales live in pack ice for most of the year, typically wintering at the southern limit of the pack ice in the Bering Sea or in polynyas. As the sea ice breaks up and recedes during the spring, they begin migrating northward into and through the Chukchi Sea to summer in the Beaufort Sea (Allen and Angliss 2012). The spring migration of bowhead whales follows fractures in the sea ice around the coast of Alaska, generally in the shear zone between the shorefast ice and the mobile pack ice. The spring migration generally occurs far offshore (well away from any noise effects from the Liberty Development) and terminates at summer feeding grounds in the eastern United States and Canadian Beaufort Sea. In the late summer and fall, the whales move shoreward, presumably following ocean currents or fronts that concentrate prey (Moore et al. 2000a; Okkonen et al. 2011). In the fall, migrating bowhead whales use shelf waters (≤164 to 656 feet depth) in all but "heavy ice" conditions, when they use continental slope habitat (Moore et al. 2000a). They occur inshore in the summer and during fall migration, which can bring the whales into areas where they may be affected by offshore oil and gas developments such as Northstar or LDPI. Most individuals, however, remain seaward of the barrier islands (Moore et al. 2000a; Treacy et al. 2006; Okkonen et al. 2011) and would not be affected by the project.

Impact Evaluation

Bowhead whales in the vicinity of the Liberty Development could be affected by sounds from vessels and aircraft traffic, summer and fall construction, drilling, and operation activities. There also is a potential for collisions with vessels associated with the construction and operation of the Liberty Development, and there is a risk of oil spills that could expose whales to toxic chemicals. This section focuses on the bowhead whale; potential related effects on subsistence hunting of bowhead whales are discussed in Section 4.1.16.2.

Disturbance

Most bowhead whales would avoid vessel traffic, although reactions to slow-moving vessels and vessels not moving in the direction of the animals are not strong (NMFS 2008). Some whales begin to avoid approaching diesel-powered vessels at 2.5 miles or more. Behavioral responses to vessels can displace bowhead whales by a few miles or more. Vessel and air traffic would likely elicit transient avoidance behavior, with little or no consequence, although few bowhead whales are expected to occur within the nearshore area where most project-related vessel and aircraft traffic would occur (Figure 4.1.12-1). Under the Proposed Project, vessel traffic would be most frequent during Year 2, when barging would support construction on the island. Vessels associated with the Liberty Development would transit within the barrier islands, where bowhead whales generally do not occur.

Noise levels associated with the Liberty Development are anticipated to be similar to levels produced during construction, drilling, and operation activities at Northstar. Studies conducted as part of a monitoring program for the Northstar facility indicate that in 1 of the 3 years of monitoring efforts, the southern edge of the fall migration path of bowhead whales may have been moved slightly (1.25 to 2 miles) farther offshore during periods when higher sound levels were recorded; there was no significant effect of sound detected on the migration path during the other 2 monitored years (Richardson et al. 2004). Evidence indicated that deflection of the southern portion of the migration in 2001 occurred during periods when certain vessels were present in the area and did not occur as a result of sound emanating from the Northstar facility itself (BOEMRE 2011d).

Much of the production noise from oil and gas operations on gravel islands is attenuated substantially within 2.5 miles and often is not detectable beyond 5.8 miles. Given that most of the fall bowhead whale migration occurs

seaward of the barrier islands, which are more than 6 miles from the LDPI, most bowhead whales are expected to migrate by with little or no detection of noise from LDPI. Occasionally a few bowhead whales may venture shoreward of the barrier islands. Although they may detect sound from the island, most sounds, with the exception of vibratory sheetpile-driving, are expected to attenuate to near or below the 120 dB re 1 µPa rms within 328 feet of the source. NMFS interim guidance uses 120 dB re 1 µPa rms received-sound level as the threshold or level B (behavioral) take of cetaceans and seals by activities or equipment that produces continuous sound (Section 4.1.8.2. The few bowhead whales that may experience noise from LDPI at these levels probably would avoid the area with negligible consequence.

Collision-Caused Injury and Mortality

Vessel strikes of bowhead whales are possible, although unlikely. Under the Proposed Project, vessel traffic would be most frequent during Year 2, when barging would support construction on the island. Although George et al. (1994) documented scarring of bowhead whales from vessel encounters, the rate was low (less than 1 percent), and there have been no documented incidents of mortality. Laist et al. (2001) determined that serious injuries to whales rarely occur in incidents involving vessels traveling at speeds of less than 10 kts. NMFS concluded that bowhead whale vessel strikes associated with Arctic OCS oil and gas leasing would be sufficiently small as to be discountable based on the small number of vessels, the small number of authorized activities, the transitory nature of the vessels, the decades of spatial and temporal overlap that have not resulted in vessel strike or mortality, and the mitigation measures in place to minimize vessel strikes (NMFS 2013).

Habitat Loss or Alteration

Bowhead whales are planktivorous feeders, relying on concentrations of krill and copepods. In the summer, bowhead whales in the Canadian Beaufort Sea often are seen near coastal-upwelling zones and frontal features that can concentrate zooplankton (Bradstreet et al. 1987, cited in Moore et al. 2000a). Ainley and DeMaster (1990, cited in Moore et al. 2000a) found that the distribution of bowhead whales was directly associated with concentrations of copepod prey at the boundary between the Mackenzie River plume and arctic marine waters. Although construction of the LDPI project would eliminate a small amount of bottom habitat and would create a structure that potentially could affect local surface currents and create downstream eddies, it is not expected to affect the quality of habitat for foraging whales. Few bowhead whales would be expected to forage in the vicinity of the Liberty Development.

Spills or Leaks

Potential effects of expected small spills and leaks of oil (less than 1,000 bbl) and large oil spills (greater than 1,000 bbl) on marine mammals are discussed in Section 4.1.8.1. NMFS assessed the probability of effects of a small oil spill in its 2013 BO on BOEM's Arctic OCS Oil and Gas Leasing and Exploration Program (NMFS 2013) and concluded that, based on the localized nature of small oil spills, the relatively rapid weathering expected for a spill of less than 1,000 bbl of oil, the small number of refueling activities associated with the proposed Liberty Development, and the safeguards in place to avoid and minimize oil spills, the probability of a BOEM-authorized activity causing a small oil spill and exposing bowhead whales in the Beaufort Sea Planning Area was considered so small as to be discountable. The probability of large oil spills from platforms (average of 3,300 bbl) or pipelines (average 6,700 bbl) during production in the Beaufort Sea was estimated to be 26 percent with a combined probability of occurrence in resource areas important to bowhead whales of less than 0.5 to 3 percent over a 20-year production life (NMFS 2013). Although unlikely to occur, potential consequences of a large spill on bowhead whales could be major (NMFS 2013). Consequences of the WCD or CDE on bowhead whales are addressed in Section 4.3.

Conservation Measures

Conservation measures to avoid or minimize the incidental take of bowhead whales and coordinate activities with the Alaska Eskimo Whaling Commission (AEWC) would be developed during ESA consultation. These measures probably would include current standard mitigation used by the oil and gas industry in the Arctic. Lease stipulations and mitigation measures described in Sections 5.2.12 of this EIA and Section 13 of the DPP are expected to avoid and minimize potential adverse effects on bowhead whales and subsistence whaling.

Preliminary Effects Determination

Project construction, drilling, and operations may affect, and are likely to adversely affect a few bowhead whales in the vicinity of the Liberty Development. Individual whales could exhibit behavioral responses to noise and to the presence of vessels and aircraft; however, physical effects (PTS, injuries from vessel collisions, exposure to spills) are unlikely. Potential impacts from the Liberty Development are not expected to impact the overall productivity, distribution, or abundance of the Western Arctic bowhead whale stock. No critical habitat has been designated for bowhead whales, but the Liberty Development is not expected to reduce those habitat elements (e.g., the presence of forage species) that sustain bowhead whales.

Impact Conclusions

Project construction, drilling, and operation may affect and are likely to adversely affect individual ringed seals, polar bears, and bowhead whales present in the vicinity of the Liberty Development. Noise and activities during the open-water season could have moderate effects on individual seals, causing avoidance behavior and resulting in short-term, localized displacement of a few individuals. Noise and activities occurring during the open-water season are expected to have a negligible impact on polar bears because they generally are absent from the vicinity of the Liberty Development during summer months. Most project activities occurring during the open-water season would not affect bowhead whales because they tend to occur outside of Foggy Island Bay and beyond the range of sounds generated by construction and drilling. Individuals could be exposed to injurious noise levels or ship strikes or could exhibit avoidance behavior if they encounter barges transiting from the Chukchi Sea to the project site.

Winter construction, drilling, and operation activities would have no effect on bowhead whales because they are absent from Foggy Island Bay in the winter months. Noise and activities occurring during the winter months could have negligible to moderate effects on ringed seals and occupied ringed seal lairs. The likelihood of disturbance to denning polar bears would be negligible if active dens are identified and avoided. Winter activities could have negligible to moderate effects on a few individual polar bears that may be temporarily displaced by noise from low-flying aircraft or that could be attracted by activities at the Liberty Development, thereby increasing the potential for hazing. The need for hazing would be minimized by development and adherence to a Polar Bear Interaction Plan.

Because only a small fraction of the larger populations of ringed seals, polar bears, and bowhead whales have the potential to occur in the immediate vicinity of Liberty Development, noise and activity-related impacts to their populations are anticipated to be negligible to minor. These determinations are consistent with BOEM's assessment of construction and operation impacts from oil and gas development on the OCS (negligible to moderate impacts from construction and routine operations; BOEM 2012) and with previous determinations for the Liberty Development by MMS (2002c) that concluded that localized, short-term displacement of a few individuals was possible.

Habitat loss and alteration from the Liberty Development would have negligible impacts on the Beringia bearded seal DPS, the arctic ringed seal subpopulation, the SBS and CBS polar bear stocks, and Western Arctic bowhead whale stock because the Liberty Development marine and nearshore impacts cover a negligible percentage of available habitats in the Beaufort Sea. This finding is consistent with previous determinations made for the Liberty Development by MMS (2002c) and for oil development on the OCS as a whole (BOEM 2012).

Small and large spills and leaks from the Liberty Development could have major impacts on individual ringed seals, polar bears, and bowhead whales, whereas impacts of small spills or leaks on their larger populations are anticipated to be negligible to minor. This finding is consistent with MMS's (2002c) previous conclusions that the spills associated with the Liberty Development were unlikely to impact marine mammals because all spills would be contained and cleaned up immediately. This determination also is in agreement with BOEM's conclusion that spills associated with arctic marine oil and gas development would have a minor to moderate potential to impact marine mammals, with the magnitude of effects dependent in part on the location, volume, and timing of the spill (BOEM 2012).

4.1.12.2 Coastal and Marine Birds

Potential project-related effects on spectacled eiders would be similar to those described for coastal and marine birds in Section 4.1.9; those effects may include: displacement away from noise and human activities; habitat loss or alteration; collisions with structures and vessels; decreased productivity due to artificially high predator abundance; and possible contamination of birds or their prey by spills or leaks of fuel, oil, or chemicals. Although the probability of a large-volume spill or WCD is extremely low (NOAA 2013a), spectacled eiders could experience widespread impacts if a large spill occurred during the open-water season. Potential impacts on listed coastal birds from a WCD are discussed under Section 4.3. Impacts to Steller's Eiders would be minimal in all cases because the species can be considered casual and unlikely to occur in this area.

The Liberty Development Project ER (LGL Alaska et al. 1998, Sections 5.1.8, 5.2.8, 5.3.5, 5.4.8, and 5.6), the Liberty DPP FEIS (MMS 2002c, Sections IIIA2c and IIIC2a), Liberty DPP EA and EIA (MMS 2007b; BPXA 2007, Section 3.1.11), the Revised OCS Lease Exploration Plan: Camden Bay, Beaufort Sea, Alaska EA (BOEMRE 2011c, Section 4.2.6), and the Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft EIS (NOAA 2013a, Sections 4.5.2.3.1) describe potential effects of development activities near the proposed Liberty Development on Steller's eiders and spectacled eiders, and are incorporated here by reference. Summaries of applicable project-related effects from these documents are presented below with updated information from recent impact-assessment studies.

Most activities during construction and gravel-mine development would occur in the winter, when migratory eiders and loons are not present on the ACP. The impact assessment discussions in Section 4.1.9 address potential impacts from activities that would occur primarily during early spring through late fall, when migratory eiders are present in the Arctic, and potential habitat impacts from activities conducted in winter that could affect coastal and marine birds**.**

Steller's Eider

Potential Presence in the Project Area

Most Steller's eiders nest far west of the Liberty Development, although a few may migrate through the Liberty Development area during the spring or fall, as described in Section 3.12.2.1.

Impact Evaluation

Steller's eiders occurring in the vicinity of the Liberty Development could be affected by noise and activity during construction, drilling and operations; habitat loss or alteration as a result of island construction and expansion at SDI; collision-caused mortality; and indirect effects caused by an increase in the abundance of predators. There also is a risk of oil spills that could expose a few birds to toxic chemicals.

Disturbance

Disturbance from project-related activities could occur primarily during construction, when more vessels, vehicles, and aircraft would be active in the area; however, disturbance also could continue through operations during the spring (early to mid-June) and summer-fall (July to September) migration periods (Fredrickson 2001). Steller's eiders on spring or fall migrations may be disturbed by hovercraft or helicopter traffic but, because they are unlikely to remain in the area for long periods, disturbance probably would be limited to a single or a few exposures. Eiders likely would react to the disturbance by diving, flushing, or avoiding the area. Steller's eiders appear to migrate in small flocks along the coast, where they would be likely to encounter project-related disturbances (Fredrickson 2001). Steller's eiders are not expected to nest east of Prudhoe Bay, so they are not likely to be disturbed due to the increased vehicle traffic during construction between Deadhorse and Endicott and the LDPI or ice-road construction and mine site development.

Habitat Loss or Alteration

Loss of nearshore foraging and migration-staging habitats could result from construction of the LDPI (approximately 24 acres). Steller's eiders feed on small marine invertebrates, especially mollusks and crustaceans, by tipping or diving in shallow waters (Frederickson 2001), and it is anticipated that small areas of their potential benthic foraging habitats would be lost. Foraging habitats also would be altered temporarily by increased turbidity from an increase in suspended sediments around the island and along the subsea pipeline route. The nesting range of Steller's eiders extends as far east as the Sagavanirktok River, but no Steller's eiders are expected to nest near the Liberty Development, and no Steller's eider nesting habitat would be lost or altered by the project.

Collision-Caused Injury and Mortality

Potential collisions with infrastructure during periods of fog and low visibility could occur during migration, as discussed in Section 4.1.9. Because few, if any, Steller's eiders are expected to migrate through the region, the risk of collision would be extremely small.

Increased Predator Abundance

As discussed in Section 4.1.9, some nest predators benefit from association with human activities and oilfield infrastructure. Increases in the abundance or foraging efficiency of predators may lead to localized decreases in productivity around developments (Liebezeit et al. 2009). Because Steller's eiders are unlikely to nest near any parts of the Liberty Development components, they would not be affected by any artificial increase in predator abundance that might occur.

Spills or Leaks

Potential effects of expected small spills and leaks of oil (less than 1,000 bbl) and large oil spills (greater than 1,000 bbl) on coastal and marine birds are discussed in Section 4.1.9. Because few, if any, Steller's eiders are expected to occur near the project, it is unlikely that any would be exposed to spills or disturbed by cleanup efforts.

Conservation Measures

Lease stipulations and mitigation measures protective of coastal and marine birds described in Section 5.2.12 of this EIA and Section 13 of the DPP would be implemented to avoid or minimize potential adverse effects on Steller's eiders.

Preliminary Effects Determination

Project construction and operations could, but are unlikely to, affect even a few Steller's eiders migrating through the Liberty Development area. Because few, if any, Steller's eiders are expected to occur near the Liberty Development and because of the incorporation of conservation measures, the project could adversely affect at most a few Steller's eiders but probably would affect none. Designated critical habitat for the Steller's eider occurs on the Yukon–Kuskokwim Delta and in marine water of southwestern Alaska; therefore, no critical habitat would be affected by the Liberty Development.

Spectacled Eider

Potential Presence in the Project Area

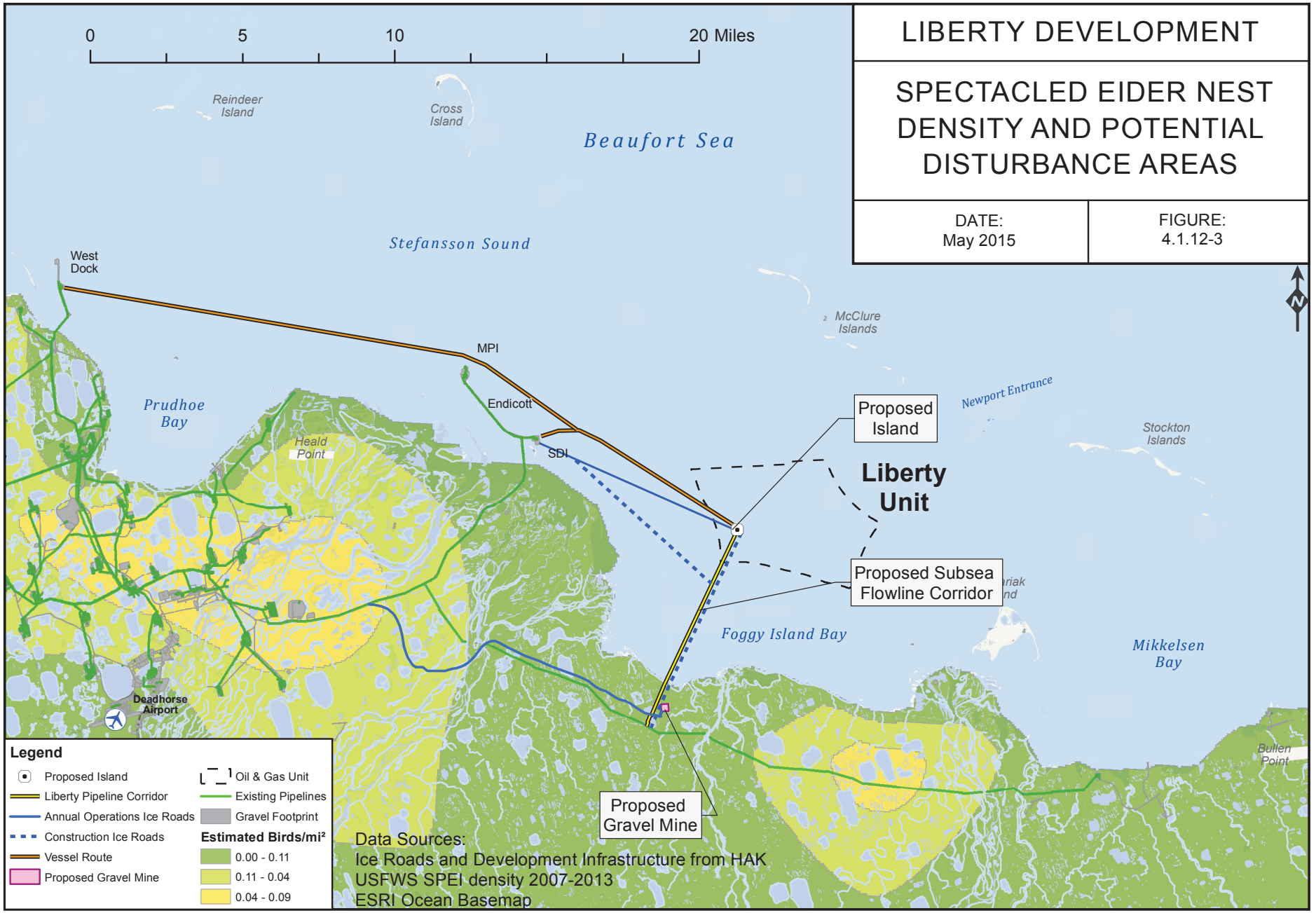
A few spectacled eiders may migrate through the Liberty Development during the spring or fall and may use coastal waters in the vicinity of the Liberty Development. A few spectacled eiders also are likely to nest on coastal tundra within the project area, as described in Section 3.12.2.2 (**Figure 4.1.12-3**).

Impact Evaluation

Spectacled eiders occurring in the vicinity of the Liberty Development could be affected by noise and activity during construction, drilling and operation, habitat loss or alteration as a result of island construction and expansion at SDI, collision-caused mortality, and indirect effects caused by an increase in the abundance of predators. There also is a risk of oil spills that could expose these birds to toxic chemicals.

Disturbance

Disturbance to spectacled eiders from project-related activities would occur primarily during construction, when more vessels, vehicles, and aircraft would be active in the area; although, disturbance also would continue through drilling and operation, as described in Section 4.1.9. Migrating and foraging spectacled eiders could be disturbed by hovercraft or helicopter traffic in nearshore waters or by vehicle and helicopter traffic between Deadhorse and Endicott. Eiders disturbed while on nearshore waters probably would react to the disturbances by diving, flushing, or avoiding the area. Spectacled eiders use coastal migration routes, where they would be likely to encounter project-related disturbances (Day et al. 2005). Eiders disturbed while using tundra habitats during nesting or brood-rearing probably would react to the disturbances by flushing from active nests, avoiding foraging habitat, increasing vigilance, and separating from their young.


LIBERTY DEVELOPMENT
SPECTACLED EIDER NEST DENSITY AND POTENTIAL DISTURBANCE AREAS
DATE: May 2015
FIGURE: 4.1.12-3
0
5
10
20 Miles
Reindeer Island
Cross Island
Beaufort Sea
Stefansson Sound
West Dock
MPI
Endicott
SDI
Prudhoe Bay
Heald Point
McClure Islands
Newport Entrance
Stockton Islands
Proposed Island
Liberty Unit
Proposed Subsea Flowline Corridor
Foggy Island Bay
Mikkelsen Bay
Bullen Point
Deadhorse Airport
Proposed Gravel Mine
N
Legend
Proposed Island
Liberty Pipeline Corridor
Annual Operations Ice Roads
Construction Ice Roads
Vessel Route
Proposed Gravel Mine
Oil & Gas Unit
Existing Pipelines
Gravel Footprint
Estimated Birds/mi²
0.00 - 0.11
0.11 - 0.04
0.04 - 0.09
Data Sources:
Ice Roads and Development Infrastructure from HAK
USFWS SPEI density 2007-2013
ESRI Ocean Basemap

Habitat Loss or Alteration

Loss of nearshore foraging and migration staging habitats or tundra-nesting habitats could result from construction of the LDPI (approximately 24 acres), the aboveground pipeline (1.5 linear miles), two pipeline support gravel pads (totaling approximately 1.6 acre footprint), the pipeline landfall area (approximately 1.0 acre), and the gravel mine site (21 acres). Spectacled eiders at sea and in nearshore habitats feed on benthic invertebrates; during nesting, they feed on insects, insect larvae, seeds, and plant material by dabbling, tipping, or diving (Petersen et al. 2000). Small areas of benthic foraging habitats would be lost due to island construction. Nearshore foraging habitats also would be altered temporarily by increased turbidity from an increase in suspended sediments around the island and along the subsea pipeline route.

Spectacled eiders may nest on tundra habitats near proposed project components, including the gravel mine site and ice roads (Figure 4.1.12-3). Potential tundra-nesting habitats would be converted to open-water at the gravel mine. Potential tundra-nesting and foraging habitats would be altered through delayed melting of the ice roads. Spectacled eiders commonly occur in very small numbers near the Liberty Development during the summer; a few could be displaced from tundra-nesting habitats due to gravel mine construction and the presence of ice roads. Habitat losses from gravel mine construction would be permanent, whereas most habitat alteration resulting from ice-road construction across tundra would occur only during gravel mine construction.

Collision-Caused Injury and Mortality

Potential collisions with infrastructure during periods of fog and low visibility could occur during migration, as discussed in Section 4.1.9. Migrating eiders may be particularly susceptible to collision-caused mortality because they often migrate along the coast and typically fly at low altitudes (average = 20 feet), and have high flight speeds (average = 50 mph) and low maneuverability (Day et al. 2005). The risk of direct fatality from collisions with vessels is greatest when waterfowl are in large molting flocks and cannot fly. The largest concentrations of molting eiders occur in coastal lagoons and along barrier islands, where no vessel traffic is anticipated. Some flocks of molting or brood-rearing eiders may occur within designated vessel routes, but collisions should be avoidable. Collisions with vehicles along the roads between Deadhorse and Endicott probably would involve brood-rearing birds. Between 2005 and 2012, no collision-caused mortalities of spectacled eiders were recorded on or near North Slope facilities (see Table 4.1.9-2); mortalities of waterfowl and seabirds that may be attributable to collisions were reported at a rate of about 5 birds/year, of which 3.5 birds/year were eiders (Table 4.1.9-2). Not all collision-caused mortalities of birds are likely to be detected and recorded; however, the level of collision-caused injury and mortality is not expected to be high, and few, if any, spectacled eider collision mortalities would be expected based on past monitoring with implementation of applicable conservation measures.

Increased Predator Abundance

As discussed in Section 4.1.9, some nest predators benefit from association with human activities and oilfield infrastructure. Increases in the abundance or foraging efficiency of predators could lead to localized decreases in productivity around developments (Liebezeit et al. 2009). The productivity of spectacled eiders nesting near any of the Liberty Development components could be reduced through artificial increases in the abundance of common ravens or foxes attracted to the development.

Spills or Leaks

Potential effects of expected small spills and leaks of oil (less than 1,000 bbl) and large oil spills (greater than 1,000 bbl) on coastal and marine birds are discussed in Section 4.1.9. An average of 0.2 to 0.3 percent and a maximum of 7.4 and 9.6 percent of the central Beaufort Sea population of spectacled eiders potentially would be exposed to a 1,500 bbl or 6,000 bbl oil spill during July, respectively (Table 4.1.9-3; Stehn and Platte 2000). No spectacled eiders

were expected to be exposed to spills of either size in August (Stehn and Platte 2000). Because a few spectacled eiders are expected to occur near the project, it is likely that some also would be disturbed by cleanup efforts if a spill occurred.

Conservation Measures

Lease stipulations and mitigation measures protective of coastal and marine birds described in Section 5.2.12 and Section 13 of the DPP would be implemented to avoid or minimize potential adverse effects on spectacled eiders.

Preliminary Effects Determination

Project construction, drilling, and operation could, but are unlikely to, adversely affect more than a few spectacled eiders in the Liberty Development area. Because small numbers of spectacled eiders are expected to occur near the Liberty Development and because of the incorporation of conservation measures, the project could adversely affect at most a few spectacled eiders. Designated critical habitat for the spectacled eider occurs in the Bering Sea. No critical habitat would be affected by the Liberty Development.

Impact Conclusions

Project construction, drilling, and operations could adversely impact more than a few individual Steller's eiders and spectacled eiders in the Liberty Development. Noise and activities during the open-water season could have minor impacts on individual eiders, causing avoidance behavior and resulting in short-term, localized displacement of a few individuals. Collisions with marine vessels are possible and are more likely to occur when birds are molting and unable to move out of the way of vessels, and collisions with facilities could occur at any time when birds are present in the vicinity of the Liberty Development.

Winter activities would have a negligible impact on Steller's eiders because they are absent during winter and do not nest within the Liberty Development area. A few individual Steller's eiders may be displaced during the open-water season from foraging areas due to increased water turbidity resulting from winter construction activities. Winter activities would have minor impacts on individual spectacled eiders. This species also is absent from the area during winter months, but may be displaced from suitable nesting or foraging habitat due to habitat alteration resulting from construction of the LDPI, hovercraft expansion at SDI, ice roads, or the gravel mine.

Because a small number of Steller's eiders and spectacled eiders use the habitats within the Liberty Development area, noise- and activity-related effects on their overall populations are anticipated to be negligible to minor. These determinations are consistent with BOEM's assessment of construction and operation impacts from oil and gas development on the OCS (BOEM 2012) and are in agreement with previous determinations made for the Liberty DPP FEIS by MMS (2002c), which found no expected effect on Steller's eiders but possible displacement of a few spectacled eiders, with the potential for population-level effects.

Spills and leaks from the Liberty Development could have minor to moderate impacts to individual Steller's eiders and spectacled eiders. Small spills (less than 1,000 bbl) could negatively affect the health or productivity of a few individuals but are unlikely to have population-level impacts. Large spills (greater than 1,000 bbl) could negatively impact a larger number of individuals than small spills, and the number of individuals affected would be dependent on timing, location, and extent of the spill. Population-level effects on Steller's eiders are unlikely, however, given the low numbers in the project area, although population-level effects on spectacled eiders are possible. This determination is consistent with the lower range of expected impacts estimated by BOEM (2012), which concluded that spills associated with arctic marine oil and gas development would have a moderate to major potential to impact marine and coastal birds, with the magnitude of effects dependent in part on the location, timing, and

volume of the spill. This finding also is consistent with MMS's (2002c) previous conclusion that the small spills associated with the Liberty Development were unlikely to impact a large number of individuals but that large spills may result in lethal or sublethal effects for a greater number of individuals, depending on the location, timing, and extent of the spill. Although population level effects are possible because of the location of the Liberty Development, the proportion of the spectacled eider population potentially affected by a large spill associated with the Liberty Development would be low.

4.1.13 Sensitive Biological Resources

Potential environmental consequences on sensitive biological resources that occur near the Liberty Development are discussed in various sections throughout the EIA. A summary of potential project-related effects on these resources and references to the sections in which they are discussed are presented in **Table 4.1.13-1**. Locations of these sensitive resources in relation to Liberty Development components are shown in **Figure 4.1.13-1**. Potential WCD effects on biological resources are addressed in Section 4.3. Mitigation measures intended to avoid or lessen effects summarized in Table 4.1.13-1 and are discussed within the respective environmental consequences sections and in Section 5.2. As noted in Section 3.13, sensitive biological resources were identified through the U.S. Department of the Interior (USDOI; BOEMRE 2011d, p. C-15) and ADNR (ADNR 2013) information to oil and gas lessees in the Beaufort Sea.

Table 4.1.13-1. Summary of Potential Liberty Development Effects on Sensitive Biological Resources

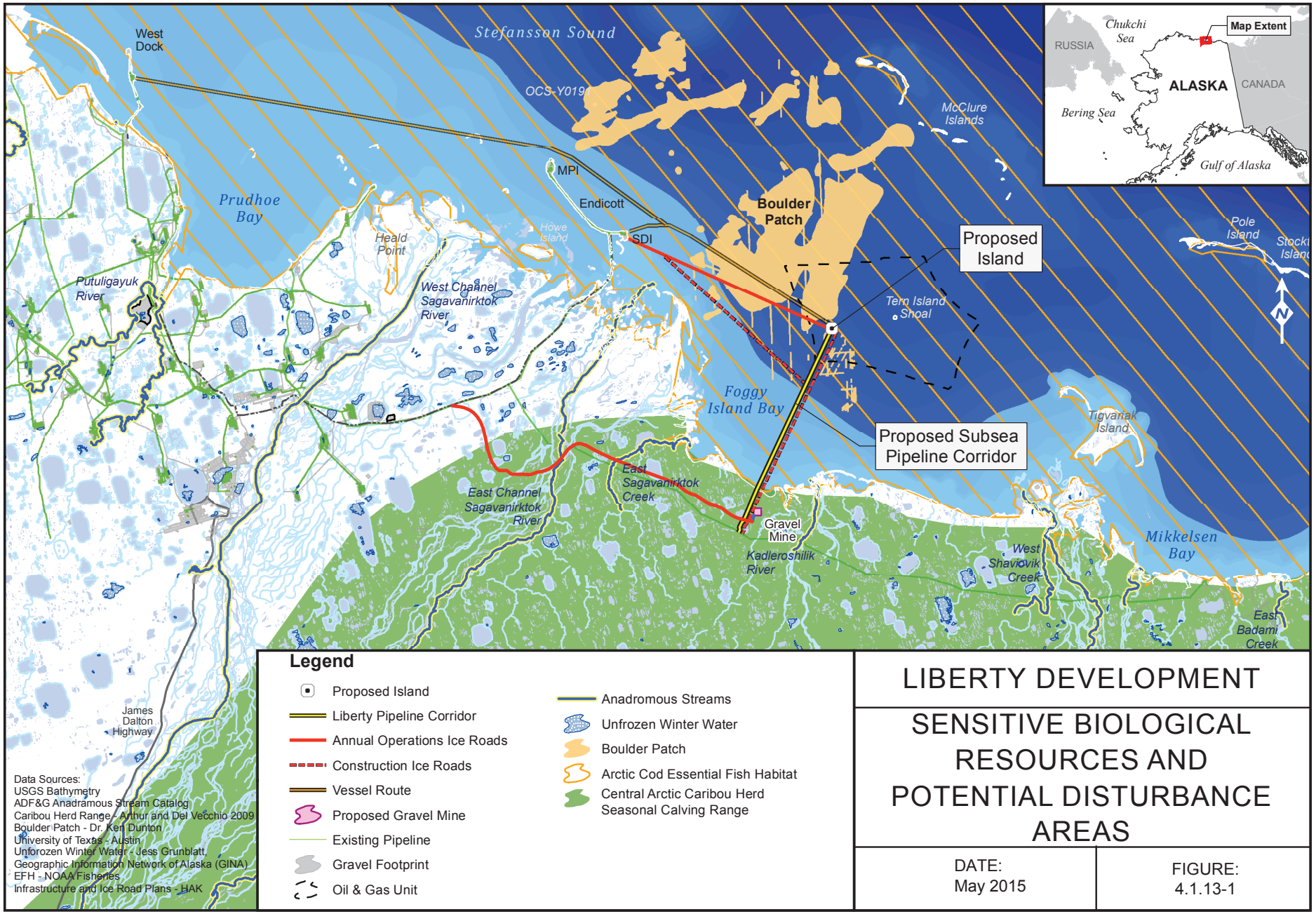
SENSITIVE RESOURCE (with reference)	SEASON OF SENSITIVITY[1]	EFFECT SUMMARY – CONSTRUCTION AND NORMAL OPERATIONS	EIA SECTION REFERENCE
Stefansson Sound Boulder Patch (BOEMRE 2011d)	Year-round	Small amount of low density boulder habitat loss; moderate reduction in kelp productivity from increase in suspended sediments during construction.	4.1.7 Benthic Communities
Cross Island and Pole Island (BOEMRE 2011d)	June to December	No physical disturbance to islands; Liberty may be audible/visible from Cross Island; potential for moderate subsistence disturbance effects in years when whaling is concentrated south of Narwhal Island.	4.1.5 Acoustic Environment 4.1.18.1 Visual 4.1.18.2 Subsistence
Pole Island – Polar Bear Denning (BOEMRE 2011d)	November to April	Liberty may be audible/visible from Pole Island; no polar bear den disturbance effects. Note that USFWS does not consider Pole Island to be polar bear denning habitat, and no other current reference to polar bear denning on Pole Island was identified.	4.1.5 Acoustic Environment 4.1.12.1 (Polar Bear)
Sagavanirktok River Delta (BOEMRE 2011d)	Year-round	Potential moderate air, water, and ground traffic disturbance and negligible to minor habitat loss effects on coastal and marine birds; no effects on overwintering fish habitats in the Sagavanirktok River; potential moderate short-term traffic disturbance for caribou along the Endicott road during construction; negligible to moderate potential winter disturbance effects on polar bears.	4.1.9 Coastal and Marine Birds 4.1.10 Fish and Shellfish 4.1.11.2 Terrestrial Mammals 4.1.12.1 (Polar Bear)

Table 4.1.13-1. Summary of Potential Liberty Development Effects on Sensitive Biological Resources

SENSITIVE RESOURCE (with reference)	SEASON OF SENSITIVITY[1]	EFFECT SUMMARY – CONSTRUCTION AND NORMAL OPERATIONS	EIA SECTION REFERENCE
Howe Island – Snow Geese (ADNR 2013, B.8.e.viii [NSB])	May to August	Potential negligible to moderate air, water, and ground traffic disturbance effects on nesting, brood-rearing, and molting Howe Island snow geese.	4.1.9 Coastal and Marine Birds
Anadromous Waters (ADNR 2013, B.3.a [ADF&G])	Year-round	No effect on Sagavanirktok or Shaviovik rivers.	4.1.10 Fish and Shellfish
Fish Overwintering Habitats (ADNR 2013, B.3.e [ADF&G])	November to April	Negligible effects on fish overwintering habitats.	4.1.10 Fish and Shellfish
Essential Fish Habitat (EFH) (ADNR 2013, B.7.e [USFWS and NMFS])	Year-round	Small amount of EFH loss with small increase in habitat diversity; temporary reduction in habitat quality from increase in water turbidity; negligible to minor impacts to nearshore and marine EFH.	4.1.10 Fish and Shellfish
Caribou Calving Areas (ADNR 2013, B.3.c [ADF&G])	Late May through June	Negligible effects because project construction would avoid activities within calving areas during the calving period and because potential air and ground traffic disturbance would not coincide with concentrated calving areas.	4.1.11.2 Terrestrial Mammals

Note:

1. The most conservative period of sensitivity (BOEM or ADNR) is listed.



LIBERTY DEVELOPMENT

SENSITIVE BIOLOGICAL RESOURCES AND POTENTIAL DISTURBANCE AREAS

DATE: May 2015

FIGURE: 4.1.13-1

4.1.14 Archaeological Resources

As noted in the 2002 Liberty DPP FEIS (MMS 2002c), any bottom- or surface-disturbing activity, such as pipeline construction, materials excavation, island installation, anchoring of vessels, or oil-spill cleanup activities could damage previously unidentified archaeological sites. Physical disturbance of sites could cause destruction of artifacts, disturbance, or complete loss of site context, and result in the loss of data. Archaeological sites are a nonrenewable resource and could not be replaced.

Regarding submerged cultural resources, the Liberty DPP FEIS (MMS 2002c) concluded that the cumulative effects of proposed projects would likely disturb the seafloor more often, but geophysical remote-sensing and archaeological surveys made before approval of any Federal or State lease actions should keep these effects negligible. Federal laws would preclude effects to most archaeological resources from these planned activities. The most recent reports (MMS 2006a, 2006b, 2008) restate this conclusion. No archaeological materials were identified in analysis of seafloor cores and seismic survey data acquired in 2013 or in previous surveys (Marmaduke and Watson 1998; Rogers 2014).

The onshore terrestrial project component consists of the Kadleroshilik gravel mine and the onshore section of the pipeline and one small pipeline support pad. A number of Traditional Land Use Inventory (TLUI) and Alaska Heritage Resources Survey (AHRS) sites are known in the vicinity. These sites should be avoided by development and will be protected by a 500-foot buffer zone. The mine footprint area was surveyed in 2013; no archaeological materials were identified (submitted to BOEM under separate cover).

Regarding terrestrial cultural resources, the Liberty DPP FEIS (MMS 2002) reiterated the findings of previous studies (Bittner 1993; Dekin 1993), which is that the greatest effects to archaeological sites in an oil spill were not from the oil itself but from the cleanup activities. Effects to archaeological resources during the Exxon Valdez oil spill, for example, were due both to physical disturbance from cleanup equipment and due to vandalism by cleanup workers. Regardless, researchers concluded that less than 3 percent of the archaeological resources within the spill area suffered any significant effects (Mobley et al. 1990; Wooley and Haggarty 1995).

Potential impacts to archaeological and cultural resources from the Liberty Development are considered to be negligible, in both the terrestrial (onshore) and marine (submerged) environments.

4.1.15 Socio-Economic Resources

BOEM (2012) considered the socio-economic impacts of development of new oil and gas leases within the Beaufort and Chukchi seas, and MMS (2007b) considered the socio-economic impacts of the Liberty Development. These socioeconomic impacts are incorporated by reference. In addition, the direct and indirect socio-economic impacts of the Liberty Development proposed in 2000 were addressed in the Liberty DPP FEIS (MMS 2002c) and include direct and indirect jobs, tax revenues to the North Slope Borough (NSB), and royalty revenues to federal and state governments, and these socioeconomic impacts are incorporated by reference. It is appropriate to provide additional and revised material, however, because of changes in the methodology used to estimate socio-economic impacts as well as changes in the Liberty Development. In particular, the current socioeconomic impact analysis incorporates results from MAG-PLAN Alaska, a region-specific economic impact model used by BOEM to estimate potential economic impacts (direct, indirect, and induced) of oil and gas development in OCS planning areas offshore of Alaska. The updated model contains the state of knowledge on new technologies, industry costs, and manpower requirements for various offshore exploration, development, and production activities in the Beaufort Sea and Chukchi Sea Planning Areas of the Alaska OCS.

MAG-PLAN Alaska provides estimates of stage 1 (direct) and stage 2 (indirect) economic impacts of OCS exploration, development (construction and drilling), and production. Stage 1 estimates the level and allocation of direct expenditures as well as direct manpower requirements and government revenues resulting from OCS oil and gas activities specified in the exploration and development scenarios, while stage 2 estimates the multiplier effects of spending associated with OCS activities on potentially affected regions in Alaska, including the NSB. In addition to estimates of potential direct, indirect, and induced employment, income, and economic output generated by the Liberty Development, model outputs include estimates of potential royalty payments, other lease payments, property taxes, and state corporate income taxes generated by the Liberty Development. In order to configure the model to the specific development and production plan of the Liberty Development, information on proposed infrastructure, timing of activities, number of development and production wells, production volumes, and other data were provided by the Liberty Operator.

4.1.15.1 Population

The Liberty Development is unlikely to significantly alter the population base of the State, NSB, or local communities of the NSB. The project is relatively small, creating about 270 onsite and offsite (e.g., Anchorage, Alaska; Houston, Texas) jobs for operation, and a maximum of 3,010 jobs during the temporary construction phase; the majority of these jobs would not be filled by residents of the NSB but may be filled by residents of Alaska. As discussed in the Liberty DPP FEIS (MMS 2002c), onsite workers would be housed at the Liberty Development facilities for both construction and operation phases, avoiding the potential for significant direct effects on the relatively small village communities in the area. Additionally, this physical separation of workers from established local communities would also render it unlikely that incoming non-resident construction workers would settle in the NSB. Therefore, the overall direct population effect is expected to be negligible.

4.1.15.2 Employment, Income, and Expenditures

A direct positive economic effect from the Liberty Development would be the creation of new jobs for project construction and operations. Estimates of the number of workers needed for the Liberty Development provide for a greater number of workers during the development phase, which includes construction and drilling, and fewer workers needed during the pre-development, production, and abandonment phases (**Table 4.1.15-1**). The maximum number of part-time, seasonal, and full-time jobs during the development phase is estimated to be about 3,010 over a 5-year period. It is estimated that the Liberty Development would generate $497 million in wages during the pre-development and development phases, and $698 million in wages during the production and abandonment phases.

Once production begins, the estimated average annual number of part-time, seasonal, and full-time jobs is about 270 over a 30-year period. This employment estimate includes support and administrative personnel that may be located in Anchorage or Houston, and incremental personnel for operating the seawater treatment plant and other project-related facilities at Endicott. The estimated level of employment, while higher than that given in the Liberty DPP FEIS (MMS 2002c), is expected to have a minor positive impact on the local, State, or national economy.

For the life of the project, it is estimated that capital expenditures would total approximately $2.4 billion, and operating expenditures would be $2.6 billion. These beneficial economic effects would be minor relative to the state economy as a whole.

Table 4.1.15-1. Estimated Employment from Liberty Development by Project Phase

	DIRECT EMPLOYMENT (NUMBER OF JOBS)				
	LOCAL	OTHER ALASKA	ALASKA TOTAL	OTHER U.S.	TOTAL
Pre-Development (Year 1 through 3)					
Annual Average	0	137	137	169	306
Maximum	0	314	314	411	725
Development (Year 4 through 8)					
Annual Average	26	875	901	665	1,566
Maximum	47	1,863	1,910	1.102	3,012
Production (Year 9 through 35)					
Annual Average	7	129	136	132	268
Maximum	13	235	248	253	501
Abandonment (Year 36)					
Annual Average	9	108	117	421	538
Maximum	9	108	117	421	538

Effects on Local Hire in the North Slope's Oil Industry

As shown in Table 4.1.15-1, the number of direct oil industry jobs created by the Liberty Development that would be filled by North Slope residents is predicted to be small and would have a minor positive effect on the economy of the NSB or communities of Kaktovik, Nuiqsut, Deadhorse/Prudhoe Bay, and Barrow. As discussed in the Liberty DPP FEIS (MMS 2002c), even with the potential employment associated with the proposed activities, participation by Borough residents would likely remain comparatively low in oil industry-related jobs on the North Slope. HAK has committed to hiring local workers on the North Slope and within Alaska. However, the oil industry employs few village residents, even though they try to recruit and provide training programs.

Many of the contractors for North Slope projects (design, construction, drilling, operations) are Alaska Native Claims Settlement Act (ANCSA) corporations, subsidiaries of such corporations, or otherwise affiliated with such corporations through joint ventures or other relationships. However, the small size of the Liberty Development means that it would not employ many more Alaska contractors or vendors except for the initial construction. The proposed activities during the development phase would be temporary and are expected to have a minor positive effect on the local economy.

The direct changes in employment, income, and expenditures resulting from the Liberty Development would initiate subsequent rounds of income creation, spending, and re-spending. Third-party contractors, vendors, and manufacturers receiving payment for goods or services required by the Liberty Development would, in turn, be able to pay others who support their businesses. In addition, persons directly and indirectly employed by the Liberty Development would generate additional jobs and income in the economy as they purchase consumer goods and services to meet household needs. These indirect and induced impacts are termed "multiplier effects." Over the life of the project, it is estimated that an additional 17,000 jobs and $1.1 billion in wages would be generated statewide through multiplier effects. These indirect beneficial effects on Alaska's economy would be minor.

The Liberty DPP FEIS (MMS 2002c) did not explicitly discuss potential economic impacts at the national level, but these could be material. The number of direct jobs created by the Liberty Development would have an insignificant effect on the national economy. However, domestic energy production is critical for the security and prosperity of the United States. The money spent on domestic energy cycles in the U.S. economy, thereby increasing domestic economic activity and jobs, while money spent on imported energy leaves the U.S. economy. Petroleum imports are an important component of the balance-of-payments deficit. For purposes of this analysis, a price of $100 per barrel is assumed, and the project's total production of 90 to 130 million barrels would have a value of approximately $9 to $13 billion. For purposes of modeling estimated revenues, a total production of 117 million barrels (approximate value of $11.7 billion) was assumed (see Table 4.1.15-2).

4.1.15.3 Federal, State, and Borough Revenue

Over the life of the project, it is estimated that the federal government would collect about $1.5 billion in royalties and lease payments, of which approximately $393 million would be shared with the State of Alaska (**Table 4.1.15-2**). In total, it is estimated that the state would receive $415 million from its share of federal royalties and lease payments, oil and gas property tax, corporate income tax, and gravel sales. In addition, oil from the project would help keep flow capacity up in the Trans-Alaska Pipeline System (TAPS) and reduce the pipeline tariff, a situation that would increase revenue to the State from royalties and production tax. It is estimated that this "TAPS effect" would generate an additional $114 million in state revenue. These beneficial revenue effects are expected to be minor at the federal and state levels, although they offset declining oil production in the state to some degree.

Table 4.1.15-2. Estimated Federal, State, and North Slope Borough Revenue from the Liberty Development

	TOTAL	ANNUAL AVERAGE
	MILLIONS 2013 $	
Royalties and Lease Payments		
Federal Royalties and Lease Payments	1,061.72	26.18
State of Alaska Share of Federal Royalties and Lease Payments	392.65	9.68
Property Taxes		
State of Alaska	2.80	0.08
North Slope Borough	34.59	1.05
Other State Taxes		
TAPS Effect	114.05	2.92
Gravel Sales	3.60	3.60
State Corporate Income Tax	15.12	0.37

The assumptions used in the analysis are as follows:

- Wellhead prices are based on data from U.S. Energy Information Administration (USEIA 2014) and projected netback costs from Alaska Department of Revenue (ADR 2013).
- Total Liberty Development oil production assumed to be 117 million barrels.
- Royalty rate: 12.5%.
- State share of royalty: 27%.
- Property tax rate: 2% (20 mills).
- Gravel sales: $3 per cubic yard.

Oil and gas property tax, which would be collected by the state from new onshore infrastructure (landfall infrastructure and pipelines) associated with the Liberty Development, is expected to total $37 million over 36 years. The state would pass through about $35 million of this tax revenue to the NSB. Additional revenues would accrue to the NSB because of increased oil flow from the Liberty Development through existing pipeline infrastructure taxed by the state and reimbursed to the NSB. Also, the revenue the NSB receives under the state's Community Revenue Sharing Program would increase slightly as a result of the larger number of oil and gas workers in the Borough because of the Liberty Development. These workers would be counted as permanent residents for purposes of community revenue sharing per capita payments to the NSB. These beneficial revenue effects would be moderate at the Borough level and would be expressed through the regional provision of services and funding to NSB communities, such as education, public safety, and health and social services.

4.1.15.4 Economic Impact Conclusions

This evaluation estimates royalties and tax-beneficial economic consequences to the NSB, State of Alaska, and U.S. Government. Non-tax royalty benefits evaluated include goods, services, and employment opportunities. BOEM (2012) considered the economic consequences of allowing oil leasing and potential oilfield exploration and development in the Beaufort and Chukchi seas to be beneficial, as these activities would increase employment and income and increase revenue from taxation of oil industry facilities. In addition, MMS (2002c) determined that the Liberty Development project proposed in 2000 would have beneficial economic consequences. The current Liberty Development would have an effect on socio-economic resources consistent with the determinations made by BOEM and MMS.

4.1.16 Coastal and Marine Uses

Coastal and marine uses in the Foggy Island Bay area not discussed in other sections of this EIA are generally limited and are expected to have negligible impacts from the Liberty Development. The proposed gravel mine is expected to be opened and closed in a single winter construction season with negligible impact on land use. The primary impacts to coastal and marine uses are likely to be from increased traffic to and from the LDPI during construction and drilling. Ice roads to the gravel site would only be constructed during the construction phase of the Liberty Development and would not impact transportation routes between coastal communities. Flights to and from the LDPI would be over water and would not disturb potential land-based uses in the area such as recreational hunting. Potential mitigations to reduce impacts are described in sections 5.2.16 and 5.2.17.

Subsistence Use

Potential impacts on subsistence resource uses of the Liberty Development area are discussed in Section 4.1.18.2.

Commercial Vessel Traffic

In the vicinity of the Liberty Development, commercial vessel traffic is generally low frequency and mostly consists of barges traveling along the nearshore waters of the coast during open-water season. Commercial travel into Foggy Island Bay is minimal. A slight increase may occur for larger modules or when transporting a drilling rig to or from the island. The Liberty Development would have a minimal effect on current commercial vessel traffic.

Research Vessels

Arctic research operations in the Beaufort Sea vary year to year and include university-led Arctic research projects, research conducted by the oil industry, National Oceanic and Atmospheric Administration (NOAA) charting survey projects, and other government research operations. Research operations may be minimally disturbed by the location of the LDPI and by the increased traffic to and from the island.

Military Operations

Military operations, primarily U.S. Coast Guard (USCG) activities, are historically limited in the vicinity of the project. The historical Distant Early Warning (DEW) Line sites in the project area are mostly either closed or minimally manned and attended. The Liberty Development would have no effect on current military operations in the area.

Commercial Fishing

Due to a fishing moratorium, commercial fishing activities do not occur in the Beaufort Sea. The Liberty Development would have no effect on current commercial fishing activities in the area.

Recreation and Tourism

Low levels of recreational use are estimated to occur near the Liberty Development, consisting primarily of summer season opportunities for fishing, hunting, and boating by tourists. Summer activities at the Liberty Development would consist of hovercraft and/or air and vessel traffic to and from LDPI. These activities would have minimal effect on coastal and nearshore recreation and tourism in the project area. Offshore tourism, including cruise ships, recreational boating, and whale watching tours, would not be impacted by the increased traffic.

Mineral Exploration or Development

There are currently limited mineral exploration and development activities near the proposed Liberty Development area. Endicott facilities are west of the area. The Badami unit is to the southeast of the Liberty Development. Shell Gulf of Mexico has submitted an exploration plan for the Beaufort Sea Oil and Gas Lease Sales 195 and 202 in Camden Bay but has not publicized any upcoming exploration activities. The coastal area of the North Slope is attractive to the oil and gas industry, and it is possible that exploratory, geological, and geophysical activities may be conducted in the future. There are also minimal existing activities on land eastward from Barrow to the Point Thomson project, which may include periodic and seasonal offshore and onshore ice roads to Badami and/or Point Thomson, or for exploration. The majority of oil and gas activities on the North Slope are focused to the west of the project area. Other mineral exploration activities are not expected. No effects are expected on mineral exploration or development activities in the area in the event such activities are undertaken.

Native Allotments

Although the proposed gravel mine is near one of the Native Allotments, use of that property is not expected to be impacted by the project either during construction or operation.

Impact Conclusions

BOEM (2012) determined that the development of new oil and gas leases within the Beaufort and Chukchi seas would have negligible impacts on coastal and marine uses, including commercial and recreational fisheries and recreation and tourism. In addition, MMS (2002c) determined that the effects of the Liberty Development project proposed in 2000 on coastal and marine uses would be negligible. The current Liberty Development would have an effect on coastal and marine uses consistent with the determinations made by BOEM and MMS.

4.1.17 Environmental Justice

Environmental Justice is defined in Executive Order (EO) 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, which requires that proposed projects be evaluated for "disproportionately high and adverse human health or environmental effects of its programs, policies, and

activities on minority populations and low-income populations." "Minority population" is defined in relation to the general population of a larger appropriate geographical area, in this case the State of Alaska. Nuiqsut, the community nearest to and potentially most affected by the Proposed Project, has a predominately Alaska Native/ American Indian population (87 percent, almost all Iñupiat; 2010 Census). The same general percentage for Alaska Native/American Indian population is true of other whaling communities of northern Alaska, except for Barrow, which has a "minority" population of only 61 percent (2010 Census). The State of Alaska population is about 15 percent Alaskan Native/American Indian and 67 percent "White," with the remainder being other categories. Thus, Nuiqsut and other Alaskan whaling communities are considered "minority populations" for the analysis of potential environmental justice effects. All exceed the 50 percent threshold specified in EPA guidelines (EPA website, http://www.epa.gov/environmentaljustice/) and also clearly exceed the State of Alaska average.

Due to the long distance from Native communities (approximately 80 and 94 miles from Nuiqsut and Kaktovik, respectively), the environmental justice impacts are most closely associated with effects on subsistence resources and activities in the Liberty area, which are discussed in Section 4.1.18.2.

4.1.18 Subsistence

Activities related to potential effects on terrestrial subsistence resource uses are managed under Section 811 of Alaska National Interest Lands Conservation Act (ANILCA), and those on marine subsistence resource uses by Section 101(a)(5) of the MMPA and Section 7(b)(4)(C) of the ESA. From the description and discussion of subsistence uses of the project area, as defined as the area within which development activities are planned, (Section 3.16.2), little subsistence activity takes place in the Liberty Development area because of its distance from Nuiqsut and Kaktovik and its proximity to the Prudhoe Bay oil field complex.

The primary subsistence use potentially affected by the Liberty Development is bowhead whaling conducted by the residents of Nuiqsut in the vicinity of Cross Island. Other than for Nuiqsut bowhead hunting, current subsistence uses of the project area are incidental to coastal travel for other purposes and occur sporadically. There is some local concern for potential contamination or lifecycle disruption effects on subsistence species that traverse the Liberty Development area but which are harvested elsewhere, such as whitefish and seals. These potential effects are discussed in less detail than those on subsistence whaling, as the information available is less definitive.

This EIA has determined that the potential biological impacts of the Liberty Development are expected to be negligible to minor for all species, except for impacts created by a low-probability, large oil spill event (Section 4.3). Bowhead whale hunting was not addressed in these evaluations. This conclusion is consistent with prior environmental effects documents, notably the Liberty Development Project ER (LGL Alaska et al. 1998, Section 5.6.4.3), the Liberty DPP FEIS (MMS 2002c, Sections IIIA2h, IIIA2i, IIIC3h, and IIIC3i), the Liberty DPP EIA (BPXA 2007, Section 3.3.12.2), the Revised OCS Lease Exploration Plan: Camden Bay, Beaufort Sea, Alaska EA (BOEMRE 2011c, Section 4.2.9), and the Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft EIS (NOAA 2013a, Section 4.5.3.2, Section 4.5.3.2.2). These documents are incorporated here by reference.

NOAA (2013a) is by far the most detailed analysis, although it is not as focused on the Liberty project area (or the region near it) as the other documents. It incorporates local (Nuiqsut) traditional knowledge. NOAA's (2013a) analysis is combined with recent documented information on Cross Island subsistence whaling (Galginaitis 2014a) for the EIA analysis. Traditional Knowledge, or TK, refers to a body of evolving practical knowledge based on observations and personal experience of local residents over an extensive, multi-generational time period. BOEM seeks to integrate TK into the NEPA process (BOEM 2012). Accordingly, this EIA addresses information provided by

local whalers regarding their experience and concerns about potential impacts on bowhead whaling in the Cross Island vicinity.

The remainder of this analysis will, therefore, focus mainly on Cross Island bowhead whaling as the primary subsistence use in or near the project area with the potential for more than negligible effects from the Liberty Development. The discussion will focus on impacts to whaling based on expected impacts to bowhead whales (Section 4.1.12.1), with consideration for other factors that might affect access to bowhead whales. Because subsistence impacts must also consider the view point from those using subsistence resources, local knowledge and concerns of Cross Island whalers and user information provided specifically for this project (see Attachment 2) is addressed in the analysis.

4.1.18.1 Summary of Subsistence Whaling from Cross Island

As discussed in Section 3.16.2, the residents of Nuiqsut whale from Cross Island, which is located over 90 miles from the community (and approximately 17 miles from the LDPI). In an average year, the bowhead harvest represents approximately a third of the total community subsistence harvest by weight, and so is very significant as a food resource. As the iconic Iñupiat subsistence activity, the bowhead hunt also represents key spiritual and cultural Iñupiat values and is a major way of transferring these values from one generation to the next. Because of the distance and the logistics involved, the window of opportunity for the Nuiqsut subsistence whale hunt is shorter than for all the other whaling villages, which whale from their home communities.

Cross Island whaling activity now most typically takes place from late August through early to mid-September, during the open-water season. Whaling efforts are predominantly within the geographic quadrant northeast of Cross Island, with some effort northwest and southeast of Cross Island (see Figure 3.16.2-3). Within this area, most whaling effort has been north of Narwhal Island (shown on Figure 2.1-1 and on Figure 3.16.2-3 as the northernmost of the McClure Islands). All documented whale strikes have been made north of Narwhal Island (except the 1973 strike, made far to the east, near Flaxman Island).

The closest whale strikes to the project area for the period 2001 to 2013 were in a range of 2.1 to 10.4 miles seaward of Narwhal Island, in a range of 2.2 to 17.6 total miles from Narwhal Island, and approximately 10.3 to 19 miles from the Liberty project area. Strikes from the 1980s were closer, on average, to Narwhal Island but were all seaward of the barrier islands. Strikes from the 1990s included a cluster of four roughly north of Narwhal Island in a range of 6.2 to 8.5 miles, one 11 miles east of Narwhal Island, and another 4.2 miles west-southwest of Narwhal Island and about 5 miles northwest of the Liberty Development area. This was the most recent whale landed by Nuiqust whalers inside of the barrier island. The two others were a whale landed in the 1980s 5.4 miles southeast of Cross Island (134°) and the whale taken in 1973 near Flaxman Island. Several recent whales have been taken almost due east of Cross Island (north of Narwhal Island) and so outside of the barrier islands.

While Cross Island whalers traveled south of Narwhal Island during several of the 2001 to 2013 seasons, only in 2005 and 2006 did they do so systematically in their search for whales (for all other years, the occasional trip south of Narwhal Island was at high speed, in transit from one location to another, and not actively looking for whales). Localized ice conditions in 2005 and the first half of 2006 confined whaling efforts landward of the barrier islands, on a “diagonal” parallel to the shore from the southeast to the northwest. During the 2005 season, the whalers’ efforts took them through the project area on several trips and within 5 to 10 miles of the project area on approximately half of their whaling trips. No whaling effort trips went through the project area in 2006; however, approximately one-third of documented whaling trips that year passed within 5 to 10 miles of the project area. Whalers reported whale sightings near the Liberty project area in 2005 and 2006, although they could not

approach these animals closely enough to strike them (all strikes for 2005 and 2006 took place 21 to 28 miles from the project area).

4.1.18.2 Local Issues and Concerns

Traditional Iñupiat knowledge, verified by the personal whaling experience of contemporary Nuiqsut whalers, warrants additional consideration in the assessment of impacts described earlier in this EIA. The whalers report that the area within the barrier islands, and especially the area south of Narwhal Island, is very important for the migration of smaller whales, which avoid the deeper water. Also, most Nuiqsut whalers prefer to target smaller, rather than larger, whales when they are available.

Nuiqsut whalers express two sorts of concerns about production activities from the proposed Liberty Island. First, they think that the sound and general disturbance from activities will deflect the whale migration seaward. This may increase the distance whalers will need to travel to find and strike whales. They also expect that whales would be disturbed, exhibit more wary or skittish behavior, and thus would be more difficult to approach. They believe that the presence of the island may change current patterns, and since whales commonly follow currents on their migration, even in the absence of sound, the island may be a source of disturbance to the bowhead whale migration. Based on the historical depth of Iñupiat traditional knowledge, and its constant personal verification for the whalers through the experience of each season, the potential for adverse effects on the success of the Nuiqsut bowhead hunt should conservatively be judged to be at least moderate for each season for the lifetime of the production unit. Effects on bowhead hunts in most NSB communities would be minimal, although those communities that have sharing relationships with Nuiqsut could be affected if the overall success rate of the Cross Island bowhead whale hunt were affected.

For the period 2001 to 2013, Cross Island whalers were able to meet their needs for bowhead harvest in all but the 2005 and 2007 seasons. Three or four whales generally provide enough for the needs of Nuiqsut and those that they share with, but they only took one whale in 2005 and two in 2007. While perceived interference from commercial (i.e., not petroleum industry-associated) vessel traffic was only one factor contributing to their lack of success for those years, it was and is probably the most salient factor to the whalers. Localized ice in 2005, poor weather and sighting conditions for whales in both years, and some mechanical problems in both years were other factors (Galginaitis 2014a).

Aircraft overflights have not been a problem during the whaling season, but are a common complaint of caribou (and other terrestrial mammal) hunters, and the concern is generalized to marine hunting as well. The number of such potential overflights can be expected to increase because of the Liberty Development. The Cross Island whaling season is relatively short, taking place within a window of about 4 weeks (the intersection of when the whales are present, temperatures are cool, and weather and other conditions are most likely to be favorable). The whalers prefer a season length of 2 to 3 weeks (Galginaitis 2014a). The number of days available to look for whales is limited, especially if there are some days when weather or other conditions prevent the whalers from looking for whales, which has been the case for most recent seasons (2001 to 2013). Thus, the whalers negatively perceive unexpected, unpredictable, and uncontrollable factors that interfere with the subsistence hunt on any day suitable for scouting for whales.

Since the poor seasons of 2005 and 2007, and the perception of interference from commercial vessel traffic, the whalers have been very sensitive to any vessel traffic transiting the Cross Island area during the whaling season. The Deadhorse Communication Center log for the last several seasons reflects their negative reactions to all such recent vessel sightings, and the whalers' consistent rejection of requests from shipping companies and industry for permission for a vessel to transit the Cross Island area – even for a single trip – during the whaling season. This

reflects Nuiqsut whalers' view of the purpose of the Conflict Avoidance Agreement (CAA) between the whalers and industry. The opportunity to strike a whale may be relatively infrequent during a given season, and anything that could interfere with a possible strike opportunity should, from the whalers' perspective, be avoided. The potential adverse effects of project-associated vessel traffic could be adequately mitigated through the process established by the CAA, but the whalers believe that this would require a shared understanding of how to implement the CAA process, and they are not always sure that such a shared understanding exists. Also, not all vessel traffic is currently subject to the CAA, and there are generally at least one or two instances each season of potential interference with Cross Island whaling from non-CAA compliant vessels.

Due to the whalers' concerns over possible deflection and/or disturbance of smaller whales transiting through or near the Liberty Development area, possible whaler avoidance of the general area of the development site, and the increased probability of vessel traffic interference in years when access to open water beyond the barrier islands is restricted (discussed below), potential adverse effects to Cross Island subsistence whaling are judged to be moderate or more for the duration of Liberty production operations. This is the general view of Nuiqsut whalers and requires serious consideration in project planning. While many and perhaps all of these potential effects could possibly be mitigated or eliminated through coordination between the whalers and industry, primarily through the CAA process, this will require a continued effort on the part of all parties and may require different mitigation measures than those implemented in the past.

NOAA (2013a) succinctly describes Iñupiat concerns regarding the potential for oil and gas activities to affect subsistence whaling, mitigation measures already in place to address those concerns, and other potential mitigation measures that may feasibly reduce other potential adverse effects, which are incorporated by reference. These potential effects include deflection due to noise (from island construction and ongoing activities as well as associated support vessel and aircraft traffic), the discharge of waste, changes in the environment due to artificial island construction and changes in the visual environment. However, it is important to recognize the difference between NOAA (2013a) and this document. NOAA (2013a) is a general regional programmatic analysis, while this document is very site-specific. Thus the NOAA (2013a) general conclusions must be tempered with the site-specific subsistence context of the Liberty Development area, particularly the very close proximity of subsistence whaling activities (and the bowhead whale migration) to the proposed Liberty Development. The NOAA (2013a) conclusion for potential effects of oil and gas activities on subsistence uses of bowhead whales is that disturbance effects of seismic and exploratory drilling are potentially moderate but could be reduced so as to not significantly affect the level of harvest. Aircraft overflights, with the appropriate mitigation measures, are judged to have only minor effects (NOAA 2013a, p. 4-210). These conclusions can be adopted for the Liberty Development as well, given the use of proper mitigation measures. This is also consistent with the conclusions reached for possible acoustical effects of the Liberty Development on bowhead whales (Section 4.1.12). Nuiqsut whalers, however, have stated they believe the LDPI, through changes to currents, vessel traffic, whale migration, and whaler preferences, must be recognized as a potentially significant effect of the Liberty Development on Cross Island subsistence whaling. Both small oil spills and very large oil spills (VLOS) are also a significant concern for local stakeholders.

4.1.18.3 Potential Adverse Effects on Cross Island Subsistence Whaling

There are generally three types of potential effects the Liberty Development could have on Cross Island subsistence whaling:

- General bowhead migration deflection or change, either temporary or more permanent;
- Oil spills (both large and small); and

- Whaler avoidance of the project area due to the Liberty Development.

These potential adverse effects on Cross Island whaling are only possible during the period when whaling takes place: the end of August through the latter part of September, during the open-water season. Thus, winter activities (island and pipeline construction, and ice road-associated activities, drilling, and processing) would not contribute to potential effects. Only construction and support activities, drilling, regular production processing operations, and oil spills would contribute to these potential adverse effects. Effects of a potential oil spill would vary with the size and season of spill, as well as the effectiveness of response, as discussed below. Whaler avoidance of the area due to development would be an indirect adverse effect.

Each of the three types of potential adverse effects will be discussed in turn. It should be noted that of the previous environmental assessments of proposed oil and gas development in or near the project area, only NOAA (2013a) incorporates some of the detailed information now available on recent (2001 to 2013) subsistence whaling near Cross Island (summarized in Attachment 2). The main focus of the analysis here will be to refine the conclusions of these previous documents in light of this more recent and detailed information.

Bowhead Migration Deflection

Bowhead whales are common in the Beaufort Sea on a seasonal basis. During spring migration, bowhead whales migrate far offshore and are unlikely to occur near the Liberty Development. During fall migration, bowhead whales pass closer to the Liberty Development, although it is thought that most whales pass seaward of the barrier islands. Occasionally, a few bowhead whales have been reported shoreward of the barrier islands (Aerts et al. 2008; Galginaitis 2014a). This is consistent with the whalers' reports that some whales (and especially smaller whales) migrate landward of the barrier islands, at least eastward of Narwhal Island. Whalers consider these shallower waters to be of critical importance for smaller whales.

To address local concerns described above, it is noted that minor modification of currents and wave conditions will occur in the immediate vicinity of the LDPI, as described in Section 4.1.2. In addition, the project plan is to inject or haul most LDPI wastes, with contingency disposal of wastewaters under an NPDES permit; impact to bowhead whales from waste are expected to be negligible. The most likely causes of deflection during migration are acoustics and air and vessel traffic.

Acoustic effects and effects of air and marine traffic to marine mammals in general were addressed in Section 4.1.8.1 and effects specific to bowhead whales in Section 4.1.12.1. It was determined that project construction, drilling, and operations may affect, and are likely to adversely affect, a few bowhead whales as a result of incidental acoustic disturbance within the project area. Fall-migrating bowhead whales passing LDPI more than 4 miles away would be beyond any expected sound propagation from the island. Bowhead whales could exhibit behavioral responses to noise and to the presence of vessels and aircraft; however, physical effects are unlikely. Air and vessel traffic is planned to avoid interference with bowhead whaling activities. Overall, activity-related impacts to the bowhead whale population are expected to be negligible to minor. As needed, mitigation measures to avoid or minimize impacts to bowhead whales would be developed during MMPA and ESA consultations.

Little, if any, whale deflection is expected, but if it occurs, deflection could affect whaling. The extent of impact would depend on a number of unknowns including the number of whales deflected, the extent of deflection, the areas used for whaling during the year of deflection, and the success of the hunt that year. No long-term effects are expected.

Oil Spills

The size of an oil spill is a key variable in determining potential impacts from the spill. Three categories of spills are generally used, ranging from small to very large or catastrophic. In Section 4.3, BOEM categories (expected small spills are less than 1,000 bbl, expected large spills are greater than 1,000 bbl, and unexpected catastrophic discharge events (CDE) are in the range of 1 to 3.4 million bbl) are adopted because BOEM's definition of the CDE was the largest to date. For evaluation of oil spill impacts to bowhead whales, a critical resource for subsistence use, this section follows NOAA (2013a) definitions (small spill is less than 1,000 bbl; large spill is greater than 1,000 bbl, consistent with BOEM (2012), but NOAA used what they termed a VLOS (150,000 bbl) in their analysis of the effect of spills on bowhead whales.

Bowhead whales have been reported in the project area by the Cross Island subsistence whalers (Galginaitis 2007, 2008), but the number of whales affected by small spills is still likely to be small, given a robust program of spill prevention and cleanup as a mitigation measure. The effects of spills on bowhead whales are described in Section 4.1.12.1, which concludes that small and large spills from Liberty Development could have major impacts on individual bowhead whales, whereas impacts of small spills on the larger population are anticipated to be negligible to minor.

The whalers may have a concern or perception that whales in the project area may be potentially contaminated as a food source by small spills, which will be addressed in the section below as *Whaler Avoidance of the Project Area*. Smaller spills are recognized as likely occurrences of the development process and are considered to have negligible to minor potential effects, if properly mitigated, "… though the *perception* of the impact [by subsistence users] could be moderate" (NOAA 2013a, p. 4-211; emphasis added).

A VLOS is recognized as a low-probability event with a major potential effect on bowhead whales and their subsistence uses (NOAA 2013a, pp. 4-438 through 4-439).The potential effects of a VLOS on bowhead whales are addressed at a general level by NOAA (2013a) and summarized as, "A VLOS could result in major impacts on bowheads." Impacts would result both from direct contact with the oil and from all the activities associated with the resultant cleanup effort. Similarly, a VLOS could have major effects on the subsistence uses of bowhead whales, both within and beyond the project area. The impacts of CDE spills are addressed in Section 4.3.

A large oil spill would have major adverse effects on the Cross Island hunt, and potentially other whaling communities as well, as is discussed in BOEM (2014). It is likely that the WCD effects for Liberty would be somewhat less than as envisioned in the BOEM (2012) EIS, due to the relative inshore location of the project and the spill response preparations that would be developed for the LDPI. That is, it seems likely that should a spill occur, it would be adequately contained so as to limit adverse effects to a single season, and even if it occurred during the bowhead whale migration, it would not affect the fall migration path or bowhead whales on a population level. This assumes that the spill response strategies described in the DPP are successful and would still probably result in disruption of the Nuiqsut whale hunt for that year. Some of the tainting or contamination concerns discussed in BOEM (2012) EIS may also develop, but this would appear to be the most likely potential effect on the whale hunt in other communities. This effect may also extend to whitefish for Nuiqsut residents, since they traverse through or near the project area during their life cycle.

Whaler Avoidance of the Project Area due to Liberty Development

There are two aspects to potential whaler avoidance of the project area. Neither can be discussed with much certainty. The first is possible whaler avoidance of the project area due to the perception that bowhead whales taken in the project area may be contaminated because of oil spills, waste discharge, or some other reason. The second is possible whaler avoidance of the project area due to the presence of the Liberty Development itself.

Subsistence users are quite sensitive to animals they take that exhibit lesions or other imperfections, and they avoid taking animals that they think may be tainted. This was exhibited by the reduced harvest of subsistence resources for several years after the Exxon Valdez oil spill and the frequent testimony of subsistence users at public hearings (NOAA 2013a). While this is a possible effect of the Liberty Development, absent a WCD incident or regular discharge of wastewater or drilling fluids to the ocean, the effect of a perception of contamination of resources because of Liberty are likely to be negligible or minor.

As described above and in Section 3.16.2.6, Cross Island hunters state that they avoid hunting in developed areas in general; and as such, whalers avoid the Northstar production unit, even though they report that they saw whales feeding there and took a whale in that area in 1997 (before Northstar was drilled). It could be argued that Cross Island whalers have a very large preference for scouting for whales east of Cross Island, and especially to the northeast. Still, in 2005 and 2006, when localized ice prevented them from looking for whales to the northeast of Cross Island, the whalers still avoided approaching any closer than 2 or 3 miles to Northstar. In more normal seasons, whalers rarely approach closer than about 6 miles to Northstar when scouting for whales. The project area is about 17 statute miles south-southeast from Cross Island, and Narwhal Island is about 12.5 miles east-southeast of Cross Island. The Liberty Development area is about 8.5 miles south of Narwhal Island. Cross Island whalers rarely scout for whales south of Narwhal Island in normal years. However, as discussed above, and in Section 3.16.2.6, in 2005, the Cross Island whalers traversed the project area while scouting for whales, and in both 2005 and 2006 a significant amount of whaling effort took place between Narwhal Island and the project area. While no whales were struck in this area, several whale sightings were reported.

It is likely that the whalers would prefer to avoid the Liberty Development area during construction and operations. This would have little or no effect during normal seasons if potential effects on bowhead whales are as minor as is assessed in Section 4.1.12.1 of this document, because nearly all scouting effort would be seaward of Narwhal Island. However, in years with more difficult conditions, it is probable that the Cross Island whalers would, while avoiding the project area, still use the northern part of the area between Narwhal Island and the project area as a search area, and would be especially sensitive to any vessel traffic associated with the Liberty Development. To avoid significantly affecting subsistence whaling uses in years when the Cross Island whalers cannot search for whales northeast of Cross Island, alternative mitigation measures to those in more normal years may be necessary. This mitigation would likely be developed during the consultation process with affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the NSB, and AEWC as required by Lease Stipulation 6, defined below. Additionally, the consultation process would likely lead measures to avoid project impacts on bowhead whaling

4.1.18.4 Conclusions

Potential impacts of offshore development in the Beaufort OCS have been previously analyzed; these analyses are considered in this EIA.

Previous Impact Conclusions

In 2002, MMS considered the consequences of the planned activities for the Liberty Island project proposed in 2000 to have only minor to moderate and temporary consequences on subsistence resource uses, with only the low probability event of a large oil spill having the potential for a significant effect.

For the communities of Nuiqsut and Kaktovik, disturbances periodically could affect subsistence resources, but no resource or harvest area would become unavailable and no resource population would experience an overall decrease. Disturbance and noise could affect subsistence species that include bowhead whales, seals, polar bears, caribou, fish, and birds. Disturbances could displace subsistence species, alter or reduce subsistence-hunter access

to these species and, therefore, alter or extend the normal subsistence hunt; but potential disruptions to subsistence resources should not displace traditional practices for harvesting, sharing, and processing those resources (MMS 2002, Executive Summary).

In 2012, BOEM, after considerable discussion, summarized the potential impacts of planned lease sales in the Beaufort Sea similarly:

> "Finding and developing oil and gas resources on the Arctic OCS has the potential to create adverse impacts on sociocultural systems and subsistence in the Arctic Planning Areas. Such impacts would range from minor to moderate for the routine Program activities, depending on the nature, timing, location, and scale of the activity. Many potential effects are expected to be limited or mitigable. … Lease stipulations for whaler-oil industry conflict avoidance agreements (CAAs) and other "non-disturbance" agreements have minimized such problems in the recent past so that noise and disturbance effects of single actions have been, and are expected to be, effectively mitigated. However, such agreements become more difficult to implement if multiple vessels are surveying at the same time. It is expected that required adaptive mitigation and management plans (AMMPs), the requirements of National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) incidental take authorizations, and required consultation with local communities would ensure that impacts on marine mammals [and subsistence users] would be minimal" (BOEM 2012, Section 4.4.13.3).

As might be expected for a comprehensive regional document, as opposed to one focused on a single development prospect, BOEM (2012) devoted much more attention to the potential effects of oil spills, and the potential consequences for communities distant from the project area, than did MMS (2002):

> "Of greatest concern to the Alaska Natives who inhabit the area are threats to their subsistence base and way of life. Not only does subsistence harvesting provide them with a substantial portion of their food supply, but subsistence-related activities are central to their cultural identity. For many, the most iconic subsistence activity is the whale hunt. … Of greatest concern to the villagers are the effects of any oil spill. Potential impacts on sociocultural systems from accidents under the proposed action could vary from minor to major, depending on the size, location, and timing of a spill. … The greatest impacts would occur in the unlikely event of a low-probability CDE. The impacts of a CDE would be most serious if the release occurred during a whale migration and affected the migration route. Contact with oil could result in the deaths of some individual animals. Native harvesters would perceive surviving oiled whales as tainted and would be hesitant to harvest them. A reduction in whale stock could result in the International Whaling Commission (IWC) reducing or eliminating whale quotas in the entire Alaskan Arctic. The deaths of a large number of birds is possible and, if breeding populations were affected, could result in a serious reduction of the availability of waterfowl to subsistence harvesters along the Pacific Flyway. Intertidal breeding populations could be decimated, resulting in a long recovery period. Anadromous fishes could be hard hit. In general, the impacts of such an unlikely spill would be major not only for the villages along the northern coast, but for all communities that depend on the sea mammals, fish, and birds that migrate to or through the Chukchi and Beaufort Seas and their shores" (BOEM 2012, section 4.4.13.3).

Conclusions of the EIA

The conclusions of this EIA in terms of potential effects of the planned actions for the development of the Liberty prospect are consistent with both documents referenced above but must be modified by the additional information developed by BOEM on the Cross Island hunt (summarized in Attachment 2), consideration of information from local whaling experts, and the application of mitigation measures. Due to the distance of both

Nuiqsut and Kaktovik from the project area, and changes in community land use patterns for subsistence, it is unlikely that subsistence uses other than for bowhead whales will be significantly affected by the proposed development (although the use of whitefish and seals that traverse the area as part of their lifecycles has the potential to be affected by a VLOS or major changes in current patterns).

Local Issues

Acoustic and marine mammals subject matter experts have determined that planned or intended development and operation of the Liberty prospect should have only minor and temporary adverse effects on bowhead whales, similar to Northstar. Additionally, these impacts should, for the most part, be avoided or minimized by the mitigation measures provided through the consultation process, other lease stipulations, and open communication with local stakeholders. However, expert local subsistence users believe some impact will occur.

Local subsistence users state that that normal Liberty project activities would have significant effects on the distribution and abundance of subsistence resources—especially bowhead whale and fish, but also seals. Nuiqsut whalers report that smaller whales transit through and near the Liberty Development area and that project activities would likely affect the distribution and behavior of these animals to an extent to adversely affect the Cross Island bowhead whale hunt. Whalers believe that these effects could arise both from the mere presence of the artificial islands (changing current patterns and siltation/sedimentation patterns, as they have experienced from the developments in the Colville River delta, like Oooguruk) as well as from the noise and visual disturbance from the Liberty Development and its associated activities.

The effects of whaler avoidance of the Liberty Development area are uncertain. The degree to which such avoidance would occur and the effects on the overall success rate of the hunt and/or the overall effort required for successful harvest would be based on decisions made by the whalers, which cannot be predicted with certainty. The Liberty Development would be much like Northstar, and whalers report they avoid that area, rarely approaching any closer than 6 miles from the island. During migration, near the Liberty Development, most whales pass seaward of the barrier islands; however, whalers have reported whale sightings near the Liberty project area in 2005 and 2006. Based on the realization that the Cross Island whalers are concerned over possible deflection and/or disturbance of smaller whales transiting through or near the Liberty Development Area, and possible whaler avoidance of the development site, with the increased probability of vessel traffic interference in years when access to open water beyond the barrier islands is restricted, potential adverse effects to Cross Island subsistence whalers could be considered moderate or more for the duration of Liberty production operations.

Overall Conclusion

Many and perhaps all of the potential effects could possibly be avoided, reduced, or eliminated through coordination between the whalers and HAK, primarily through the mitigation process or in the consultations required under Lease Stipulation 6. Subsistence Whaling and Other Subsistence Activities (discussed in DPP Section 16), which states that:

> "Exploration and development and production operations shall be conducted in a manner that prevents unreasonable conflicts between the oil and gas industry and subsistence activities (including, but not limited to, bowhead whale subsistence hunting).
>
> Prior to submitting an exploration plan or development and production plan (including associated oil-spill contingency plans) to the MMS for activities proposed during the bowhead whale migration period, the lessee shall consult with the potentially affected subsistence communities, Barrow, Kaktovik, or Nuiqsut, the North Slope Borough (NSB), and the Alaska Eskimo Whaling Commission

> (AEWC) to discuss potential conflicts with the siting, timing, and methods of proposed operations and safeguards or mitigating measures which could be implemented by the operator to prevent unreasonable conflicts. Through this consultation, the lessee shall make every reasonable effort to assure that exploration, development, and production activities are compatible with whaling and other subsistence hunting activities and will not result in unreasonable interference with subsistence harvests.
>
> A discussion of resolutions reached during this consultation process and plans for continued consultation shall be included in the exploration plan or the development and production plan."

Success and effective consultations will require a continued effort on the part of all parties and may require different mitigation measures than in the past. Such consultation is likely to be more difficult and protracted than in the past, due to the importance of potentially affected subsistence resources to local stakeholders and the magnitude.

A large oil spill would have major adverse effects on the Cross Island subsistence bowhead hunt and potentially moderate to major effects on Nuiqsut fishing activities. Depending on the extent of the spill and the success of the cleanup, a large oil spill could potentially adversely affect all Alaskan whaling communities, although that would be a very low probability event.

4.1.19 Visual

Neither the Liberty DPP FEIS (MMS 2002c) nor the Liberty EA (MMS 2007b) discusses effects of the development on visual resources. The OCS Oil and Gas Leasing Program: 2012-2017 Final Programmatic EIS (BOEM 2012) describes potential impacts to visual resources from development of offshore and onshore oil and gas infrastructure, which is incorporated here by reference. According to that assessment, visual impacts from the Liberty Development would continue for the duration of operations. Based on the extent of infrastructure removal, decommissioning could alleviate visual impacts (BOEM 2012).

BOEM (2012) determined that aesthetic changes could impact recreation and tourism, and that the magnitude of this impact would vary with distance to existing parks, refuges, and primary recreational use areas. As described in Section 3.15.4.4 of this EIA, recreation within the vicinity of the Liberty Development is low, and there are no facilities to support recreational use of the near-shore Beaufort Sea coast; however, the Kadleroshilik River is within State-managed hunting and fishing areas. The sensitivity of recreational users to additional visual features of an industrialized nature is considered high. However, recreational use is rare in areas from which the Liberty Development would be visible, and most effects would be temporary (occurring during construction or drilling); therefore, effects on recreation from changes to the aesthetic environment would be considered minor and short-term, which is consistent with BOEM's determination in its 2012 Final Programmatic EIS.

As described in Section 3.16.1, the proposed facilities would merge with the horizon (i.e., not be visible) as viewed from Prudhoe Bay, Deadhorse, Dalton Highway, Nuiqsut, and Kaktovik, based on distance from the Liberty Development area. However, these facilities would be visible within the foreground-middle ground or background distance zones from the Native Allotments in the study area.

Lighting from construction activities and lighting on LDPI during drilling and operations (including flaring) is likely to appear to the Prudhoe Bay and Deadhorse oilfield workers as a faint glow on the horizon during periods of darkness (i.e., night and wintertime), which could increase in intensity under certain atmospheric conditions. However, due to the distance, the Liberty Development would create only a minimal contrast with the existing

visual environment during construction, drilling, and operations as seen from these locations. This glow would appear more intense from the Native Allotments as it would be within the foreground-middle ground and background distance zones.

Lighting from construction activities at the mine site and onshore pipeline facilities would appear particularly bright at one Native Allotment, creating a strong visual contrast during periods of darkness. It is not known if or how sensitive land uses would be affected. Effects from lighting of construction activities would cease upon completion of the construction phase, which would take place over a 2- to 3-year period. Effects from lighting on Liberty Island during drilling activities would cease upon completion of the drilling phase, but light emissions during production activities would occur over the life of the project, or up to 25 years.

With the possible exception of lighting during construction, drilling, production activities and flaring, the other project features on LDPI would not be visible from Nuiqsut and Kaktovik. During the summer and on clear weather days, the unlit drilling and production facilities may be visible from Prudhoe Bay, Deadhorse, Dalton Highway, and the Native Allotments. The infrastructure on LDPI would break horizontal views by introducing structures for oil and gas production and an island base 19 feet above the water. Maximum facility height on the LDPI are estimated to be 52 feet. Rig mast heights would be approximately 184 feet high, with the flare 215 feet high. Two cranes would be permanently stored on site, with maximum tip height of 178 feet and maximum boom length of 355 feet; however, cranes will be laid down when not in use.

The visibility of the unlit project facilities on LDPI would be similar to the visibility of the Point Thomson drilling rig at a distance of 20 miles, as described in USACE 2012a, "…. At 20 miles, observers needed to be keenly aware of the target to be able to see it (that is, it would likely be invisible to a casual observer not otherwise aware it was there)." Therefore, at a distance of greater than 20 miles (Prudhoe Bay, Deadhorse, and Dalton Highway), the unlit project features on LDPI would barely be possible to observe from these locations.

At a distance of greater than 4 miles from each Native Allotment, the LDPI infrastructure would create a moderate visual contrast with the broad horizon. The unlit LDPI infrastructure would be difficult if not impossible to see from the Allotments during the winter and under Arctic haze conditions.

A hovercraft hangar located at the Endicott SDI would be within the foreground-middle ground zone of the closest Native Allotment (a distance of approximately 2 miles), the hangar would be similar in height and nature to the existing industrial facilities at Endicott and would therefore create no contrast with the existing visual environment. The mine site and onshore pipeline would be located within the foreground-middle ground zone of one Native Allotment. The onshore pipeline, and possibly the reclaimed mine site would be visible from this Allotment given the openness of the surrounding landscape and their close proximity. As stated previously, it is not known if the Allotments are inhabited or what their existing land uses are; therefore, it is not known if sensitive land uses would be affected. The reclaimed mine site would likely be a large lake, contoured to appear natural and attract wildlife, which should have little effect on the Allottee or use of the Allotment.

The LDPI is located less than 3 to 5 miles away at the point of closest approach by subsistence whalers, and it is expected that LDPI would be visible to whalers on a typical day (see Section 3.16.2). It is possible that LDPI would be visible from Cross Island, but it would almost certainly be visible from boats near Narwhal Island. The tall structures (e.g., flare and drilling rig) and the painted facilities would contrast with the sky. Based on distance, this contrast could change the character of the existing landscape and could discourage local use of the area for whaling and hunting. The magnitude of impact would depend on distance, aesthetic sensitivity, and expectations of whalers and hunters in areas where project features are visible.

4.2 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED DEVELOPMENT ALTERNATIVE

Alternatives considered for the Liberty Development were introduced in Section 2.2. The only action alternative that carried through a preliminary level of impact analysis is a generalized version of a project considered but not carried forward as a project alternative in the 2002 Liberty FEIS—offshore drilling with a pipeline to Endicott for processing at existing facilities. Because it meets the requirement of non-uERD drilling (i.e., offshore drilling), and a pipeline route has been identified that is now considered to be technically and environmentally feasible, this scenario was further evaluated in developing the proposed DPP.

This Liberty Development alternative (Alternative 1) eliminates offshore processing, reduces the infrastructure required offshore, reduces long-term operations staffing needs on the island, eliminates onshore pipelines, and uses existing Endicott facilities (Duck Island Unit).

4.2.1 Effects Summary from Construction and Routine Operations

Following is a summary of the impacts that are expected to result from construction and routine operations of an offshore drilling island with multiphase production transported via subsea pipe in pipe flowline for processing at the MPI (i.e., Alternative 1). This summary represents a cursory evaluation with results indicating that it is similar in many ways to the Proposed Project, with the most distinct differences resulting from the length and routing of the subsea pipeline. Many impacts of the two projects are similar. The only significant effect expected from either the Proposed Project or Alternative 1 is impact of a WCD. Potential environmental impacts associated with Alternative 1 are summarized in **Table 4.2-1**.

The Alternative subsea pipeline is longer and presents a greater risk to the Boulder Patch, and possibly from strudel scour, than the Proposed Project. This alternative relies on processing at the Endicott MPI, which is an older facility, with less-efficient fuel combustion equipment. Additionally, the possibility of increasing production at Endicott would need to be balanced with the capacity that would be allocated to Liberty. As a result, Alternative 1 is not HAK's preferred plan of development and is not discussed further in this EIA.

Table 4.2-1. Potential Environmental Impacts Associated with Alternative [1]

RESOURCE	POTENTIAL IMPACT OF ALTERNATIVE: OFFSHORE DRILLING; PROCESSING AT ENDICOTT	PROPOSED PROJECT COMPARISON
Climate and Meteorology	Measureable impacts on climate change are expected to be negligible. Effects of climate change on the project are mitigated by adaptive design for island and pipeline.	See Section 4.1.1. impacts are expected to be similar.
Oceanography	Minor localized current movement impacts. Sedimentation effects are expected to be negligible.	See Section 4.1.2. Impacts are expected to be similar.
Geology	The reservoir would be penetrated for oil recovery and oil would be removed from the formation, with waterflood required to maintain reservoir pressure. Based on available geotechnical information, effect to/from subsea and onshore permafrost expected to be minor. Gravel mining an estimated 1.25 million cy would result in an approximately 21-acre mine site. Mining and mine site rehabilitation requires approvals by the USACE and ADNR, and will contain mitigation measures to avoid or reduce impacts, which overall are expected to be minor to moderate.	See Section 4.1.3. Impacts are expected to be similar.
Air Quality	Emission sources typical of other North Slope oilfield development and operations, with peak emission rates during drilling at the offshore island would occur. Processing at existing facilities (MPI) minimizes the need for additional processing emission units on island.	See Section 4.1.4. New production facilities would have up-to-date emissions sources; up to date emission sources may offset potential for increased emissions.
Acoustics	Based on typical mitigation measures and those expected to result from MMPA and/or ESA consultations, it is expected that impacts on the acoustic environment would be minor.	See Section 4.1.5. Impacts are expected to be similar.
Water Quality	The primary effect is TSS generation during flowline and island construction. Higher concentrations of TSS (10-20 mg/L) would be largely localized along the pipeline route. Lower concentrations (<5 mg/L) would be more widely distributed from the pipeline route and persist longer. Due to the flowline route to the south and west of the Boulder Patch, elevated TSS concentrations (10-20 mg/L) would extend over more of the Boulder Patch (as much as 1,067 acres). There would be no discharge of drilling wastes. Wastewater discharge would be temporary and managed under an EPA NPDES permit, which is issued to protect water quality. Typically, point source discharges (i.e., wastewater treatment effluent) would be	See Section 4.1.6. More water would be required for ice roads and pads to support monitoring and maintenance of onshore facilities. Effect of TSS generation during pipeline and island construction is expected to be similar. Higher concentrations of TSS (10-20 mg/L) would be largely localized along the pipeline route. Lower concentrations (<5 mg/L) would be more widely distributed from the pipeline route and persist longer. Due to the pipeline route south of the Boulder Patch, elevated TSS concentrations (10-20 mg/L) would only extend over 200 acres of the Boulder Patch.

Table 4.2-1. Potential Environmental Impacts Associated with Alternative [1]

RESOURCE	POTENTIAL IMPACT OF ALTERNATIVE: OFFSHORE DRILLING; PROCESSING AT ENDICOTT	PROPOSED PROJECT COMPARISON
	injected to minimize discharge.	Discharge methods and impacts are expected to be similar.
Benthic Communities.	Based on the curved flowline alignment, impacts on benthic communities represent a direct and non-recoverable loss of about 0.6% of the Boulder Patch epiflora and epifauna. Increased total suspended solids from flowline and island construction would have minor to moderate impacts on the primary productivity of kelp, estimated at a 13 to 15% reduction in annual production the year following installation of the flowline. Calculated area affected by non-lethal XSS would be approximately 37.0 km^2.	See Section 4.1.7. Due to the south-southwest pipeline alignment, the Proposed Project would result in less direct and non-recoverable loss of Boulder Patch, less effect on productivity (estimated 9.5 % reduction), and less calculated area (estimated 21.7 km^2) affected by non-lethal TSS. In summary, less potential impact to the Boulder Patch and associated benthic communities.
Marine Mammals	Project noise and activities in the winter would not cause disturbance to species not present in winter (spotted seals, gray whales, and beluga whales). Noise and activities associated with the open-water season could have negligible to moderate effects on individual spotted seals. Noise and activities associated with the open-water season would have negligible to moderate effects on individual gray whales and beluga whales because these species primarily occupy waters offshore of the proposed Liberty Development. Because the majority of bearded seal, spotted seal, gray whale, and beluga whale populations occur outside of Foggy Island Bay, noise and activity-related impacts to these overall populations are anticipated to be negligible. Spills and leaks of oil, chemicals, or wastewater arising from the Proposed Project could result in impacts to the health of exposed marine mammals, and noise and activities associated with spill cleanup could result in short-term disturbance and displacement of marine mammals. Although impacts to individual marine mammals could be major, impacts of small spills or leaks on spotted seal, gray whale, and beluga whale populations are anticipated to be negligible to minor.	See Section 4.1.8. Similar noise generation, vessel traffic, habitat alteration is expected, with minor differences in timing and location of construction activities. There would be more traffic and on-island activity during operations due to offshore processing. No substantive difference in potential impact is expected.
Coastal and Marine Birds	Potential project-related impacts on marine and coastal birds would be expected to be negligible to minor with few exceptions. Winter construction activities could affect a small number of individuals through the loss or alteration of nesting or foraging habitat. However, the amount of habitat lost or altered would be small compared with the availability of suitable marine and terrestrial habitat within Foggy Island Bay and the Arctic Coastal Plain. Localized displacement of marine birds from the project area may occur during operations and drilling, but	Section 4.1.9. Proposed vessel traffic and air traffic routes and level of activity are similar. There could be more helicopter trips due to more offshore activity. There would be greater onshore habitat loss due to the pipeline. The additional facilities and activities on the LDPI could provide an attractant (e.g., lighting) and habitat for predator birds. Mitigation in place or typically required would eliminate or reduce related impacts.

Table 4.2-1. Potential Environmental Impacts Associated with Alternative [1]

RESOURCE	POTENTIAL IMPACT OF ALTERNATIVE: OFFSHORE DRILLING; PROCESSING AT ENDICOTT	PROPOSED PROJECT COMPARISON
	suitable habitat may be found nearby. Drilling- and operations-related impacts to coastal and marine bird populations are not expected to result in population-level effects. Exposure to spills and leaks of oil, chemicals, or wastewater arising from the Proposed Project could negatively affect the health of coastal and marine birds, and activities associated with spill cleanup could result in the short-term disturbance and displacement of birds in the vicinity of the spill. Potential impacts from small to large spills or leaks on coastal and marine birds are anticipated to range from minor to moderate, dependent on the timing, location, and extent of the spill.	
Fish and Shellfish	Impacts are expected to be consistent with BOEM's determination (2002c and 2012) that effects on fish and shellfish would be negligible.	Section 4.1.10. Impacts are expected to be similar. Potential entrainment effects of the STP would be mitigated by design.
Terrestrial Biology	Impacts to vegetation and wetlands are expected to range from minor to moderate with overall routine activities expected to result in direct loss and damage during gravel mine development. Impacts to terrestrial mammals from construction and operations are expected to be minor to moderate short-term disturbances. Long-term loss of about 21 acres of tundra habitat would occur, and potential minor construction and collision mortality for local terrestrial mammals may occur.	Section 4.1.11. Impacts are expected to be similar but slightly greater in extent due to the onshore development of the pipeline trench, tie-in pad and ice road crossing pad, which would result in greater vegetation loss and additional activity in the area that could create disturbance. The gravel mine final footprint is expected to be similar. While there could be short-term effects on individual animals, no effect on overall distribution and abundance of terrestrial mammals is expected.
Threatened and Endangered Species	Each of the five marine mammal species and two coastal/marine birds species that are listed or candidate species was considered. Impacts vary with species. Because only a small fraction of the larger populations of ringed seals, polar bears, and bowhead whales have the potential to occur in the immediate vicinity of Liberty Development, noise and activity-related impacts to their populations are anticipated to be negligible to minor. Potential effects on humpback whales are not expected. Potential effects on Pacific walrus are not likely to result in more than transitory disturbance of a few individuals. Small and large spills and leaks from the Liberty Development could have major impacts on individual ringed seals, polar bears, and bowhead whales, whereas impacts of small spills or leaks on their larger populations are anticipated to be negligible to minor. This determination is in agreement with BOEM's conclusion that spills associated with	See Section 4.1.12. Impacts are expected to be similar, although there is some difference in construction activity scheduling. The Proposed Project would have no sealift, which would reduce the potential for marine collision or conflict. In general, impacts are of a similar nature as those for coastal birds and non-listed marine mammals.

Table 4.2-1. Potential Environmental Impacts Associated with Alternative [1]

RESOURCE	POTENTIAL IMPACT OF ALTERNATIVE: OFFSHORE DRILLING; PROCESSING AT ENDICOTT	PROPOSED PROJECT COMPARISON
	arctic marine oil and gas development would have a minor to moderate potential to impact marine mammals, with the magnitude of effects dependent in part on the location, volume, and timing of the spill (BOEM 2012). Because a small number of Steller's eiders and spectacled eiders use the habitats within the Liberty Development area, noise- and activity-related effects on their overall populations are anticipated to be negligible to minor. Spills and leaks from the Liberty Development could have minor to moderate impacts to individual Steller's eiders and spectacled eiders. Small spills (less than 1,000 bbl) may negatively affect the health or productivity of a few individuals but are unlikely to have population-level impacts. Large spills (greater than 1,000 bbl) may negatively impact a larger number of individuals than small spills, and the number of individuals affected will be dependent on timing, location, and extent of the spill. The small proportion of spectacled eider and yellow-billed loon populations potentially affected by a large spill in the Liberty Development area would be negligible to their populations.	
Sensitive Biological Resources	Impacts to sensitive biological resources are addressed in related sections on benthic communities (Boulder Patch), polar bear, marine and coastal birds (e.g., snow goose), and fish.	See Section 4.1.13. Impacts to most resources are expected to be similar.
Archaeological Resources	Based on results from cultural surveys in the area, potential impacts to archaeological and cultural resources are considered to be negligible, in both the terrestrial (onshore) and marine (submerged) environments.	See Section 4.1.14. Based on existing surveys, no cultural resources have been identified at the island or along pipeline route, both offshore and onshore. The final determination will be made with additional geophysical data collection.
Socio-Economic Resources	A direct positive economic effect would be the creation of new jobs for project construction and operations. The maximum number of part-time, seasonal, and full-time jobs during the development phase is estimated to be about 2,280 over a 5-year period. It is estimated that this project would generate $452 million in wages during the pre-development and development phases, and $761 million in wages during the production and abandonment phase. Oil and gas property tax is expected to total $252 million over 38 years. The State would pass through about $234 million of this tax revenue to the NSB. Additional revenues would accrue to the NSB because of increased oil flow through existing pipeline infrastructure	See Section 4.1.15. A direct positive economic effect would be the creation of new jobs for project construction and operations. The maximum number of part-time, seasonal, and full-time jobs during the development phase is estimated to be about 3,010 over a 5-year period. It is estimated that this project would generate $497 million in wages during the pre-development and development phases, and $698 million in wages during the production and abandonment phase. Oil and gas property tax is expected to total $37 million over 38 years. The State would pass through about $35

Table 4.2-1. Potential Environmental Impacts Associated with Alternative [1]

RESOURCE	POTENTIAL IMPACT OF ALTERNATIVE: OFFSHORE DRILLING; PROCESSING AT ENDICOTT	PROPOSED PROJECT COMPARISON
	taxed by the State and reimbursed to the NSB.	million of this tax revenue to the NSB. Additional revenues would accrue to the NSB because of increased oil flow through existing pipeline infrastructure taxed by the State and reimbursed to the NSB.
Land/Coastal/Marine Use	Coastal and marine uses not addressed under other resources are generally limited and impacts are expected to be negligible. The gravel mine is expected to be opened and closed in a single winter construction season with negligible impact on land use. The primary impacts to coastal and marine uses are likely to be from increased traffic to and from the island during construction and drilling. Ice roads to the gravel site would only be constructed during the construction phase of the Liberty Development and would not impact transportation routes between coastal communities. Flights to and from the LDPI would mostly be over water and would not disturb potential land-based uses in the area such as recreational hunting. Potential effects on recreation, tourism, research, commercial vessel traffic are expected to range from none to negligible.	See Section 4.1.16. Impacts are expected to be similar. There would be more coastal traffic during all seasons to and from the LDPI due to greater infrastructure/operations activity on the island.
Environmental Justice	Due to the long distance from Native communities (approximately 80 and 90 miles from Nuiqsut and Kaktovik, respectively), the environmental justice impacts are most closely associated with effects on subsistence resources and activities in the Liberty area, which are discussed below.	See Section 4.1.17. Due to the long distance from Native communities (approximately 80 and 90 miles from Nuiqsut and Kaktovik, respectively), the environmental justice impacts are most closely associated with effects on subsistence resources and activities in the Liberty area, which are discussed below.
Visual	In most cases, visual impacts to the viewscape and to viewers are expected to be negligible to minor. However the magnitude of impact on Native whalers and hunters in areas where project features are visible would depend on their distance, aesthetic sensitivity, and expectations. The contrast of industrial facilities could change the character of the existing landscape and could discourage local use of the area for whaling and hunting.	See Section 4.1.18.1. Impacts are expected to be generally similar, but slightly greater with this development plan due to the greater infrastructure, activity, flaring, and traffic associated with offshore production. Onshore, the pipeline would have visual effect, although it is expected to be minor due to the distance from established communities.
Subsistence	Local whalers have expressed concerns over possible deflection and/or disturbance of whales transiting through or near the Liberty Development Area, possible whaler avoidance of the development site, and with the increased probability of vessel traffic interference making potential adverse effects to Cross	See Section 4.1.18.2. Impacts are expected to be similar, although it is possible that production facilities with flaring would likely increase concerns for the potential for spills, increased noise, visibility and an increased likelihood of deflecting whales and/or

Table 4.2-1. Potential Environmental Impacts Associated with Alternative [1]

RESOURCE	POTENTIAL IMPACT OF ALTERNATIVE: OFFSHORE DRILLING; PROCESSING AT ENDICOTT	PROPOSED PROJECT COMPARISON
	Island subsistence whalers moderate or more for the duration of Liberty production operations. However, many and perhaps all of the potential effects could possibly be avoided, reduced, or eliminated through coordination between the whalers and HAK, primarily through the mitigation process or in the consultations required under Lease Stipulation 6. *Subsistence Whaling and Other Subsistence Activities.* It is expected that a large oil spill would have major adverse effects on the Cross Island subsistence bowhead hunt, and potentially moderate to major effects on Nuiqsut fishing activities.	whalers. The shorter pipeline going south to shore may be perceived as having less risk.
Impact from Spills	Impacts from spills would vary based on the type, location, timing of the spill and effectiveness of the response and expected to be essentially the same as the proposed action.	See Section 4.3. Impacts are expected to be similar, although there is a slightly greater risk of spills offshore due to the production infrastructure and activities.
Cumulative Effects	Cumulative impacts are based on similar sized, located, and operated project.	See Section 4.4. Impacts are expected to be similar.

Key: ADNR = Alaska Department of Natural Resources; APDES = Alaska Pollutant Discharge Elimination System; bbl = barrel; cy = cubic yard; EPA = U.S. Environmental Protection Agency; ESA = Endangered Species Act; km2 = square kilometers; LDPI = Liberty Drilling and Production Island; mg/L = milligrams per liter; MMPA = Marine Mammal Protection Act; MPI = Main Production Island; NPDES = National Pollutant Discharge Elimination System; NSB = North Slope Borough; STP = Seawater treatment plant; TSS = total suspended solids; USACE = U.S. Army Corps of Engineers; XSS = excess suspended solids.

4.3 ENVIRONMENTAL CONSEQUENCES OF OIL SPILLS

While all operators go to great lengths to prevent a release of oil (or other hazardous material), some spills may occur. Depending on the location, size, and duration of a spill, a variety of natural resources may be affected, including marine mammals, marine and coastal birds, fish, benthic and pelagic invertebrates, water quality, marine and coastal habitats, and areas of special concern (such as subsistence or protected areas).

A variety of accidental events or spills may occur during the years of development and production. Analysis of data from OCS activities in the Gulf of Mexico, Pacific, and Alaska indicate that most offshore oil spills are less than 1 bbl in size, and these small spills accounted for approximately 95% of all OCS spills but less than 5% of the total volume of oil spills on the OCS (Anderson et al. 2012; Anderson and LaBelle 2000). The following summarizes potential consequences of a small (<1,000 bbl) release and a worst-case discharge.

The majority of small spills could be contained on a vessel or platform, and refined fuel spills that reach the water would evaporate and disperse within hours to a few days. Further, those spills reaching the water may be contained by booms or absorbent pads. BOEM estimates small spills are likely to occur over the life of the exploration and development activities (BOEM 2015).

The magnitude of the impacts would depend on the specific location affected and the nature and magnitude of the activity or accident. The Final Programmatic EIS (BOEM 2012) detailed the following potential effects of small (<1,000 bbl), expected accidental spills:

- Minor and short-term impacts to coastal and marine water quality. Water quality would rapidly recover without mitigation, due to mixing, dilution, and weathering.
- Minor to moderate impacts to marine mammals, while impacts from oil spill response activities are expected to be minor.
- Minor impacts to marine and coastal birds, as small spills would only impact small areas of habitat and relatively few individuals.
- Negligible impacts to fish for spill less than 50 bbl; minor impacts for spills up to 1,000 bbl.
- Small, localized, sub-lethal impacts to invertebrates. Overall, impacts from small spills would range from negligible (for spills less than 50 bbl) to minor (for spills up to 1,000 bbl).

The environmental consequences of a very large or worst-case discharge (WCD) have been described for various Beaufort Sea lease sales and projects, including past proposed Liberty Development projects, and can be found in the following documents: MMS 1990c, 1996b, 2002c, 2003a; BOEM 2012.

The documents listed above provide varying definitions of small, large, and very large spill volumes. The most recent definition of spills by size for the Beaufort Sea is from BOEM (2012). BOEM described consequences for what they define as an expected small spill (less than 1,000 bbl), an expected large spill (greater than 1,000 bbl), and an "unexpected event and spill – catastrophic discharge event" (CDE). The BOEM CDE volume is estimated to be between 1,700,000 and 3,900,000 bbl (BOEM 2012, **Table 4.3-1**). The LDPI worst case discharge is 2,060,000 bbl.

Table 4.3-1. NEPA Analysis of Worst Case Discharge

DOCUMENT	DISCHARGE	SPILL DURATION	SCENARIO SEASON	DISCHARGE SOURCE	VOLUME (BBL)
MMS 1990c (EIS Lease Sale 124)	Low-Probability High- Effects, Very large oil spill event	249 days	Winter under ice, detected on July 22.	Pipeline	160,000
MMS 1996b (EIS Lease Sale 144)	Low-Probability High-Effects, Very large oil spill event	249 days	Winter under ice, detected on July 22.	Pipeline	160,000
MMS 2002c	Low probability, very large oil spill	15 days (based on State regulations)	This document has some limited information for all three seasons, but the most for Summer, Open Water. (Solid ice, broken ice, open water)	Well blowout	180,000 reaches the water or ice. (15,000-bbl flow rate per day for 15 days, totaling 225,000 bbl. 20% evaporates, an estimated 180,000 bbl reaches open water) Source: Volume 2, Page IX-2
MMS 2003a	Low Probability, Very large oil spill	15 days (based on State regulations)	The three general environments into which the oil could discharge are solid ice, broken ice, and open water. There are brief discussions of each scenario type in IV.I.1.	Well blowout	Approximately 20% of the 225,000 leaving 180,000 bbl after evaporation
MMS 2008-0055 Draft EIS Lease Sales 209, 212, 217, and 221	Large Oil Spill	Unspecified	Open water, under ice, under sea ice, broken ice, coastal shoreline.	Pipeline Platform/Storage Tank	4,600 bbl or 1,500 bbl (one spill) Source: Volume 4, Table A.1-1

Table 4.3-1. NEPA Analysis of Worst Case Discharge

DOCUMENT	DISCHARGE	SPILL DURATION	SCENARIO SEASON	DISCHARGE SOURCE	VOLUME (BBL)
BOEM 2012	An Unexpected Accidental Event and Spill – Catastrophic Discharge Event	60-300 days (based on time to drill a relief well)	"The greater range in spill duration in the Beaufort reflects different assumptions about the drilling rig and timing of drilling relative to seasonal ice conditions. The scenario range incorporates both open- and late open-water season and winter blowout scenarios (the late open-water season may delay the relief well drilling until the following open-water season). These are discharge volumes and do not account for decreases in volume from bridging, containment, or response operations. Note that under BOEM and BSEE regulations, exploration and development plans and oil spill response plans must incorporate a separate worst-case discharge calculation derived from individual well parameters and characteristics." Section 4.4.3 Table 4.4.2-2)	Loss of well control	1,700,000 to 3,900,000, depending on the availability of a rig to drill a relief well.

Key: bbl = barrels; BSEE = Bureau of Safety and Environmental Enforcement; BOEM = Bureau of Ocean Energy Management; EIS = Environmental Impact Statement; MMS = Minerals Management Service; NEPA = National Environmental Policy Act.

Additional Source: Draft Environmental Impact Statement OCS EIS/EA MMS 2008-0055

Link: http://www.boem.gov/About-BOEM/BOEM-Regions/Alaska-Region/Environment/Environmental-Analysis/Draft-Environmental-Impact-Statement-OCS-EIS/EA-MMS-2008-0055.aspx

The documents listed above, MMS 1990c, 1996b, 2002c, and 2003a, all used very large spill volumes that were less than BOEM's 2012 CDE. BOEM's CDE is the largest volume considered in evaluating the impact of a catastrophic oil spill in the Beaufort Sea. BOEM (2012) also provides an analysis of the potential for such an event to take place. The likelihood of such an event is very small (BOEM 2012, Section 4.3.3.1), which is why it is described as an "unexpected event." Since BOEM (2012) uses the largest CDE to date (which exceeds the volume of the Liberty Development project's WCD, as noted in Section 2.8), BOEM (2012) is incorporated into this document by reference.

After being discharged, oil "weathers" due to several processes, including evaporation of volatile components of oil, weathering (dispersion, emulsification, microbial degradation, photochemical degradation, and sedimentation) and transport. Cold Arctic conditions tend to slow the weathering process. These processes change the nature of the oil and change the effectiveness of different response options. Response options include mechanical recovery, application of dispersants and in situ burning.

The consequences of a CDE occurring in such a way that discharged oil would reach open water or broken ice is also described in BOEM (2012). This discussion includes potential toxicity to organisms that are contacted by the oil through ingestion, inhalation, or absorption. In addition to impacts to surrounding flora and fauna, a CDE would also have negligible to major impacts to subsistence, socioeconomic, and other human activity in the area. A discussion of these impact levels is provided below.

Impact Levels

BOEM used the terms in Table 4.3-1 to categorize the range of impacts of a CDE on physical and biological resources in the Beaufort Sea. Terms and conditions used by BOEM in previous NEPA analyses related to Liberty Development are described below.

BOEM describes the level and nature of impacts for 19 categories of resource or issue. These impacts are summarized in **Table 4.3-2**. BOEM's original 19 categories have been increased to 20 by distinguishing marine mammals from terrestrial mammals. The description of these resources is provided in Section 3.

Throughout BOEM's analysis, the influences of the oil's discharge location, size, and timing on the impact are mentioned as key factors that determine impact. The BOEM (2012) analysis covers a larger area with a range of conditions (including distance from shore, depth of water, type of drilling platform, and season (open water, broken ice, etc.). Inclusion of this range of variables contributes to the range of impact levels.

The Liberty Development location on a gravel island in 19 feet of water in Foggy Island Bay provides a more limited number of conditions for a CDE's impact to occur than is described in BOEM's lease-wide analysis. In addition to the differences of potential impacts caused by Liberty's location, HAK has proposed a preventative and response strategy that would further reduce impacts of a CDE compared with the mitigations considered by BOEM. Liberty is in water too shallow to use dispersants, leaving mechanical recovery and in situ burning as the most effective response options.

HAK's mitigation strategy includes restricting drilling into the hydrocarbon-bearing reservoir to avoid periods of break-up and freeze-up. This mitigation decreases the potential need to respond to any WCD during these shoulder seasons. The major response seasons would be winter or summer. The impact conclusions provided in Table 4.3-2 are, therefore, structured on winter and summer estimates of impacts from a WCD lasting 30 days, consistent with BOEM guidance to develop winter and summer scenarios.

HAK has also adopted an aggressive strategy to quickly remove any discharged, and ongoing discharge of, oil by igniting at the wellhead in situ. This tactic would exchange a short-term decrease in air quality in the vicinity of the Liberty Development for a longer-term mechanical collection, exclusion, and recovery effort that would likely expose more organisms. The NOAA Office of Response and Restoration states, "[w]hen conducted properly, in situ burning significantly reduces the amount of oil on the water and minimizes the adverse effect of the oil on the environment" (NOAA 2011). NOAA (2014b) recently determined that the residue from burned oil is not toxic to organisms. Rapid conversion of the discharged oil from a liquid to the products of combustion (CO_2, soot, and residues) would also decrease impact compared with mechanical recovery. Applying BOEM Impact Levels to the Liberty Development, including aggressive burning of discharged oil at the wellhead, and in situ with oil on ice or water, yields reduced levels of impacts for several resource areas. Table 4.3-2 outlines these specific reductions, as well as the project characteristics and HAK's response strategies.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
WATER QUALITY			
Water Quality - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface" (Section IX.A.2.pg IX-3)	Moderate with competent ice preventing contact with liquid water, concentrations of petroleum hydrocarbons would not become elevated; land water quality standards would not be affected, until break-up. If the response strategy is successful, water quality standards would likely be violated due to oil sheen, but petroleum compounds concentrations would be expected to be elevated at areas where residue remains and not widely spread through Foggy Island Bay
Water Quality - Summer Scenario	Moderate-Major: "A catastrophic discharge event could present sustained degradation of water quality from hydrocarbon contamination in exceedance of State and Federal water and sediment quality criteria. These effects could be significant depending upon the duration and area impacted by the spill. Impacts from the event would depend on the spill size and composition, weather conditions, the location of the spill, and the effectiveness of spill containment and cleanup activities."(Section 4.4.3.2.4.)	Open Water/Broken Ice: Petroleum hydrocarbons from 180,000 bbl of oil entering the waters of Foggy Island Bay could exceed the 1.5-parts per million acute toxic criterion during the first several days of a spill in an area less than 290 km^2 (112 mi^2) and the 0.015-parts per million chronic criterion for several months in an area of about 14,000 km^2 (5,405 mi^2)	Moderate-Major. Water quality standards would be violated by the presence of oil sheen, and petroleum compound concentrations would be elevated, likely above water quality standards, within areas where oil is contained by booms. As oil is removed from the water, and currents dilute dissolved petroleum hydrocarbons, water quality standards would be met eventually.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
AIR QUALITY			
Air Quality - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water…. There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface" (Section IX.A.2.pg IX-3)	Moderate to Minor. Potential sources of air pollutants (NO_2, CO, SO_2, VOC, PM_{10}, $PM_{2.5}$ and GHG) include: • Planned or unplanned ignition and sustained combustion of expelled natural gas and crude oil at the wellhead, • In situ burning of crude oil deposited onto snow and ice surfaces, • Exhaust from fuel-fired response equipment, and • Evaporation of VOC from crude oil deposited on any snow or ice surfaces. Of these four sources of emissions, combustion of natural gas and crude oil at the wellhead would likely be the predominant source of air pollutant emissions, followed by in situ burning during spill response. Air pollutants produced from these two activities are likely to be lofted to relatively high altitudes (greater than 100 m) above the surface, which would facilitate dispersion and dilution of emissions and reduce ambient air quality impacts at locations downwind from the source(s). Potential emissions from the fuel-fired response equipment would be comparable to, or less than, potential air pollutant emissions from the stationary emission sources at the LDPI during planned drilling operations. Evaporation of VOC,

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			including hazardous air pollutants (HAPs), from crude oil would likely result in Moderate to Minor impacts at distances less than 1 km from the spill site. Air quality impacts would become Negligible upon completion of spill response activities.
Air Quality - Summer Scenario	Moderate to Minor: "During an unexpected CDE, the greatest impacts on air quality would occur during the initial explosion of gas and oil, and during the spill response and cleanup. Impacts could continue for days during the initial event and for months during the spill response and cleanup. Despite the length of time that could be involved, emissions from a CDE would be temporary and, over time, air quality in Arctic Alaska would return to pre-event conditions. If in situ burning is used during the response to a CDE, carcinogenic dioxins and furans could be formed. These chemicals can bioaccumulate in the food chain. Studies performed during the DWH event indicated that levels of these chemicals were about the same as levels from residential wood stoves and forest fires, so that bioaccumulation is not expected to be a problem. Although dioxins were created during DWH burns, reports found that workers, onshore residents, and residents consuming fish had incremental lifetime cancer risks well below EPA's target risk level…." Overall, the air quality impacts of an unexpected CDE, including in situ burning, in Arctic Alaska	"A very large oil spill could cause an increase in the concentrations of gaseous hydrocarbons (volatile organic components) due to evaporation from the spill. The effects would be low."[Section IX.6.m (1)]	Moderate to Minor. Potential sources of air pollutants (NO_2, CO, SO_2, VOC, PM_{10}, $PM_{2.5}$ and GHG) include: • Planned or unplanned ignition and sustained combustion of expelled gas and crude oil at the wellhead, • In situ burning of crude oil deposited onto snow, water, and ice surfaces, • Emissions from fuel-fired response equipment, and • Evaporation of VOC from crude oil deposited on any land or water surfaces. Of these four emission sources, the combustion of gas and crude oil at the wellhead would likely result in the greatest amount of air pollutant emissions, followed by in situ burning during spill response. Air pollutants from these two activities are likely to be emitted to relatively high elevations (greater than 100 m) above the surface, which would facilitate the dispersion and dilution of emissions and reduce ambient air quality impacts at locations downwind of the source. Potential emissions from the fuel-fired response

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	could be moderate during the initial explosion of gas and oil and during the spill response and cleanup but would become minor after the well was capped." (Section 4.4.4.3.4)		equipment would be comparable to potential air pollutant emissions from the stationary emission sources at the LDPI during planned drilling operations. Evaporation of VOCs, including hazardous air pollutants (HAPs), from crude oil would likely result in Moderate to Minor impacts at distances less than 1 km from the spill site. Air quality impacts would become Negligible upon completion of spill response activities.
ACOUSTIC ENVIRONMENT			
Acoustic Environment - Winter Scenario	"… icebreakers, if used, are among the noise sources"(Section 4.4.5.3) *[NOTE: Icebreakers would not be used in Foggy Island Bay]* Discharge and response on competent ice not considered separately.	Noise from response activities on solid ice not considered directly.	In winter, the WCD response would involve the use of heavy equipment moving around the ice and on North Slope gravel roads, plus light aircraft and helicopter traffic. These activities would continue for at least 90 days. Noise generated by this equipment would potentially affect terrestrial and marine mammals in proximity to the activities for the duration of the response, but the magnitude of the affect is considered to be Minor.
Acoustic Environment - Summer Scenario	Minor-Moderate: "Seismic surveys, skimmers, mechanical equipment, support vessels and aircraft, and icebreakers, if used, are among the noise sources associated with response and cleanup activities for an unexpected CDE. Noise from these response activities could continue for days during the initial event and for months during spill response and cleanup. When these activities cease, ambient noise would return to pre-spill levels. Noise from response activities	"…noise disturbance to bowheads from vessel and aircraft traffic involved with cleanup activities likely would be similar to that described in Section III. C. 3. "[Section IX.A.6.a(1)] Section III.C.3. refers to Section III.c.2. (1). (a) "If a 1,580 barrel pipeline spill occurred during the broken ice period in the fall, some bowheads may be displaced temporarily from and area due to the large numbers of personnel, equipment, vessels, and air craft	In summer, tugs, barges and work boats will be used to contain and clean up the discharge. There will also be vehicle activity on gravel roads, along with aircraft and helicopters. The noise from these sources could affect terrestrial and marine mammals, fish, and birds in proximity to the activities, for the duration of the response. Consistent with BOEM's consideration of similar noise sources in the 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS (BOEM

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	could affect terrestrial and marine mammals, fish, and birds. Noise would be transient along the trajectories of support vessels and aircraft but would persist for the possibly extended duration of cleanup and response activities. If the event involves a major loss of well control, the associated pressure wave could harass or injure nearby marine mammals. Noise impacts from response activities for an unexpected CDE are expected to be minor to moderate." (Section 4.4.5.3)	conducting oil spill cleanup operations." "Oil spill cleanup activities during September and October could disturb bowhead whale during their fall migration" NOTE: Most sections of the EIS Section IX address potential effects of spill response activities instead of the effects of noise from those activities,	2012) for the Alaskan Arctic, this impact is considered to be Minor to Moderate.
COASTAL AND ESTUARIES			
Coastal and Estuaries - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface" (Section IX.A.2.pg IX-3)	If well ignition and ice are successfully used to limit oil spread and prevent contact with liquid water, the coastal and estuarine areas would not be expected to be contacted by oil. Such areas could be contacted by smoke/soot from well ignition/in situ burning. Impacts would be Negligible. If not completely successfully, impacts would increase in proportion to the oil that makes contact. Even with a successfully implemented strategy, some residues would likely remain, and could contact estuaries and coastal areas. Assuming the residues are of a much lower volume and weathered, impacts would be considered to be Minor to Major depending on how heavily contacted.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
Coastal and Estuaries - Summer Scenario	Minor-Moderate: "An unexpected 1.7–3.9 million bbl CDE in the Beaufort Sea or a 1.4–2.1 million bbl CDE in the Chukchi Sea would be associated with a loss of well control. Oil or other spilled materials might be transported from offshore areas to coastal wetlands by currents or tides. The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. A CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline being affected and heavy deposits of oil in multiple locations. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, temperature, and species sensitivity. Impacts to coastal habitats from a CDE would range from moderate, if recovery of habitats occurs, to major, if recovery does not occur and exposure results in habitat loss."(Section 4.4.6.1.3)	See vegetation and wetland habitat	If well ignition and containment/in situ burning and site protection are successfully used to limit the spread of discharge, oil contact would be decreased compared to a WCD with no response. If contact is made, impacts would depend on the amount of oiling and specific coastal/estuarine areas. Impacts would be similar to those described for coastal and marine birds that use these areas (Moderate to Major).
VEGETATION AND WETLANDS			
Vegetation and Wetlands - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open	Minor to Moderate. Some coastal vegetation and wetlands may be exposed to soot and residue that may damage vegetation in salt marshes or sheltered tidal flats. Soot and residue may reach

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface" (Section IX. A. 2.)	sensitive shoreline habitats on the east side of the Sagavanirktok River Delta and Foggy Island Bay. The degree of effects would depend on the extent of exposure, the substrate type, degree of sediment contamination, and sensitivity of the vegetation community. Biodegradation would be slow along arctic coastlines, and residue might persist for many years on peat shores, but would be expected to persist for less than a decade. Cleanup in these habitats would create additional damage to vegetation and wetlands, which would be slow to recover.
Vegetation and Wetlands - Production Scenario	"Oil or other spilled materials might be transported from offshore areas to coastal wetlands by currents or tides. The amount of oil deposited on coastal habitats would depend on various factors, such as spill volume, distance from shoreline, ambient conditions, degree of weathering, and effectiveness of response actions. A CDE would potentially result in heavy or widespread deposits of oil and would have a greater likelihood for extensive areas of shoreline being affected and heavy deposits of oil in multiple locations. The degree of effects and length of recovery depend on a number of factors such as the type of oil, extent of biota exposure, substrate type, degree of sediment contamination, time of year, temperature, and species sensitivity. Impacts to coastal habitats from a CDE would range from moderate, if recovery	The 180,000-bbl oil spill would extensively oil shorelines from the Endicott Causeway east along the shore of Foggy Island Bay. Salt marshes in this area could be inundated with oil that would kill both plants and invertebrate species in the marshes. Complete recovery of the salt marshes could take several decades. However, the local persistence of oil in coastal wetlands is not expected to have significant effects on the distribution and abundance of plant species (vegetation-wetlands) in the region. (Section IX. A. 6. g.)	Moderate to Major. Successfully implementing the response strategy would reduce spill volumes to the shoreline and land, and anticipated effective cleanup would leave little residue. The degree of effects would depend on the extent of exposure, the substrate type, degree of sediment contamination, and sensitivity of the vegetation community. Soot and residue may reach sensitive shoreline habitats in Foggy Island Bay. Cleanup in shoreline habitats would create additional damage to vegetation and wetlands that would recover slowly in this arctic environment.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	does not occur and exposure results in habitat loss." (Section 4.4.6.1)		
MARINE BENTHIC			
Marine Benthic - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface" (Section IX.A.2.pg IX-3)	Minor. Assuming a successfully executed response strategy incorporating wellhead ignition, mechanical recovery, situ burning, and using ice as a barrier to liquid water contact removes the majority of oil discharged to Stefansson Sound, impacts would likely be Minor. This assumes only small amounts of oil residue and tar balls will inevitably redistribute into the sea ice and possibly to the subtidal during ice break-up. The residual oil that seeps into and through sea ice is likely not sufficient to produce large concentrations of hydrocarbons in subtidal environments. Also, high concentrations of micro-sized particulates and turbulence are necessary to mix particles with oil droplets for hydrocarbon invasion of the subtidal. Turbulent conditions are rare during ice covered months. Based on limited dispersion and degradation, only a fraction of the hydrocarbons released onto the ice are expected to become incorporated into the subtidal region of Stefansson Sound. It is estimated that the small amount of oil reaching the subtidal will have minimal effects on habitat integrity and ecosystem function. Long-term ecological effects resulting from subtidal contamination from WCD during ice cover are unlikely.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
Marine Benthic - Summer Scenario	Minor-Major: "An unexpected CDE would physically disturb the seafloor around the spill site, and a subsurface plume extending a large distance from the spill could form if dispersants are used or if the oil released is mixed with gas. The impact of a CDE depends on several factors such as the size, duration, timing, and location of the spill, and the nature of the benthic habitat contacted by the oil. The season in which the spill occurs is especially important in Arctic waters due to heavy seasonal ice cover that could hinder cleanup efforts. In the unlikely event that a CDE occurred, sensitive benthic habitats could suffer long-term loss of ecological function because of both hydrocarbon toxicity and the subsequent cleanup activities. Hydrocarbons could persist at sublethal concentrations in sediments for decades, and sensitive habitats (i.e., kelp beds and intertidal zones) damaged by a spill would likely recover slowly. However, hydrocarbons would be broken down by natural processes, and most benthic habitats are likely to recover. Overall, impacts to marine benthic habitat from a CDE could range from minor to moderate, depending on the habitats affected and the level of oiling experienced by those habitats. Major impacts to hard-bottom kelp habitat could occur if these areas were heavily oiled and high mortality occurs."(Section 4.4.6.2. 3)	"Large-scale effects on marine invertebrates from oil spills have been observed in the intertidal and subtidal zones of other regions. There are limited intertidal and nearshore subtidal zones in the Beaufort Sea. Instead, it is a highly disturbed area that is seasonally recolonized by a small number of opportunistic fauna during the summer (about 3 months). The nearshore area does support a few resident and many nonresident benthic invertebrates (amphipods, mysids, copepods, clams, snails, crab, and shrimp), which are fed upon by vertebrate consumers during the summer. If contacted by surface oil, these invertebrates are likely to die or be sublethally effected."(Section IX. A. 6. E)	Moderate to Major. Assuming a successfully executed response strategy incorporating wellhead ignition, mechanical recovery and in-situ burning removes the majority of oil discharged to Stefansson Sound, impacts could still be Moderate to Major. Up to 750,000 bbl were discharged into Prince William Sound during Exxon Valdez spill. Only 13% of discharged oil was dispersed into the subtidal of Prince William Sound but concentrations of hydrocarbons in the subtidal were orders of magnitude higher than typical background concentrations for 7 months. Concentrations of toxic hydrocarbons decreased after the initial 7 month period and were undetectable by the second year. It is expected that a similar scenario during open-water periods where toxic hydrocarbons in the subtidal will occur from the onset of the discharge, with nontoxic subtidal hydrocarbon concentrations persisting several years post WCD. During periods of elevated hydrocarbon concentrations in the subtidal, an increase in hydrocarbon degrading bacterial populations, which have the propensity to alter typical biogeochemical processes, is estimated. However, the activities of these microbial assemblages are strongly regulated by low temperatures, which will slow hydrocarbon degradation. Filter feeding invertebrates are likely to incorporate hydrocarbons from sediments and flocculants and thus would have higher concentrations than surrounding sediments. Previous studies have confirmed such

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			biomagnification. Bivalves in highly oiled bays after the Exxon Valdez spill possessed much higher concentrations of alkylated hydrocarbons. As a food source for higher trophic grazers, toxicity of bivalves could negatively impact the health of upper trophic levels from mild toxicity to more lethal outcomes. Following the Exxon Valdez spill, subtidal epifaunal invertebrate population densities and species richness decreased in highly oiled areas but recovered after 3 years. Eventual recovery of the subtidal epifauna following an open-water WCD from the LDPI is expected. Macroalgal density, biomass, and percent cover would be altered due to residual oil dispersal to the subtidal but should recover from any long-term adverse effects, based on observations of algal resilience from the Exxon Valdez spill in Prince William Sound. Oil reaching the subtidal as a result of oil displacement after a WCD during summer open water will have an immediate impact on subtidal invertebrate populations. Epilithic invertebrate populations would recover, but this process could take many years based on the slow recruitment rates of epilithic species as cited frequently in the peer-reviewed literature.
MARINE PELAGIC			
Marine Pelagic - Winter Scenario	"In the Arctic planning areas, oil could become trapped under sea ice for an extended period, where it would remain relatively unweathered and capable of being transported large	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open	If well ignition and ice are successfully used to limit oil spread and prevent contact with liquid water, the marine pelagic environment would not be contacted. Impacts would be Negligible. If not

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	distances. Oil under ice or frozen in ice could therefore degrade pelagic habitat for an extended period of time with the extent of the impacts increasing with the size of the oiled area; the largest area affected would occur with a CDE. Sea ice habitat could be degraded or lost if contact with oil spills results in lethal or sublethal effects on biota growing beneath the ice…" Minor-Moderate (Section 4.4.6.3.3)	water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.) "During the winter/spring (about 10 months) the very large oil spill would not have a measureable effect on plankton, because few are present during this time and oil would not be dispersed in the water column." Section (IX. A. 6. e.)	completely successful, impacts would be similar to those for water quality (Moderate) and invertebrates (Minor to Moderate).
Marine Pelagic - Summer Scenario	Minor-Moderate: "A CDE could potentially reduce habitat quality over potentially large areas. Pelagic organisms could be exposed to lethal or sublethal concentrations of hydrocarbons or mixtures of hydrocarbons and dispersants (if used). The effects from oil spills would depend on the size, timing, duration, and location of the spill and on various environmental factors. Pelagic habitat in nearshore areas would likely have the greatest potential for long-term contamination. Unique pelagic habitat and associated biota such as sea ice could also be affected by oil spills. …. CDE response activities such as burning, skimming, and chemical releases (e.g., dispersants or coagulants) could also affect pelagic habitat and biota. Over time, hydrocarbons in the water	"To summarize, a very large oil spill would affect half the planktonic organisms in about one half the Stefansson Sound or a total of about one quarter of Stefansson Sound plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration (12 hours) there would be only a temporary, local effect on the planktonic community. The recovery of the community would be complete within 1-2 weeks (the estimated flushing time for Stefansson Sound)." (Section IX. A. 6. e)	Minor to Major within Stefansson Sound. If well ignition and containment/in situ burning are successfully used to limit the spread of discharged oil, the areas of pelagic environment exposed would be decreased. To the extent the response is less successful; more pelagic environment would be exposed, and concentrations of hydrocarbons in the water column would increase. Exposure would be more near the oil discharge area, and less as the distance from LDPI increases, unless significant amounts of oil are allowed to accumulate along the shore line. Exposure would not be uniform. Areas of Stefansson Sound may not have any contact, while other sections may have direct contact. Impacts to the pelagic environment would be similar to those described for water quality (Moderate to Major) and invertebrates and fish

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	column would be diluted and broken down by natural processes and pelagic habitat would recover. Overall, a CDE could result in minor to moderate impacts to pelagic habitat and sea ice habitat." (Section 4.4.6.3.3)		(Moderate). Dispersants use would not be part of the summer response planning if the burning and containment/recovery scenarios were successful.
ESSENTIAL FISH HABITAT			
Essential Fish Habitat - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX.A.2)	Minor. A small amount of burn residue and oil would remain on the ice surface following cleanup. With competent ice preventing contact with liquid water, oil would not enter the water until ice begins to thaw in the spring. During break-up this oil would be gradually released into the water column mostly well offshore in the vicinity of the LDPI. While additional cleanup would be difficult under broken ice conditions, the total amount of oil would be small. High natural turbidity during the break-up period combined with wave action and broken ice would act to disperse residual oil that escaped the initial cleanup efforts. If the response strategy is successful, petroleum compound concentrations would be expected to be elevated only within limited areas where residue remains, but not be widely spread through Foggy Island Bay or in areas beyond Foggy Island Bay. All marine waters within the project area are designated as EFH for arctic cod. The small amount of oil or residue entering marine waters would have a minor impact on cod EFH. Oil entering the water following break-up and reaching shoreline areas could have an impact on freshwater EFH for

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			salmon and other anadromous species at the mouths the Sagavanirktok and Shaviovik Rivers, but such impacts would be Minor. Potential impact to EFH would be primarily limited to one open-water season.
Essential Fish Habitat - Summer Scenario	Moderate-Major: "A CDE could cause long-term declines of managed species that rely on shallow coastal, intertidal, and freshwater areas or species that are associated with sea ice. Spills occurring under ice could result in long-term degradation of EFH and managed species because of the cleanup difficulties. Managed species that suffer large losses of early life stages or long-term sublethal impacts could suffer population-level effects from a CDE. Overall, a CDE could result in moderate to major impacts on EFH, largely depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH." (Section 4.4.6.4.3)	"Essential fish habitat for salmon in Alaska could be adversely affected by a 180,000-bbl oil spill in a variety of ways. However, oil is not likely to come in contact with salmon spawning habitat or measurably affect individual salmon in the Liberty area following an oil spill caused by a blowout. If spilled oil concentrated along the coastline at the mouths of streams or rivers to which salmon seek access, the potential movements of a small number of salmon could be disrupted during migrations. Potential prey could be adversely affected. About one-quarter of the zooplankton that contact an oil-spill plume that resulted from a blowout would be adversely affected, but zooplankton populations would be expected to recover within months. If oil from an offshore spill moved into nearshore waters where potential prey fish concentrate, some individuals might be killed or experience sublethal effects including changes in growth, feeding behavior, fecundity, movements, and displacement from preferred habitat. Potential habitat could be adversely affected. Salt marshes in the Liberty area could be inundated with oil that would kill both plants and associated invertebrates and small fishes.	Moderate. An oil release during open-water conditions during the summer from the LDPI wellhead would likely result in a moderate amount of oil entering the water at the LDPI location. Standard cleanup methods would be employed to capture and/or burn as much oil as possible, the success of which would largely depend on the conditions on the sea surface at the time of the spill. The natural configuration of Foggy Island Bay combined with the presence of the Endicott Causeway suggests that most oil and any resultant impacts to fish would be contained within Foggy Island Bay. EFH for arctic cod includes all marine waters in the project area. The availability of cod habitat could be temporarily reduced as cod avoid the area to prevent direct contact with spilled oil or due to reduction in abundance of planktonic or epibenthic fish food organisms. EFH for salmon and other anadromous species might be affected if oil reached the mouths of the Sagavanirktok and/or Shaviovik rivers. Impact to freshwater EFH from a marine spill would be very limited. Spill cleanup would continue to completion and effects would likely be limited to one open-water season.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		Complete recovery of the salt marshes would be expected to take decades. The quality of water in essential fish habitat for salmon is likely to be degraded to hydrocarbon levels above State and Federal criteria at a regional level (greater than 1,000 square kilometers), but effects are not expected to persist for longer than a year. Salmon prey and prey habitat could be adversely affected further by oil-spill-response and cleanup activities." (Section IX. A. 6. c.)	
MARINE MAMMALS			
Marine Mammals - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.)	Minor to Major. Non T&E marine mammals typically are absent from the project area during winter months; therefore, it is unlikely that any would come into direct contact with the spill or be disturbed by cleanup activities (e.g., noise, the presence of large equipment). Any marine mammals in the area could be disturbed by cleanup activities; however, these disturbances would be short-term and localized. Any pinnipeds present in the area could encounter spilled oil on ice, although disturbance from cleanup activities are likely to deter animals from approaching the spill area. Because competent ice would prevent the spill from contact with liquid water and spilled oil would be removed or burned before break-up, cetaceans would not encounter spilled oil. After break-up, non-listed marine mammals could be exposed to residues that remain from burning, through direct physical contact, ingestion of

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			residue while grooming, and/or ingestion of contaminated prey. These exposures could result in severe, possibly lethal, physiological effects. Concentrations of petroleum compounds would be expected to dilute to below water quality standard limits as distance from residues increases.
Marine Mammals - Summer Scenario	Moderate-Major: "In the case of an unexpected, low-probability CDE, there is greater potential for more severe and population-level effects compared to a large oil spill (i.e., impacts could be moderate to major on one or more species of marine mammals). The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years."(Section 4.4.7.1.3)	"Most individual bowhead whales exposed to spilled oil are expected to experience temporary, nonlethal effects. Whales may suffer baleen fouling or irritated skin or sensitive tissues, or they may ingest oil or oil-contaminated prey. Exposure of bowhead whales to a very large oil spill may kill a few individuals. However, few bowhead whales are expected to die, because oil weathers very quickly and exists on the sea surface primarily as tarballs, which would be widely dispersed. [Section IX. A. 6. a (1)] If a large oil spill occurred during September and October, oil-spill-cleanup activities could disturb bowhead whales during their fall migration. There is no information available regarding bowhead disturbance from oil-spill-cleanup operations, but noise disturbance to bowheads from vessel and aircraft traffic involved with cleanup activities likely would be similar to that already described in Section III.C.3. Most oil-spill-cleanup work probably would occur inside the barrier islands, because the spill model indicates that spilled oil has a relatively low	Moderate to Major. Non T&E marine mammals are expected to be present in or near Foggy Island Bay during summer months and could be directly or indirectly affected by a WCD. Individuals that come into physical contact with oil or residues ingest oil or residues while grooming, or ingest contaminated prey could experience severe, possibly lethal, physiological effects. Non-listed marine mammals also could be disturbed by cleanup activities (e.g., mechanical removal, in situ burning) that may cause temporary threshold shifts and avoidance behavior, although these disturbances likely would be short-term and localized. Non-listed marine mammals could experience declines in prey availability or quality if local prey populations are adversely affected by the spill. Indirect impacts from food web changes could persist beyond the season of spill occurrence. Concentrations of petroleum compounds would be expected to dilute to below water quality standard limits as distance from residues increases.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		probability of reaching areas outside of the barrier islands. Some whales may be disturbed by vessel or aircraft traffic and displaced seaward if cleanup activities occurred outside the barrier islands or in the channels between the barrier islands during the whale migration. Oil-spill-cleanup activities likely would be ongoing for several seasons and likely for more than 1 year. "[Section IX. A. 6. a (1)] "A 180,000-bbl blowout oil spill could result in the oiling of several hundred to a few thousand ringed seals and a number of bearded seals and polar bears. A small number of beluga whales and maybe a few walruses could be exposed to the spill and may be affected from the exposure. The recovery of seals and polar bears could take perhaps 3-4 years and about 6-10 years, respectively. The recovery of walrus and beluga whale populations is expected within 1 year of the spill." (Section IX. A. 6. b)	
TERRESTRIAL MAMMALS			
Terrestrial Mammals - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover.	Negligible. Few caribou and muskoxen would be present; brown bears and arctic ground squirrels would be in hibernation during winter. A few arctic and red foxes could be exposed to soot from burning or residue, which could result in physiological effects that reduce survival or productivity. Terrestrial mammals may be exposed

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.)	to spilled oil through ingestion of contaminated food, inhalation of airborne mist or soot, and ingestion during grooming that may result in lethal and sublethal effects.
Terrestrial Mammals - Summer Scenario	Minor-Major: "…there is greater potential for terrestrial mammals and their habitats to be impacted compared to an assumed large oil spill. Impacts to terrestrial mammals would be minor to major. The combination of a CDE and cleanup efforts could persist beyond one season, perhaps lasting several years."(Section 4.4.7.1.3)	"A 180,000-bbl blowout oil spill, assumed for analysis, would oil coastal habitats used by caribou, muskoxen, grizzly bears, and arctic foxes. Central Arctic Herd caribou are the most likely to encounter oil from this spill. Caribou would be most exposed to the oil when some of them enter coastal waters to seek relief from insects. Several hundred caribou and small numbers of muskoxen, grizzly bears, and arctic foxes could come in direct contact with the spill and suffer injury or death. However, recovery of these populations is expected within 1 or 2 years."(Section IX. A. 6. d)	Minor. Terrestrial mammals may be exposed to spilled oil through ingestion of contaminated food, inhalation of airborne mist or soot, and ingestion during grooming that may result in lethal and sublethal effects. Exposure to soot from burning or oily residue could result in physiological effects that reduce survival or productivity. Reduced spill volumes and anticipated effective cleanup would leave little residue and small chance for exposure and contamination. Primary effects on terrestrial mammals may be disturbance from cleanup activities, which would also tend to displace caribou and muskoxen away from contaminated coastal areas, further reducing their chance of exposure.
MARINE AND COASTAL BIRDS			
Marine and Coastal Birds - Winter Scenario		Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated	Minor to Major. Marine and coastal birds typically are absent from the project area during winter months; therefore, it is unlikely that any would come into direct contact with the spill or be disturbed by cleanup activities (e.g., noise, vehicle traffic). Common ravens, snowy owls, and ptarmigan could come into direct contact with oil or be disturbed by cleanup efforts during the winter, but the number of individuals impacted

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.) "A winter spill entering the environment after the ice melts in the spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. Mortality of prey organisms could decrease the availability of food and adversely affect the ability of young waterfowl and shorebirds to develop as rapidly as they would normally or the ability of individuals to accumulate fat reserves for migration; this would be additive to the population effects of losses of oiled individuals."(Section IX.A. 6. c)	would be small. After break-up, marine and coastal birds could be exposed to persistent petroleum residues, either through direct physical contact or the ingestion of contaminated prey. If persistent petroleum residues are present in open-water leads that are used for staging by loons and waterfowl, a large number of individuals could be affected.
Marine and Coastal Birds - Summer Scenario	"The Beaufort Sea and Chukchi Sea Planning Areas provide important nesting, molting, and stopover habitat for many species of coastal and marine birds. An unexpected CDE in the Arctic has the potential to affect large numbers of birds that are already at the edge of their geographic range and are sensitive to additional stress. Spill cleanup in ice conditions would be more difficult and the cleanup process itself could displace birds from nearby habitats. Impacts to marine and coastal birds from a CDE in the Arctic planning areas are expected to be moderate to major."(Section 4.4.7.2.3)	"A 180,000-bbl oil spill, assumed for analysis, occurring in the open-water season is likely to result in the loss of thousands of brood-rearing and young waterfowl and shorebirds, if they contact stranded oil along a substantial proportion of the 322 kilometers (200 miles) of affected shoreline. In lagoon habitats, observed high densities of long-tailed ducks suggest that on some occasions, tens of thousands of molting individuals could be contacted by a spill sweeping over thousands of square kilometers, representing a significant loss from the regional population. Likewise, contact of substantial numbers of post breeding common eiders in the vicinity of barrier islands or Ross' gulls in the vicinity of Point Barrow, August through	Moderate to Major. Marine and coastal birds are present within Foggy Island Bay in sometimes-substantial numbers during the open-water season and could be affected by an unexpected WCD. Individuals that come into physical contact with oil or residues or ingest contaminated prey could experience both lethal and sublethal effects. Waterfowl and loons are at the greatest risk of coming in contact with oil because of the amount of time they spend in the water. Marine and coastal birds also could be disturbed by noise and activity associated with cleanup activities. Effects of disturbance from cleanup activities would be short-term but could result in reduced health and productivity if alternative suitable foraging areas are not available nearby. Lethal and sublethal

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		September, could result in significant losses."(Section IX. A. 6. c)	effects experienced during the season of spill occurrence could be compounded by declines in prey availability and/or quality, thereby extending the effects of a catastrophic spill beyond the season of occurrence.
FISH			
Fish - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.) "The likely effects on fishes due to a 180,000-bbl oil spill, assumed for analysis, primarily would depend on the season and location of the spill, the lifestage of the fishes (adult, juvenile, larval, or egg), and the duration of the oil contact. Due to their very low numbers, no measurable effects are expected on fishes in winter." (Section IX. A. 6. f)	Minor to Moderate. A small amount of burn residue and oil would remain on the ice surface following cleanup. With competent ice preventing contact with liquid water, oil would not enter the water until ice begins to thaw in the spring. During break-up this oil would be gradually released into the water column mostly well offshore in the vicinity of the LDPI. While additional cleanup would be difficult under broken ice conditions, the total amount of oil would be small. High natural turbidity during the break-up period combined with wave action and broken ice would act to disperse residual oil that escaped the initial cleanup efforts. If the response strategy is successful, petroleum compound concentrations would be expected to be elevated only within limited areas where residue remains, but not be widely spread through Foggy Island Bay or in areas beyond Foggy Island Bay. Potential impact to fish resources would be primarily limited to one open-water season. Impacts to fish or fish habitats would be Minor to Moderate under these circumstances.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
Fish - Summer Scenario	Minor-Moderate: "A CDE would affect a wider area, with the magnitude of the impacts depending on the location, timing, and volume of spills, distribution and ecology of affected fish species, and other environmental factors. Most adult fish are highly mobile and would likely avoid lethal hydrocarbon exposures, although they may be subjected to sublethal concentrations. Smaller species and egg and larval life stages are more likely to suffer lethal or sublethal exposures from oil contact because of their relative lack of mobility. Under most circumstances, a CDE would affect only a small proportion of a given fish population; therefore, overall population levels may not be affected. Oil contacting shoreline areas used for spawning or providing habitat for early life stages of fish could result in large-scale lethal and long-term sublethal effects on fish. In Alaskan waters, where oil may be slow to break down, coastal oiling could measurably depress some fish populations for several years. Overall, the impacts to fish from a CDE could range from minor to moderate." (Section 4.4.7.3.3)	"Effects on fishes would be more likely to occur from an offshore spill moving into nearshore waters in summer, where fishes concentrate to feed and migrate. The probability of an offshore oil spill occurring and contacting nearshore waters is low. If an offshore oil spill did occur and contacted the nearshore area, some marine and migratory fish might be harmed or killed. However, it would not be expected to have a measurable effect on fish populations, and recovery of the number of fish harmed or killed would be expected within 5 years." (Section IX. A. 6. f)	Moderate. An oil release during open-water conditions during the summer from the LDPI wellhead would likely result in a moderate amount of oil entering the water at the LDPI location. Standard cleanup methods would be employed to capture and/or burn as much oil as possible, the success of which would largely depend on the conditions on the sea surface at the time of the spill. The natural configuration of Foggy Island Bay combined with the presence of the Endicott Causeway suggests that most oil and any resultant impacts to fish would be contained within Foggy Island Bay. Important anadromous and marine fish resources occupying the nearshore brackish water zone could be affected through direct impact or through degradation of habitat. Shoreline and open-water oil cleanup efforts would be continued to completion and finished prior to freeze-up. Potential impact to fish resources would be primarily limited to one open-water season. Impacts to fish or fish habitats would be Moderate under these circumstances.
INVERTEBRATES AND LOWER TROPHIC LEVELS			
Invertebrates & Lower Trophic Levels - Winter Scenario	Discharge and response on competent ice not considered separately.	"Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in	Minor. A small amount of burn residue and oil would remain on the ice surface following cleanup. With competent ice preventing contact with liquid water, oil would not enter the water until ice begins to thaw in the spring. During break-up this

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.) "During the winter/spring (about 10 months) the very large oil spill would not have a measureable effect on plankton, because few are present during this time and oil would not be dispersed in the water column."(Section IX. A. 6. e)	oil would be gradually released into the water column mostly well offshore in the vicinity of the LDPI. While additional cleanup would be difficult under broken ice conditions, the total amount of oil would be small. High natural turbidity during the break-up period combined with wave action and broken ice would act to disperse residual oil that escaped the initial cleanup efforts. If the response strategy is successful, petroleum compound concentrations would be expected to be elevated only within limited areas where residue remains, but not be widely spread through Foggy Island Bay or in areas beyond Foggy Island Bay. Because of the small amount of oil and rapid dilution, the concentration of petroleum compounds within the water column and in bottom sediments would be low. Impact to planktonic or benthic organisms would be minor and temporary.
Invertebrates & Lower Trophic Levels - Summer Scenario	Up to Moderate: "A CDE would likely contact shoreline areas, and benthic invertebrates in sensitive intertidal and shallow subtidal habitats could experience large-scale lethal and long-term sublethal effects. In Alaska, local populations of intertidal organisms affected by such large spills could be measurably depressed for several years and oil could persist in shoreline sediments for decades. However, a CDE is unlikely to occur, and benthic and pelagic invertebrates typically have short generation times and should recover. Invertebrates	"To summarize, a very large oil spill would affect half the planktonic organisms in about one half the Stefansson Sound or a total of about one quarter of Stefansson Sound plankton. Because of their wide distribution, large numbers, and rapid rate of regeneration (12 hours) there would be only a temporary, local effect on the planktonic community. The recovery of the community would be complete within 1-2 weeks (the estimated flushing time for Stefansson Sound)." (Section IX. 6. A. e)	Moderate. An oil release during open-water conditions during the summer from the LDPI wellhead would likely result in a moderate amount of oil entering the water at the LDPI location. Standard cleanup methods would be employed to capture and/or burn as much oil as possible, the success of which would largely depend on the conditions on the sea surface at the time of the spill. The natural configuration of Foggy Island Bay combined with the presence of the Endicott Causeway suggests that most oil and any resultant impacts to marine invertebrates would be

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	associated with hard-bottom kelp communities could also be affected and, if so, recovery of the community could be long-term. Oil from a CDE occurring under ice is more difficult to locate and clean than surface spills and may have more persistent effects on water column and sea ice-associated invertebrates. Overall, impacts to invertebrates from a CDE could range up to moderate. "(Section 4.4.7.5.3)	"This very large oil spill assumed for purposes of analysis could contact all of the Stefansson Sound coastline. It could have lethal and sublethal effects on coastal and benthic communities within the affected area. The recovery of seasonal invertebrates would be expected within 2 months, but fractions of the oil might remain in shoreline sediments for up to 10 years."(Section IX. A. 6. e)	contained within Foggy Island Bay. Planktonic and/or benthic resources could be affected through lethal or sublethal toxicity with greatest effects likely occurring within the important nearshore brackish zone where water is shallow and invertebrate abundance is high. Shoreline and open-water oil cleanup efforts would be continued to completion and finished prior to freeze-up. Effects of such a spill would likely be limited to one season.
AREAS OF SPECIAL CONCERN			
Areas of Special Concern - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.)	There are no designated Areas of Special Concern in Stefansson Sound/Foggy Island Bay, so there would be no impact.
Areas of Special Concern - Summer Scenario	Minor-Moderate: "Should oil from a CDE reach an Area of Special Concern, the impacts would depend on the location and size of the spill, the type of product spilled, weather conditions, the type of area affected, the effectiveness of cleanup operations, and other environmental conditions at the time of the spill. Although a	Not a category addressed.	If well ignition and containment/in situ burning are successfully used to limit the spread of discharged oil, no Area of Special Concern identified by BOEM 2012 would be contacted. There are no designated areas of special concern in Stefansson Sound/ Foggy Island Bay. If there is no contact impacts

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	CDE is unexpected, if oil from a CDE were to reach an Area of Special Concern, coastal habitats and fauna, as well as subsistence use, could be negatively affected. Based on monitoring data following the Exxon Valdez spill, oil in some coastal habitats would likely persist for multiple years. Overall, a CDE could result in up to moderate effects on Areas of Special Concern."(Section 4.4.8.3)		would be Negligible.
POPULATION, EMPLOYMENT, AND INCOME			
Population, Employment, and Income - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.) "In the event a very large oil spill occurred (180,000-bbl), the subsequent cleanup would generate approximately 3,000 jobs for 1-2 years, declining to zero by the third year following the spill. Disruptions to the harvest of subsistence resources would affect the economic well-being of North Slope Borough residents primarily through the direct loss of	Impacts of accidental oil spills could include the short-term loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision; and possible shortages of commodities or services. In the short term, the impacts of a spill would also include projected cleanup expenditures and employment created in cleanup and remediation activities. Longer-term employment and income impacts could occur if fishing and/or tourism were to suffer due to the real or perceived impacts of the spill. A successfully contained WCD would have Minor to Moderate impacts.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		subsistence resources."(Section IX. 6. A. k)	
Population, Employment, and Income - Summer Scenario	Minor-Moderate: "CDE could result in the loss of employment, income, and possible shortages of commodities or services in both coastal and inland areas affected by the spill. Losses of property value could also occur in coastal communities, with increased cost of local public service provision also possible. In the short term, impacts of a CDE, measured in terms of projected cleanup expenditures and the number of people employed in cleanup and remediation activities, would be expected to be large. Longer-term impacts would likely be small, unless recreational activities and tourism suffered as a result of the real or perceived impacts of the event, or if there were substantial changes to energy production in the region as a result of the accidental spill; this would be more likely in the event of a CDE spill. Overall, the impacts of a CDE would be between minor to moderate." (Section 4.4.9.3).	"In the event a very large oil spill occurred (180,000-bbl), the subsequent cleanup would generate approximately 3,000 jobs for 1-2 years, declining to zero by the third year following the spill. Disruptions to the harvest of subsistence resources would affect the economic well-being of North Slope Borough residents primarily through the direct loss of subsistence resources." (Section IX. 6. A. k)	Impacts of accidental oil spills could include the short-term loss of employment, income, and property value; increased traffic congestion; increased cost of public service provision; and possible shortages of commodities or services. In the short term, the impacts of a spill would also include projected cleanup expenditures and employment created in cleanup and remediation activities. Longer-term employment and income impacts could occur if fishing and/or tourism were to suffer due to the real or perceived impacts of the spill. A successfully contained WCD would have Minor to Moderate impacts.
LAND USE AND INFRASTRUCTURE			
Land Use and Infrastructure - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover.	Negligible – Coastal and marine uses of the project area during winter are minimal. The primary effect would be the exclusion of winter research operations and winter oil and gas exploration activities from the area affected by the spill during the response period.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.)	
Land Use and Infrastructure - Summer Scenario	Major*: "In the unlikely event of a low-probability CDE within the Arctic, moderate to major impacts to land use, development patterns, and infrastructure would be expected. Impacts would be greater in areas with little infrastructure in place to handle accidents and where a greater reliance is placed on coastal activities for subsistence. There is limited existing infrastructure in place in the Arctic to be able to address this type of event; consequently, impacts of an unexpected CDE to land use would likely be greater in the Arctic than in the GOM and Cook Inlet Planning Areas."(Section 4.4.10.3) **BOEM did not directly designate this impact level. It was determined using BOEM's test on Land Use and Infrastructure Statement "greater than in Cook Inlet or GOM", where Cook Inlet was "not expected to be major. Moderate is the impact level below Major."*	Not directly considered.	Moderate to Major: A summer spill scenario would likely have a Moderate to Major impact on coastal and marine uses of the project area. Although coastal and marine uses of the project area are minimal, the length of a spill response will affect the extent of the impact due to exclusion of normal uses of the project area from the area of spill response. Primarily, tourism and vessel traffic would be affected as these activities would be prohibited from the affected area of the spill. It is unlikely that a summer WCD event and response would affect onshore activities, and onshore/ coastal activities, such as recreational use of the Kadleroshilik River, would be negligibly affected unless near the coast. Oil remaining after the initial response to a WCD would have a negligible effect on onshore activities such as recreational use of the Kadleroshilik River.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
COMMERCIAL AND RECREATIONAL FISHERIES			
Commercial and Recreational Fisheries - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.)	Commercial and recreational fisheries could suffer due to the real or perceived impacts of an oil spill. Overall, impacts on fishing from a spill are expected to be Minor to Moderate. See impacts to fish.
Commercial and Recreational Fisheries - Summer Scenario	Moderate: "In the event of a CDE, fisheries recoveries could be impacted on a manner similar to that from a large spill. However, a larger proportion of a fish population could be affected, and impacts could be much more long-term on duration. Overall, impacts on commercial and recreational fishing from a CDE are expected to be moderate. "Section 4.4.11.3)	Not a category considered.	Commercial and recreational fisheries could suffer due to the real or perceived impacts of an oil spill. Overall, impacts on fishing from a spill are expected to be Minor to Moderate. See impacts to fish.
TOURISM AND RECREATION			
Tourism and Recreation - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover.	Tourism could suffer due to the real or perceived impacts of an oil spill. Overall, impacts on tourism from a spill are expected to be Minor to Moderate.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.)	
Tourism and Recreation - Summer Scenario	Minor-Moderate: "The effects of an unexpected CDE would likely include beach and coastal access restrictions; restrictions on visitation, fishing, or hunting while cleanup is being conducted; and aesthetic impacts associated with the event itself and with cleanup activities. A CDE could result in minor to moderate impacts. These impacts are expected to be temporary, with the magnitude dependent on the location and size of the event and the effectiveness of cleanup operations. Longer-term impacts may also be substantial if tourism were to suffer as a result of the real or perceived impacts of the event, or if there were substantial changes to tourism and recreation sectors in the region as a result of the event." (Section 4.4.12.3.2.)	Not directly considered.	Tourism could suffer due to the real or perceived impacts of an oil spill. Overall, impacts on tourism from a spill are expected to be Minor to Moderate.
SOCIOCULTURAL/SUBSISTENCE			
Sociocultural/ Subsistence - Winter Scenario	Discharge and response on competent ice not considered separately.	Overall effects from a very large oil spill on subsistence harvest patterns in the area around the communities of Nuiqsut and Kaktovik would be significant, because one or more important subsistence resources could become unavailable. This would result from their:	The potential effects of a major oil spill on subsistence activities would be Moderate to Major. If such a spill were to occur in the winter, the scope and scale of cleanup activities could affect or even effectively cancel the following fall Cross Island subsistence whale hunt, either through the need to continue physical cleanup

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		• displacement, • undesirability for use from contamination or perceived tainting, • reduced numbers or their pursuit becoming more difficult because of increased hunter effort, and • increased risk or cost for a period of 1-2 years. Biological effects to subsistence resources might not affect species distributions or populations, but disturbance could extend the subsistence hunt in terms of miles to be covered, making more frequent and longer trips necessary to harvest enough resources in a harvest season. The loss of waterfowl populations to oil spills would cause harvest disruptions that would be significant to subsistence hunters who regard the spring waterfowl hunt to be of primary importance. In the event of a large spill contacting and extensively oiling habitats, the presence of hundreds of humans, boats, and aircraft would increase the displacement of subsistence species and alter or reduce access to subsistence species by subsistence hunters. (Section IX.A.6.h) "Oil spill contact in winter could affect polar bear hunting." (Section IX. A. 6.h.) "BPXA's Oil Discharge Prevention and Contingency Plan … includes four scenarios for cleaning up oil in	activities in the area or through the perception of contaminated or tainted subsistence resources. The perception of tainted resources could possibly persist over several years, depending on the size of the spill and the perceived success (or not) of the cleanup effort. It is likely that due to the location of Liberty that these effects would be limited to the Cross Island bowhead whale hunt. Social institutions in Nuiqsut would be stressed and current problems would be exacerbated, but the social fabric of the community should be able to cope with them in an adaptive way – although disruptive effects would still be major. The cleanup effort would be far from any population centers and would be relatively distant from major subsistence use areas for all resources and communities except for Nuiqsut bowhead whale hunting. While a large oil spill has major adverse effects, it may provide some local and temporary employment opportunities.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		open water, solid ice, and broken ice. … Spill cleanup would reduce the amount of oil in the environment and tend to mitigate spill effects." "… oil-spill cleanup activities more likely should be viewed as additional impacts, causing displacement of subsistence resources and subsistence hunters and employment disruptions." (Section IX. A. 6.h.)	
Sociocultural/ Subsistence - Summer Scenario	Major: "The greatest impacts would occur in the unlikely event of a low-probability CDE. The impacts of a CDE would be most serious if the release occurred during a whale migration and affected the migration route. Contact with oil could result in the deaths of some individual animals. Native harvesters would perceive surviving oiled whales as tainted and would be hesitant to harvest them. A reduction in whale stock could result in the IWC reducing or eliminating whale quotas in the entire Alaskan Arctic. The deaths of a large number of birds is possible and, if breeding populations were affected, could result in a serious reduction of the availability of waterfowl to subsistence harvesters all along the Pacific Flyway. Intertidal breeding populations could be decimated, resulting in a long recovery period. Anadromous fishes could be hard hit. In general, the impacts of such an unlikely spill would be major not only for the villages along the northern coast, but for all communities that depend on the sea mammals, fish, and birds that migrate to or	"The effects of a very large oil spill on sociocultural systems would cause chronic disruption to sociocultural systems for a period of 1-2 years, with a tendency for additional stress on the sociocultural systems but without a tendency toward the displacement of existing institutions."(Section IX.6.A.i)	The potential effects of a major oil spill on subsistence activities would be Moderate to Major. The cleanup activities would probably disrupt at least one Cross Island bowhead whale season, due to the need for a great deal of vessel traffic in the area, and thus prevent any harvest during the cleanup. If a cleanup extended over several years, it would disrupt several seasons. This would have major effects on Nuiqsut for those years. These effects would not extend to other whaling communities unless the spill was large enough that it affected the viability and continued growth of the bowhead whale population. In that case, all whaling communities could be greatly affected. The perception of contamination or tainting of bowheads whales due to their passage through or near an oil spill could extend to several years. Such widespread effects for other subsistence resources do not seem as likely, but are possible. A large oil spill could adversely affect fish stocks and would certainly raise contamination concerns, so

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	through the Chukchi and Beaufort Seas and their shores. An unexpected CDE would prove challenging for existing response capacity and capability, especially if the spill were under ice or in broken ice. The cleanup process itself has the potential to cause displacement of subsistence resources and subsistence hunters, and would have major impacts in the short term depending on the timing and duration of the displacement. The associated influx of cleanup workers is likely to overwhelm the resources of local communities and could result in cross-cultural conflicts."(Section 4.4.13.3)		effects could be Moderate to Major for Nuiqsut. These effects would also be felt by those individuals and communities with trading relations with Nuiqsut. The potential effect on migratory bird stocks would be less than discussed in BOEM 2012, due to the limited geographic scope of the Liberty Development, compared to the 5-year leasing plan. Social institutions in Nuiqsut would be stressed and current problems would be exacerbated, but the social fabric of the community should be able to cope with them in an adaptive way – although disruptive effects would still be major. The cleanup effort would be far from any population centers and would be relatively distant from major subsistence use areas for all resources and communities except for Nuiqsut bowhead whale hunting. While a large oil spill has major adverse effects, it may provide some local and temporary employment opportunities.
ENVIRONMENTAL JUSTICE			
Environmental Justice - Winter Scenario	Discharge and response on competent ice not considered separately.	Behavior of a Blowout Oil Spill on Solid Ice. Oil would drain from the gravel island to the solid sea ice and would fall to the solid sea ice in a scattered pattern. No oil would enter open water….There would be little or no change in the oil's physical properties at very low temperature when buried under snow cover. Blowing snow would tend to combine with pooled oil, until the oil is effectively saturated	Due to the long distance from Native communities, the environmental justice impacts are most closely associated with effects on subsistence resources and activities in the Liberty area, which are discussed above (Sociocultural/Subsistence).

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		with snow crystals. The oil would not penetrate the ice surface." (Section IX. A. 2.) "If a spill occurred, oil-spill contact in winter could affect polar bear hunting and sealing."(Section IX. 6. A. h)	
Environmental Justice - Summer Scenario	Moderate-Major: "A CDE could have moderate to major impacts on low-income and minority communities, although the magnitude of impacts of a CDE would depend partly on the location, size, and timing of the event, and many of the long-term impacts of a CDE on low-income and minority communities are unknown. Long-term impacts on subsistence resources may be expected, however, and these may lead to longer and greater environmental justice impacts. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations."(Section 4.4.14.3)	"Alaska Iñupiat Natives, a recognized minority, are the predominant residents of the North Slope Borough, the area potentially most affected by Liberty Development. Effects on Iñupiat Natives could occur because of their reliance on subsistence foods, and Liberty Development may affect subsistence resources and harvest practices. Potential effects would be experienced by the Iñupiat community of Nuiqsut, and possibly Kaktovik, within the North Slope Borough. In the unlikely event that a large oil spill occurred and contaminated essential whaling areas, major effects could occur when impacts from contamination of the shoreline, tainting concerns, cleanup disturbance, and disruption of subsistence practices are factored together." (Section III. D. 12)	Due to the long distance from Native communities, the environmental justice impacts are most closely associated with effects on subsistence resources and activities in the Liberty area, which are discussed above (Sociocultural/Subsistence).
ARCHAEOLOGICAL AND HISTORIC RESOURCES			
Archaeological and Historic Resources - Winter Scenario Resources	Discharge and response on competent ice not considered separately.	Discharge and response on competent ice not considered separately.	Negligible to Major. If oiled ice reaches the shoreline, then mechanical removal, either before or after break-up, could potentially impact coastal historic and archaeological sites. As noted in previous studies (MMS 2002c; BOEM 2012), the

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			greatest effects to coastal historic and prehistoric archaeological resources are likely to result from cleanup activities. Impact levels would be dependent on the extent of shoreline cleanup operations. If the initial response strategy is successful, minimal or no impact to historic and archaeological resources would result.
Archaeological and Historic Resources - Summer Scenario	Minor-Major: "In the event of a CDE that is not expected, some impacts could occur on coastal historic and prehistoric archaeological resources. Although it is not possible to predict the precise numbers or types of sites that would be affected, contact with archaeological sites would probably be unavoidable, and the resulting loss of information would be irretrievable. The magnitude of the impacts would depend on the number of resources affected and on the significance and uniqueness of the information lost. Impacts can result from both direct contact with oil and from cleanup operations. Based on experience gained from the Exxon Valdez oil spill, some impacts from direct contact with oil from even a CDE are expected, and additional impacts are expected during cleanup activities. Response actions associated with a CDE have the greatest potential for adversely affecting archaeological and historic resources. Impacts from a CDE could range from minor to major. In the event of a CDE, many resources would likely be affected. There is a greater likelihood that more of the	"The greatest effects to onshore archaeological sites would be from cleanup activities resulting from accidental oil spills. The most important understanding from past cleanups of large oil spills is that the spilled oil usually did not directly affect archaeological resources (Bittner 1993). The State University of New York at Binghamton evaluated the extent of petrochemical contamination of archaeological sites as a result of the Exxon Valdez oil spill (Dekin 1993). Researchers concluded that the three main types of damage to archaeological deposits were oiling, vandalism, and erosion, but fewer than 3% of the resources would suffer significant effects."	Minor to Major. Physical disturbance from cleanup equipment could potentially impact coastal historic and archaeological sites. As noted in previous studies (MMS 2002c; BOEM 2012), the greatest effects to coastal historic and prehistoric archaeological resources are likely to result from cleanup activities. Impact levels would be dependent on the extent of shoreline cleanup operations. If the initial response strategy is successful, minimal or no impact to historic and archaeological resources would result.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	resources would be affected at a major level during a CDE."(Section 4.4.15.3		
CLIMATE CHANGE			
Climate Change - Winter Scenario	The impact of a winter spill on climate change is not specifically addressed. BOEM indicates that 43-year total Beaufort and Chukchi Sea Program GHG emissions would be 10,660,000 tons total, or 247,907 tons per year. This represents 0.0037 percent of total 2009 US GHG emissions. BOEM goes on to say that "given the small percentage of contributions of oil and gas activities in Arctic region to global GHG emission, the potential impact on climate change would probably be small."(Section 4.4.4.3)	The impact of a winter spill on climate change is not specifically addressed. MMS Section III.D.10 indicates that "activities associated with exploration, development, and production of oil and gas resources from the Outer Continental Shelf (OCS) program result in emission of GHGs, but there is uncertainty in the magnitude of the emissions. MMS further indicates that "the incremental contribution of greenhouse gases from the proposed OCS program are negligible when compared to the total greenhouse emissions contributions, they cannot be expected to have a significant effect on climate change."	The projected GHG emissions from a winter WCD would be 1,648,616 tons per year. This represents 0.02 percent of nationwide GHG emissions in 2010 (6,810,000,000 tons per year). While this is a larger percentage than considered previously by BOEM and MMS, it is still Negligible compared to nationwide emissions and even less significant compared to global emissions.
Climate Change - Summer Scenario	The impact of a summer spill on climate change is not specifically addressed. BOEM indicates that 43-year total Beaufort and Chukchi Sea Program GHG emissions would be 10,660,000 tons total, or 247,907 tons per year. This represents 0.0037 percent of total 2009 US GHG emissions. BOEM goes on to say that "given the small percentage of contributions of oil and gas activities in Arctic region to global	The impact of a summer spill on climate change is not specifically addressed.	The projected GHG emissions from a summer WCD would be 239,128 tons per year. This represents 0.0035 percent of nationwide GHG emissions in 2010 (6,810,000,000 tons per year). Due to the smaller volume of oil discharge, the summer GHG emissions are lower. GHG emissions of this magnitude would be Negligible.

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
	GHG emission, the potential impact on climate change would probably be small."(Section 4.4.4.3)		
THREATENED AND ENDANGERED SPECIES (MARINE MAMMALS)			
Threatened and Endangered Species (Marine Mammals)- Winter Scenario	Discharge and response on competent ice not considered separately.	Discharge and response on competent ice not considered separately.	Moderate to Major. Of the T&E mammal species potentially occurring in or near Foggy Island Bay, only ringed seals and polar bears are present during winter months. Both species could encounter spilled oil on ice, but the potential for direct contact is low because of immediate spill response. Cleanup activities (e.g., burning of oil on ice) are likely to deter most animals from approaching, although polar bears can find spilled petroleum hydrocarbons attractive, causing them to be at increased risk to spill exposure and to hazing. Because competent ice would prevent the spill from contact with liquid water, marine mammals would not encounter spilled oil while in the water. Any marine mammals in the area could be disturbed by cleanup activities, which could cause temporary threshold shifts and avoidance behavior; however, these disturbances would be short-term and localized. Denning polar bears and pupping ringed seals are particularly sensitive to disturbance and could abandon dens and offspring. After break-up, T&E marine mammals could be exposed to remaining spill residues, either through direct physical contact or ingestion of contaminated prey. These exposures could result in severe, possibly lethal, physiological

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			effects. For young of the year, exposure to toxins could be especially detrimental because physiological impacts are size-dependent. Concentrations of petroleum compounds would be expected to be elevated in areas where residues persist. Petroleum compounds would be expected to dilute to below water quality standards as distance from residues increases.
Threatened and Endangered Species (Marine Mammals)-Summer Scenario	Not considered separately	"Most individual bowhead whales exposed to spilled oil are expected to experience temporary, nonlethal effects. Whales may suffer baleen fouling or irritated skin or sensitive tissues, or they may ingest oil or oil-contaminated prey. Exposure of bowhead whales to a very large oil spill may kill a few individuals. However, few bowhead whales are expected to die, because oil weathers very quickly and exists on the sea surface primarily as tarballs, which would be widely dispersed." "If a large oil spill occurred during September and October, oil-spill-cleanup activities could disturb bowhead whales during their fall migration. There is no information available regarding bowhead disturbance from oil-spill-cleanup operations, but noise disturbance to bowheads from vessel and aircraft traffic involved with cleanup activities likely would be similar to that already described in Section III.C.3. Most oil-spill-cleanup work probably would occur inside the barrier islands, because	Moderate to Major. Bearded seals, ringed seals, polar bears, and bowhead whales are expected to be present in or near Foggy Island Bay during summer months and could be directly or indirectly affected by an unexpected WCD. Potential impacts would be greatest for ringed seals and bearded seals because they are the two species most likely to occur in the immediate vicinity of the LDPI and pipeline. Polar bears are less common in Foggy Island Bay during the summer, and most bowhead whales remain offshore of the barrier islands. T&E marine mammals that come into physical contact with oil or residues, ingest oil or residues while grooming or feeding, and/or ingest contaminated prey could experience severe, possibly lethal, physiological effects. Individuals also could be disturbed by cleanup activities (e.g., mechanical removal, in situ burning) that may cause temporary threshold shifts and avoidance behavior, although these disturbances would be short-term and localized. T&E marine mammals could experience declines in prey availability and/or quality if local prey populations are

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		the spill model indicates that spilled oil has a relatively low probability of reaching areas outside of the barrier islands. Some whales may be disturbed by vessel or aircraft traffic and displaced seaward, if cleanup activities occurred outside the barrier islands or in the channels between the barrier islands during the whale migration. Oil-spill-cleanup activities likely would be ongoing for several seasons and likely for more than 1 year." A 180,000-bbl blowout oil spill could result in the oiling of several hundred to a few thousand ringed seals and a number of bearded seals and polar bears. A small number of beluga whales and maybe a few walruses could be exposed to the spill, and may be affected from the exposure. The recovery of seals and polar bears could take perhaps 3-4 years and about 6-10 years, respectively. The recovery of walrus and beluga whale populations is expected within 1 year of the spill."	adversely affected by the spill. Indirect impacts from changes to food webs could persist beyond the season of spill occurrence. Concentrations of petroleum compounds would be expected to be elevated in areas where residues persist. Petroleum compounds would be expected to dilute to below water quality standards as distance from residues increases.
Threatened and Endangered Species (Marine Birds)- Winter Scenario	Spill cleanup in ice conditions would be more difficult and the cleanup process itself could displace birds from nearby habitats. Impacts to marine and coastal birds from a CDE in the Arctic planning areas are expected to be moderate to major."	"A winter spill entering the environment after the ice melts in the spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. Mortality of prey organisms could decrease the availability of food and adversely affect the ability of young waterfowl and shorebirds to develop as rapidly as they would normally or the ability of	Negligible. Steller's eiders, spectacled eiders, and yellow-billed loons typically are absent from the project area during the winter; therefore, it is unlikely that any of these species would come into direct contact with the spill or be disturbed by cleanup activities (e.g., noise, vehicle traffic). After break-up, Steller's eiders, spectacled eiders, and yellow-billed loons could be exposed to persistent

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
		individuals to accumulate fat reserves for migration; this would be additive to the population effects of losses of oiled individuals." A spill occurring in winter and released in spring could contact loons and other migrant waterfowl concentrated in open water near river deltas. For species such as the yellow-billed loon, with relatively small populations and low productivity, this could represent a significant loss. Because there is no clear population trend in the coastal plain population, and there is a lack of certain data required to model population fluctuations, an estimate of recovery time from such a loss currently would be too speculative to be meaningful. Also, losses may be difficult to separate from natural variation in population numbers."	petroleum residues through either direct physical contact or ingestion of contaminated prey. If persistent petroleum residues are present in open-water leads that are used for staging by eiders and loons, a small number of individuals could be affected through direct contact with residues.
Threatened and Endangered Species (Marine Birds)- Summer Scenario	"The Beaufort Sea and Chukchi Sea Planning Areas provide important nesting, molting, and stopover habitat for many species of coastal and marine birds. An unexpected CDE in the Arctic has the potential to affect large numbers of birds that are already at the edge of their geographic range and are sensitive to additional stress. ….the cleanup process itself could displace birds from nearby habitats. Impacts to marine and coastal birds from a CDE in the Arctic planning areas are expected to be moderate to major."	"A 180,000-bbl oil spill, assumed for analysis, occurring in the open-water season is likely to result in the loss of thousands of brood rearing and young waterfowl and shorebirds, if they contact stranded oil along a substantial proportion of the 322 kilometers (200 miles) of affected shoreline."	Moderate to Major. Steller's eiders, spectacled eiders, and yellow-billed loons are present within Foggy Island Bay during the open-water season and could be affected by an unexpected WCD. Individuals that come into physical contact with oil or residues or ingest contaminated prey could experience lethal or sublethal effects. Steller's eiders, spectacled eiders, and yellow-billed loons also could be disturbed by noise and activity associated with cleanup activities. Effects of disturbance from cleanup activities would be short-term but could result in reduced health and productivity if alternative suitable foraging areas

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			are not available nearby. Lethal and sublethal effects experienced during the season of spill occurrence may be compounded by declines in prey availability or quality, thereby extending the effects of a catastrophic spill beyond the season of occurrence.
VISUAL			
Visual - Winter Scenario	Discharge and response on competent ice not considered separately.	Discharge and response on competent ice not considered separately.	A wellhead fire intended to destroy the majority of the released oil would be the most noticeable change in the visual environment from the spill and spill response activities. The plume of smoke may be obscured by the dark winter sky. This flame would be visible within the foreground-middle ground and background distance zones from the native allotments and would attract the viewer's attention from these locations. The flame would be visible as a glow on the horizon within the seldom-seen zones from the communities of Prudhoe Bay and Deadhorse and from the portion of Dalton Highway within the study area. The sensitivity of Prudhoe Bay and Deadhorse oilfield workers to changes in the visual landscape of an industrialized nature are considered low. Impacts to these viewers would be considered Negligible-to-Minor. Assuming all but the residues from the spill would be recovered successfully prior to break-up, and

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			the spill would be contained to ice in the immediate vicinity of Liberty Island darkness during the winter months would obscure the spilled oil from viewers. Lights from equipment involved in spill response activities would be visible within the foreground-middle ground and background distance zones from the native allotments; but, these lights would blend with the lights from drilling activities on LDPI and would therefore be unlikely to create a noticeable change in the visual environment. In summary, visual impacts from the winter spill scenario on whalers would be considered Negligible, impacts to users of native allotments are unknown, and impacts to Prudhoe Bay and Deadhorse oilfield workers and users of the portion of Dalton Highway within the study area would be considered Negligible-to-Minor.
Visual - Summer Scenario	Not directly considered.	Not directly considered.	Whalers, which are considered to have a high sensitivity to changes in the visual environment, would be expected to actively avoid hunting in areas with a visible sheen and in areas where spill response activities are visible. The visual impacts of the summer spill scenario on whalers would be considered Moderate-to-Major. The spill and spill response activities could potentially also be visible from the native allotments within the study area. Given the existing industrial traffic within the foreground-

Table 4.3-2. Comparison of Liberty-Specific and BOEM's/MMS's Impact Conclusions – 30 Day WCD Scenario

RESOURCE	BOEM 2012 PROGRAMMATIC EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	MMS 2002 LIBERTY DEVELOPMENT EIS IMPACT CONCLUSION (EFFECTIVENESS OF A RESPONSE NOT INCLUDED)	LIBERTY DEVELOPMENT EIA IMPACT CONCLUSION (INCLUDES EFFECTIVENESS OF RESPONSE STRATEGY)
			middle ground and background zones from the native allotments, the contrast of the mechanical recovery portion of the spill response activities with the existing visual environment would be Negligible. A wellhead fire intended to destroy the majority of the released oil would potentially be the most noticeable change in the visual environment from the spill and spill response activities. Impacts to Prudhoe Bay/Deadhorse viewers, depending on their sensitivity to industrial sights would be considered Negligible-to-Minor. In summary, visual impacts from the summer spill scenario on whalers would be considered Moderate-to-Major, impacts to users of native allotments are unknown, and impacts to Prudhoe Bay and Deadhorse oilfield workers and users of the portion of Dalton Highway within the study area would be considered Negligible-to-Minor.

Key: APDES = Alaska Pollutant Discharge Elimination System; bbl = barrel; BOEM = Bureau of Ocean Energy Management; CDE = catastrophic discharge event; CO = carbon monoxide; CWA = Clean Water Act; DWH = Deepwater Horizon; EFH = Essential Fish Habitat; EIS =Environmental Impact Statement; EPA = U.S. Environmental Protection Agency; ft = feet; GHG = greenhouse gas; GOM = Gulf of Mexico; HAP = hazardous air pollutant; km = kilometer; km^2 = square kilometer; LDPI = Liberty Drilling Island; mi = mile; mi^2 = square mile; MMS = Minerals Management Service; NO_2 = Nitrogen dioxide; NOAA = National Oceanic and Atmospheric Administration; NPDES = National Pollutant Discharge Elimination System; OCS = Outer Continental Shelf; PM = particulate matter; ppm = parts per million; SDI = Endicott Satellite Drilling Island; SO_2 = sulfur dioxide; T&E = threatened and endangered; VOC = volatile organic compounds; WCD = worst-case discharge.

4.4 CUMULATIVE EFFECTS

The purpose of the cumulative effects analysis is to identify potential effects from the Proposed Project that, when in combination with effects from other existing or proposed projects in the region, may cumulatively become significant. An analysis of cumulative effects is required by the National Environmental Policy Act (NEPA) and, for the purposes of this document, the definition of cumulative impacts comes from 40 CFR 1508.7 whereby:

> A cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.
>
> To determine the scope of environmental impact statements, agencies shall consider… cumulative actions, which when viewed with other proposed actions have cumulatively significant impacts and should therefore be discussed in the same impact of the Arctic Outer Continental Shelf (OCS) were recently analyzed in the Oil and Gas Leasing Program: 2012-2017 Final Programmatic EIS (BOEM 2012). NOAA (2013a) and USACE (2012a) also recently analyzed the effects of onshore and offshore oil and gas activities on the North Slope of Alaska and in adjacent State of Alaska and OCS waters. These analyses are incorporated by reference and summarized below for the central Beaufort Sea and coastal North Slope of Alaska, as well as updated to identify any potential activities that may occur in this area during the life of the proposed Liberty Development.

4.4.1 Spatial and Temporal Scope of the Analysis

The geographic area evaluated in this cumulative effects analysis includes the onshore area east of Teshekpuk Lake, west of the Arctic National Wildlife Refuge, and north of 70° latitude, extending seaward to include both State waters shoreward and the federal waters in the Beaufort Sea Planning Area OCS 2012 to 2017 lease areas (**Figure 4.4.1-1**; BOEM 2012). The geographic area is greater for the at-sea portion of this cumulative impact analysis because of the large geographic range of most marine mammals in the project area and, subsequently, subsistence hunters.

Reasonably foreseeable future actions addressed in the analysis of cumulative effects include all currently identified proposals for new development, and an estimate of potential exploration and development associated with recent and presently proposed lease sales. This cumulative analysis includes future oil and gas activities expected to occur within the next 30 to 40 years. Beyond that timeframe, activities are considered speculative. Past, present, and reasonably foreseeable future oil and gas activities in the Central Beaufort Sea are listed in **Table 4.4-1**. The offshore exploration and development scenario for the OCS Program Beaufort Sea cumulative case and OCS 5-Year Program is listed in **Table 4.4-2**.

4.4.2 Impact Sources

Activities that would contribute to cumulative impacts within the central Beaufort Sea include: oil and gas exploration, development, and production; marine vessel traffic; air traffic; scientific research; military facilities and training exercises; major community development projects; subsistence; recreation and tourism; and climate change.

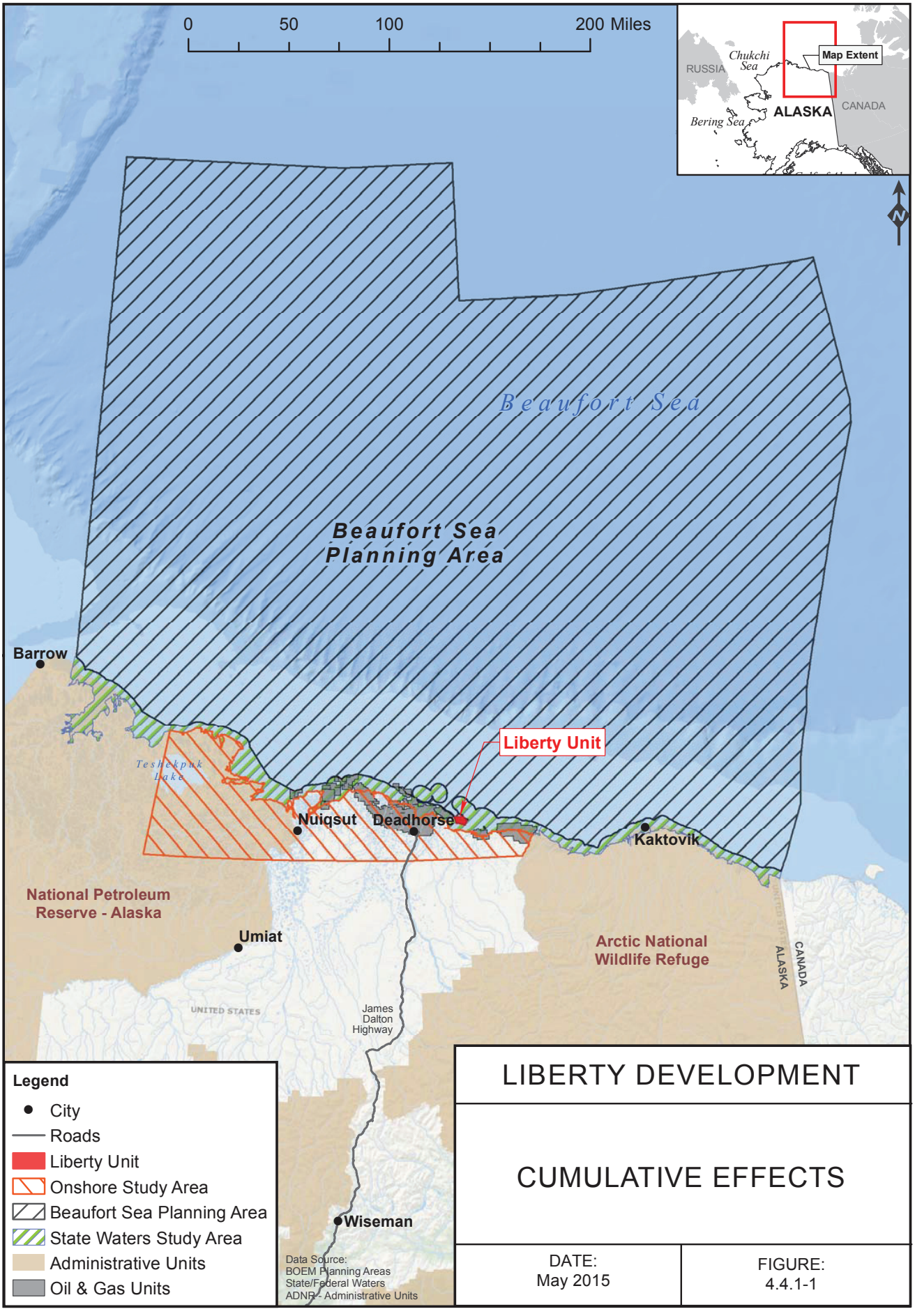

0
50
100
200 Miles
Map Extent
RUSSIA
Chukchi Sea
ALASKA
CANADA
Bering Sea
N
Beaufort Sea
Beaufort Sea Planning Area
Barrow
Liberty Unit
Teshekpuk Lake
Nuiqsut
Deadhorse
Kaktovik
National Petroleum Reserve - Alaska
Umiat
Arctic National Wildlife Refuge
ALASKA
CANADA
UNITED STATES
James Dalton Highway
Wiseman
Legend
City
Roads
Liberty Unit
Onshore Study Area
Beaufort Sea Planning Area
State Waters Study Area
Administrative Units
Oil & Gas Units
Data Source:
BOEM Planning Areas
State/Federal Waters
ADNR - Administrative Units
LIBERTY DEVELOPMENT
CUMULATIVE EFFECTS
DATE:
May 2015
FIGURE:
4.4.1-1

Table 4.4-1. Past, Present, and Reasonably Foreseeable Future Oil and Gas Activities in the Central Beaufort Sea

ACTION/PROJECT[1]	ACTIVITIES	TIMING OPEN WATER	TIMING WINTER	PAST	PRESENT	FUTURE
Badami Unit	Production currently 1,500 barrels of oil per day, pipeline to Endicott, additional exploration ongoing, winter sea ice-road access.	X	X	X	X	X
Colville River Unit	Includes: Alpine Participating Area (PA), Nanuq Kuparuk PA, Nanuq Nanuq PA. Qannik PA, Fiord Nechelik PA, Fiord Kuparuk PA. Alpine (CD-1, CD-2), Fjord (CD3), Nanuq (CD4). Currently producing, pipeline to Kuparuk, overland annual ice road access, aircraft traffic. Alpine West (CD-5)-Construction began in 2014; drilling operation to begin mid 2015; potential sealift activity and overland ice road access.	X	X	X	X	X
Qugruk Unit	Repsol drilling two appraisal wells into the Qugruk prospect (Q5 and Q-7) and one exploration well (Tuttu 1.)		X	X	X	X
Greater Mooses Tooth (GMT) Unit and Bear Tooth Unit – NPR-A	GMT 1 (previously known as Alpine Satellite CD6) in early permitting stages for 33-well capacity gravel pad connected to CD-5 by gravel road. Drilling at Rendezvous 3 and Flattop 1 in winter 2014.		X	X	X	X
Duck Island Unit	Includes: Eider PA, Sag Delta North PA, and Endicott PA. Currently producing offshore production facility, pipeline and vehicle access to Prudhoe Bay via causeway.	X	X	X	X	X
Kuparuk River Unit	Includes: Kuparuk PA, Meltwater PA, NorthEast/West Sak PA, Tabasco PA, Tarn PA, and West Sak PA. Currently producing, pipeline and road access from Prudhoe Bay. Start of Mustang production in late 2014. Permitting a 24-well 2S pad, production at Shark Tooth to begin in late 2015. Currently permitting for NE West Sak 1H pad production in 2017.	X	X	X	X	X
Southern Miluveach Unit	Start of Mustang production targeted for late 2014.		X	X	X	X
Milne Point Unit	Includes: Kuparuk PA, Sagavanirktok River PA, Schrader Bluff PA. Currently producing, access by road system from Prudhoe Bay.	X	X	X	X	X
Northstar Unit	Currently producing offshore production facility, buried pipeline to onshore.	X	X	X	X	X

Table 4.4-1. Past, Present, and Reasonably Foreseeable Future Oil and Gas Activities in the Central Beaufort Sea

ACTION/PROJECT[1]	ACTIVITIES	TIMING OPEN WATER	TIMING WINTER	PAST	PRESENT	FUTURE
Prudhoe Bay Unit	Includes: Aurora PA, Borealis PA, Combined Niakuk PA, Gas Cap PA, Lisburne PA, Midnight Sun PA, N. Prudhoe Bay PA, Oil Rim PA, Orion PA, Point McIntyre PA, Polaris PA, Raven PA, West Beach PA. Currently producing, pipeline and road access, central North Slope processing facilities. Northern terminus of Trans-Alaska Pipeline System.	X	X	X	X	X
Nikaitchuq Unit	Includes: Schrader Bluff PA. Currently producing from onshore production facility at Oliktok Point, pipeline to Kuparuk; currently drilling from constructed offshore artificial island at Spy Island, pipeline to shore.	X	X	X	X	X
Oooguruk Unit	Includes Jupark PA, Nuiqsut PA, Torok PA. Currently producing offshore production facility, buried pipeline to onshore. Nuna development expected to commence in 2014.	X	X	X	X	X
Point Thomson Unit	Exploratory drilling completed, gas cycling with production to begin as early as 2015, onshore pipeline to Badami, barge, air, and ice road access.	X	X	X	X	X
OCS Exploration	Sivulliq Prospect and Torpedo Prospect Shell originally had plans to drill four exploration wells in Camden Bay, two wells at the Sivulliq prospect and two wells at the Torpedo prospect. Shell was forced to constrain its 2012 operations to drilling of the initial 1,500 feet of its Arctic wells after its oil spill containment system was damaged. Shell does not currently have plans to resume exploration in the Beaufort Sea. A new Beaufort Sea OCS Lease Sale is currently scheduled for 2017.	X		X		X
Exploration – State Land and Water	Programs vary and change. Previously drilled sites may be re-evaluated when conditions change, including advanced technology, new reservoir information, improved access, or more-favorable production economics. Exploration wells have been completed in the Liberty Development area in the past (e.g., Red Wolf). There are no known applications for future exploration in this area. The Alaska Department of Resources, Division of Oil and Gas deferred 11 lease tracts, totaling approximately 28,000 acres from the 2013 North Slope and Beaufort sea areawide lease sale to make acreage available for long-term production testing of onshore gas hydrates. These tracts may be deferred again in 2014.	X	X	X	X	X

Table 4.4-1. Past, Present, and Reasonably Foreseeable Future Oil and Gas Activities in the Central Beaufort Sea

ACTION/PROJECT[1]	ACTIVITIES	TIMING OPEN WATER	TIMING WINTER	PAST	PRESENT	FUTURE
Seismic surveys, geophysical/geological surveys	Typically short term activity, within designated areas. Current/future activities include: West Canning 3-D survey; Great Bear and Niksik 3-D surveys, Cronus 3-D survey, and Schrader Bluff 3-D seismic survey. Nigliq-Fjord and Big Bend 3-D surveys planned during 2014 season. Recent activity in the Liberty Project area includes seismic, geohazard, and geophysical surveys in 2013 and 2014.	X	X	X	X	X
Alaska Commercial Gas Project	Large multi-year sealifts delivering processing modules and pipeline to West Dock; construction of large gas processing plant; construction of large-diameter gas pipeline.	X	X			X

Note:
1. This listing is not all inclusive, but represents major known oil and gas activities considered in evaluating cumulative effects.
Key: GMT = Greater Mooses Tooth; NPR-A = National Petroleum Reserve—Alaska; OCS = Outer Continental Shelf; PA = Participating Area.

Table 4.4-2. Offshore Exploration and Development Scenario for the OCS Program Beaufort Sea Cumulative Case and OCS 5-Year Program

SCENARIO ELEMENTS	BEAUFORT SEA	
	CUMULATIVE CASE	OCS 5-YEAR PROGRAM
Years of activity Oil (million barrels – Mbbl) Gas (trillion cubic feet – Tcf)	40–50 500–1,100 0–5.75	40–50 200–400 0–2.2
Platforms	2–10	1–4
Exploration and delineation wells	12–40	6–16
Platform production wells	90–310	40–120
Subsea production wells	20–25	10
New offshore pipelines (miles)	50–423	30–155
New onshore pipelines (miles)	40–290	10–80
Service vessel trips/week	2–30	1–12
Helicopter trips/week	2–30	1–12
New pipeline landfalls	0	0
New shore bases	0	0
New waste facilities	2–4	0
New natural gas processing facilities	2–4	0
Docks/causeways	2–4	0
Exploration wells: muds, cuttings, produced water	425 tons dry mud with 80% recycled; 525 tons dry rock cuttings, totaling 610 tons discharged at each well site.	
Development wells: muds, cuttings, produced water	All muds, cuttings, and produced-water treated and disposed of in wells.	
Bottom Area Disturbed (acres): Platforms Pipelines based on 1.7 to 15 acres per platform and 1.2 to 4 acres per mile of pipeline	 7–37 173–1,470	 4–15 104–536
Surface Soil Disturbed (acres): Pipelines Onshore construction based on 18 acres per mile of pipeline	717–4,510	173–1,443

Source: BOEM 2012.

4.4.2.1 Oil and Gas Activities

The primary source of industrial development in the project area is due to oil and gas development. Oil and gas production contributes to cumulative effects on air and water quality, subsistence, economic development, and marine mammals. Most of the previous oil and gas developments have occurred on the North Slope of Alaska and in the nearshore waters of the Beaufort Sea. Exploration activities for oil and gas have also occurred over the last 60 years in the project area, but the impacts from exploration activities tend to be limited in duration and occur in the immediate vicinity of exploration activities and transportation support routes unless they lead to the development of a project (NOAA 2013a). The North Slope and coastal Beaufort Sea of Alaska currently has 35 fields and satellites producing oil with additional discoveries under development, particularly in the OCS of the Chukchi and Beaufort seas (BOEM 2012). Past, present, and reasonably foreseeable future oil and gas activities in the project area that have or may contribute to cumulative effects are listed in Table 4.4-1. Activities like seismic surveys, geophysical/geological surveys, and exploration drilling change over time and are not individually listed.

From the perspective of cumulative effects, multiple exploration activities that may occur over a large geographic area raise concerns about disturbance to fish and wildlife. Up to a 7.8-mile radius around each drill site was estimated to be exposed to continuous sounds ≥120 decibels (dB) re 1 µPa rms for Shell's Kulluk exploration drilling rig in Camden Bay (NOAA 2012). Thus, the potential geographic extent of exploration activities, along with associated air and vessel traffic, could potentially have sound-producing activities occurring across much of the range of many marine mammal species (NOAA 2013a). In addition, cumulative interference from multiple oil and gas projects with subsistence hunting is also of concern to North Slope Natives (NOAA 2013a).

4.4.2.2 Marine Vessel Traffic

The greatest contributors of anthropogenic sound to the Beaufort Sea during the Proposed Project would most likely be from marine vessels (Shell 2011). Vessel traffic in the project area currently consists primarily of traffic to support oil and gas industries, barges or cargo vessels that supply coastal villages, research vessels, smaller vessels for subsistence and local transportation during the open-water season, military vessel traffic, and recreational vessels such as cruise ships and a limited number of ocean-going sailboats (NOAA 2013a).

Marine vessel traffic in the Arctic Ocean is growing rapidly with the thinning and retreat of the ice pack. The eastern Beaufort Sea would have increased tug and barge traffic for fuel supply and infrastructure development, increased oil and gas exploration, eco-tourism, mining, and subsistence activities (USCG 2013). The total number of vessels in the Arctic doubled from approximately 120 vessels in 2008 to 250 vessels in 2012 (USCG 2013). Due to the increased vessel traffic, the U.S. Coast Guard (USCG) anticipates having an increased presence in the Arctic in the future.

4.4.2.3 Aircraft Traffic

The oil and gas industry uses helicopters and fixed-wing aircraft to support routine activities within the project area. This would contribute to aircraft traffic and the noise associated with it that already occur in the project area. Currently at least four companies operate passenger and air cargo services between North Slope communities and population centers, flying inland and along the coast (NOAA 2013a). Arctic coastal communities and government agencies and researchers typically use small commuter-type aircraft for the majority of air travel and freight hauling between villages. The level of aircraft traffic within the project area is likely to increase during the life of the Proposed Project as a result of climate change and/or increased industrial activity and community development.

4.4.2.4 Scientific Research

Numerous scientific research programs operating from marine vessels and aircraft take place in offshore areas of the Beaufort and Chukchi seas each year. Research activities may contribute to cumulative effects by causing disturbance of marine mammals and impacts to subsistence harvest through marine vessel and aircraft traffic, and disturbance of bottom sediment through sampling. Other research activities that may contribute to cumulative effects in the marine environment include deployment of oceanographic equipment for collecting water and sediment samples, and use of nets and trawls for collection of phytoplankton, zooplankton, benthic invertebrate, pelagic invertebrate, and fish sampling. Some, but not all, of these activities could coincide in time and space with the project area. **Table 4.4-3** identifies research studies that have been and continue to be pursued in the central Beaufort Sea (NOAA 2013a).

Table 4.4-3. Past, Present, and Reasonably Foreseeable Future Scientific Research Activities in the Central Beaufort Sea

ACTION/PROJECT	ACTIVITIES	TIMING OPEN WATER	TIMING WINTER	PAST	PRESENT	FUTURE
NOAA Aerial Surveys of Arctic Marine Mammals[1]	Aerial surveys to document distribution and relative abundance of marine mammals in the Alaskan Beaufort and northeastern Chukchi Seas.	X		X	X	X
USFWS Aerial Polar Bear Surveys	Aerial surveys to document polar bear population and locations. From Barrow to demarcation point.	X		X	X	X
Industry Maternal Polar Bear Den Surveys	Aerial and ground based surveillance for polar bear dens.		X	X	X	X
Bowhead satellite tagging study[2]	Aircraft and vessel traffic; satellite telemetry study of bowhead use of Beaufort and Chukchi Seas.	X		X		
BOEM Environmental Studies Program[3]	Numerous field studies using small and/or large vessels or aircraft to collect data or samples of sea water, fish, invertebrates, marine mammals, birds, and sediments.	X	X	X	X	X
OFC Arctic Stock Assessment (e.g., movement of ringed seals, Beaufort belugas)	Vessel traffic.	N/A	N/A		X	X

Notes:

1. NOAA 2014a.
2. ADF&G (http://www.wildlife.alaska.gov/index.cfm?adfg=marinemammals.bowhead).
3. BOEM 2014.

Key: BOEM = Bureau of Ocean Energy Management; N/A = not available; NOAA = National Oceanic and Atmospheric Administration; OFC = Office of the Federal Coordinator (for Alaska Natural Gas Transportation Projects); OCS = Outer Continental Shelf; USFWS = U.S. Fish and Wildlife Service.

Source: Updated from NOAA 2013a.

4.4.2.5 Military

Military activity is anticipated to increase in the Arctic in the foreseeable future. Military activities in the project area include the transit of aircraft overflights as well as marine vessels and submarines through area waters, and training-related maneuvers (NOAA 2013a). Potential military activities that may occur in the Beaufort Sea during the life of the Proposed Project are listed in **Table 4.4-4**. Military activities could contribute to cumulative effects through the disturbance of marine mammals, effects to the subsistence harvest, and the potential degradation of water quality through marine fuel spills (NOAA 2013a).

4.4.2.6 Community Development Projects

Currently, the NSB is conducting upgrades for the airport and village power distribution grid at Nuiqsut, and fuel pipeline upgrades at Kaktovik (NSB 2014; http://north-slope-procurement.com/). It is possible that either major infrastructure projects, such as the construction of boat harbors, or minor projects, such as the construction of schools or laundry and showering facilities, may occur during the life of the Proposed Project. Information about large infrastructure projects in the NSB is contained in their Capital Improvement Program. Construction of these projects would likely cause increased amounts of noise and disturbance in coastal areas, as well as increased marine and aircraft traffic in the project area. Potential cumulative effects to marine mammals and subsistence harvest may result from this increase in marine and air traffic (NOAA 2013a).

4.4.2.7 Subsistence

Subsistence is essential to the livelihood of many Alaskan Native communities and other rural residents. Subsistence activities occur in both the terrestrial and marine portions of the project area and typically involve the use of snowmachines and boats for access. Marine mammals may thus be affected by disturbance from boat and snowmachine traffic in addition to mortality from harvest. Current and past subsistence resources in the project area include bowhead whales, beluga whales, bearded, ringed and spotted seals, walrus, polar bear, birds/eggs, caribou, moose, brown bear, small mammals, freshwater fish, berries, roots, and plants (NOAA 2013a). Future subsistence activities for communities in the project area are anticipated to remain at current levels (NOAA 2013a).

4.4.2.8 Recreation and Tourism

Recreation and tourism activities in the project area include tourist buses on the shore in Prudhoe Bay, cruise ships and ecotours on marine vessels in small numbers, as well as sport fishing and hunting activities. Ecotourism vessels recently began operating in the Chukchi Sea; 12 adventurers in 2009, increasing to 17 in 2010 (Colvin 2011, cited in NOAA 2013a). If the open-water season increases, as is currently predicted by climate change, it is likely that the presence of recreation and tourism ships may increase in the Beaufort Sea in the future. Recreational marine traffic could contribute to potential cumulative effects through increased disturbance of marine mammals and impacts to subsistence harvest (NOAA 2013a).

Table 4.4-4. Past, Present, and Reasonably Foreseeable Future Military Activities in the Central Beaufort Sea

CATEGORY	AREA	ACTION/PROJECT	ACTIVITIES	TIMING OPEN WATER	TIMING WINTER	PAST	PRESENT	FUTURE
Military	Eastern Beaufort Sea Coastal - Barter Island	Distant Early Warning (DEW) Line Sites	Radar site still active, aircraft traffic, barge traffic	X	X	X	X	X
	Central Beaufort Sea Coastal - Bullen Point Short Range Radar Site		Aircraft traffic, barge traffic	X	X	X	X	X
	Central Beaufort Sea Coastal -Flaxman Island Short Range Radar Site		Demolition complete			X		
	Submarines	Arctic Submarine Laboratory has historically conducted various arctic activities (http://www.csp.navy.mil/asl/Timeline.htm) locations unknown.	Vessel traffic, sonar impacts, ship strikes	X	X	X	X	X
	U.S. Coast Guard icebreakers	*Healy* and *Polar Sea* icebreakers	Vessel traffic, potential ships strikes, icebreaking	X	X	X	X	X
	Overflights	North American Aerospace Defense Command (NORAD) Elmendorf Air Force Base	Aircraft traffic	X	X	X	X	X

Source: NOAA 2013a.

4.4.2.9 Climate Change

Greenhouse gas emissions trap heat in the atmosphere and contribute to global climate change. The Earth's average temperature has risen by 1.4°F over the past century, and temperatures are projected to rise another 2°F to 11.5°F over the next century (EPA 2013b). Greenhouse gas emissions from the project would result from the direct combustion of fossil fuels by North Slope facilities, the combustion of fuels during the transport and refining of produced oil, and the ultimate combustion of the oil produced as a fuel from this project. However, the projected GHG emissions from the Liberty Development are small, as shown in Table 4.1.1-2, and the Liberty Development would contribute minimal impact to climate change. The incremental contribution of projected GHG emissions from the Liberty Development is negligible for the United States in 2010, (Table 4.1.1-2). Thus, the Liberty Development would add a minimal incremental contribution to climate change.

Currently, the Arctic environment is changing at an unprecedented rate. Temperatures across Alaska have warmed twice as fast as the continental United States during the past 50 years (EPA 2013b). The impacts of climate change on the North Slope of Alaska can already be seen. These impacts include: coastal erosion, sea ice retreat, permafrost melt, ocean acidification, and increased storm intensity. These changes have been attributed to rising carbon dioxide (CO_2) levels in the atmosphere and corresponding increases in CO_2 levels in the waters of the world's oceans. Increased concentrations of CO_2 in sea water causes an increase in the acidity of sea water, which may result in reduced calcification rates of calcifying organisms such as corals, mollusks, algae, and crustaceans (EPA 2013b). Ocean acidification in the Arctic Ocean is occurring at a more advanced rate compared with oceans at lower latitudes due to the increase in open-water surface area from loss of sea ice.

Impacts of climate change could contribute to cumulative effects by shortening the drilling seasons, potentially extending the life of project. Climate change could also indirectly increase the number of marine vessels in the project area: as climate change progresses, the season ice roads are operable may shorten, creating an increase use in marine vessel traffic. The longer open-water season may also contribute to increased marine traffic by enhancing the economic viability of ecotourism, oil and gas development, and/or fishing opportunities in the project area. In addition to increased vessel traffic, climate change may cause changes to the habitat, behavior, distribution, and populations of wildlife within the project area (NOAA 2013a). These changes, or changes in the access to wildlife resources, would correspondingly impact subsistence resources.

4.4.3 Conclusion

Table 4.4-5 presents the conclusions from BOEM's cumulative analysis for the Arctic OCS Program, which takes into account the effects of past, present, and reasonably foreseeable future actions and trends affecting resources in the Arctic region (BOEM 2012). Past and present actions are generally accounted for in the baseline environment and the analysis of direct and indirect impacts under each resource area. Direct and indirect impact descriptions use the same four-level classification scheme presented at the beginning of Section 4 and in Section 4.3: **negligible**, **minor**, **moderate**, and **major**.

The incremental contribution to cumulative effects of routine construction and operational activities of the Liberty Development to each resource are evaluated for comparison. The incremental contributions of the 2012 to 2017 OCS Arctic Region Program (BOEM 2012), and the proposed Liberty Development are characterized in terms of **none** (**no**), **small**, **medium**, or **large** and take into account effects from routine operations and expected accidental events and spills. Use of the comparative terms "small," "medium," or "large" is the same system used by BOEM to describe the incremental contribution of the proposed 5-year OCS lease sale program to the potential cumulative effects of all past, present, and reasonably foreseeable future actions in the Alaska Arctic Region (BOEM 2012, p. 4-

952). The Liberty Project is only one element of the 5-year OCS leasing program; therefore, the term “none” was added for those cases when the relative contribution of the Liberty project to the overall cumulative effect is negligible.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
Water Quality	Factors affecting the water quality in the Beaufort Sea include marine vessel traffic, wastewater discharge, oil and gas production (currently only in State waters), and military operations. Water quality is also affected by numerous other factors, including river inflows, mining, and municipal waste discharges. Cumulative impacts on water quality are attributed to a combination of all these factors and, overall, are considered to be **moderate**. Impacts related to marine vessel traffic in the Beaufort Sea (especially shipping and research vessels, icebreakers, and cruise ships) would likely increase in the coming decades as the open-water season begins earlier and ends later (an effect of climate change).	The incremental contribution of routine operations under the OCS Program would be **small** to **medium**. Compliance with NPDES permits and USCG regulations would reduce the magnitude of most impacts. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would depend upon weather and sea conditions at the spill site, the type of oil spilled, the depth of the spill event, and the volume and rate of spillage; therefore, the incremental contribution of expected oil spills to cumulative water quality impacts could range from **small** to **large**.	The incremental contribution of routine operations under the Liberty Development would be **small**. No drilling wastes would be discharged into the marine environment. Although total suspended solids concentrations would be significantly increased during construction of the drilling island and subsea pipeline, these increases would be temporary. Effluent limits and compliance with general NPDES and APDES permit conditions ensure federal and State water quality standards provisions of the CWA are met. Incremental contribution of expected oil spills to cumulative water quality impacts could range from **small** to **large**.
Air Quality	The Arctic region has a low population. The primary industrial emissions in the region are associated with the oil and gas industry, power generation, small refineries, paper mills, and mining. Currently, the North Slope Borough is designated as an unclassified/attainment area for all criteria pollutants. The region does experience air pollution problems (e.g., Arctic haze), however, due to long-range transport of air pollutants from industrial parts of northern Eurasia and North America. Overall, cumulative impacts on air quality in the Arctic over the next 40 to 50 years are expected to be **minor** to **moderate**.	The incremental contribution of routine operations under the OCS Program would be **small** because they would not significantly increase onshore airborne pollutants or affect visibility. The effects of expected accidental oil spills (most of which are less than 1,000 bbl) would be localized and temporary due to dispersion; therefore, the incremental contribution of expected oil spills to cumulative air impacts could range from **small** to **medium**.	The incremental contribution of routine operations under the Liberty Development would be **small** because they would not significantly increase airborne pollutants or affect visibility. Incremental contribution of expected oil spills to cumulative air impacts could range from **small** to **medium**.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
Acoustic Environment	Arctic waters are a unique acoustic environment mainly because of the presence of ice, which can contribute significantly to ambient sound levels (e.g., ice cracking generates noise; ice deformation generates low-frequency noise). Ambient levels of natural sound can vary dramatically between and within seasons. During open-water season, wind and waves are important sources of ambient sounds. The main sources of anthropogenic noise are aircraft overflights, marine vessel traffic, oil and gas activities (including seismic surveys and production operations), human settlements, and military activities. The quality of the acoustic environment in the Beaufort Sea would continue to be adversely affected by ongoing and future non-OCS program activities and by future OCS program activities (currently there are no existing OCS activities, although seismic studies and exploratory drilling have been conducted in the past). The magnitude of cumulative impacts in the Beaufort Sea is time-specific and location-specific and could range from **minor** to **major**, depending on the ambient acoustic conditions and the nature and combination of noise sources from all OCS and non-OCS activities.	The contribution of routine operations under the OCS Program to cumulative impacts could range from **small** to **medium** and would vary with time and location, and would depend on the characteristics of the noise sources present. The incremental increase in adverse acoustic environmental impacts from expected accidental oil spills in Arctic waters (mainly due to noise sources associated with response and cleanup) would be localized and temporary; therefore, the incremental contribution of expected oil spills (most of which are less than 1,000 bbl) to cumulative noise-related impacts would be **small**.	The largest contributions to noise would result from the LDPI and subsea pipeline construction. Construction, drilling and production of the Liberty Development would result in **minor** noise impacts, and the incremental contribution to noise-related impacts would be **small**. The incremental contribution of noise-related impacts from expected oil spills (most of which are less than 1,000 bbl) would be localized and temporary and would be **small**.
Barrier Beaches and Dune	Arctic coastal habitats are greatly influenced by a short growing season and extremely cold winters; onshore sediments are underlain by permanently frozen soil (permafrost). They are also greatly affected by the dynamics of sea ice,	Routine operations under the OCS Program would result in **minor** localized impacts primarily due to facility construction, pipeline trenching and landfalls, channel dredging, and marine vessel traffic. The contribution of the	Routine operations under the Liberty Development would result in **negligible** localized impacts to barrier beaches and dunes from construction vehicles and marine vessel traffic. The incremental contribution of the Liberty

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	which dominates coastal habitats during most of the year. The Arctic coastline is highly disturbed due to the movement of sea ice that frequently is pushed onshore, scouring and scraping the coastline. The effects of climate change on Arctic habitats are also significant. These include decreases in sea ice cover, warming of permafrost, a longer growing season, and changes in precipitation. Portions of the coast have experienced considerable erosive losses (up to 1,500 feet) over the past few decades; the erosion rate in areas of the Beaufort Sea coast more than doubled between 1955 and 2005. Projections for future climate change indicate that these changes are expected to continue. Cumulative impacts on barrier beaches and dunes result from factors that increase erosion of beach and dunes, such as disturbance of dune vegetation or beach and dune substrates. Increases in wave action also contribute to the erosion of beaches. Accidental oil spills may also affect these resources. While there are no past or ongoing OCS activities in the Beaufort Sea Planning Area (other than exploratory drilling), other ongoing and future actions/trends that affect beaches and sand dunes include those related to State oil and gas development, marine vessel traffic, coastal development, and climate change. These activities can be reasonably expected to continue into the future. Cumulative impacts on coastal and estuarine habitats in the Arctic	OCS Program to cumulative impacts on beaches and dunes, therefore, would generally be **small** to **medium**. The incremental impacts of expected accidental oil spills associated with the OCS Program would be **small** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to particular habitats; and the timing and nature of spill containment and cleanup activities. The majority of these spills would be small (less than 50 bbl) and most of them would not likely contact and affect coastal and estuarine habitats. Large oil spills (1,000 bbl or greater) have the greatest potential to affect extensive areas of shoreline and coastal and estuarine habitats. Although these are rare events, the impacts of such releases on coastal habitats could range from **moderate** to **major** if they were to occur.	Development to cumulative impacts on beaches and dunes would be **none** to **small**. No permanent facilities would be sited in beach or dune habitats. The incremental impacts of expected accidental oil spills could range from **small** to **large** depending on the location, timing, duration, and size of the spill; proximity to coastal habitats; and timing and nature of spill containment and cleanup activities.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	region are considered to be **moderate**.		
Benthic and Pelagic Habitats	Cumulative impacts on marine benthic and pelagic habitats in the Arctic region result from any activities that disturb ocean bottom or marine habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply of biota depending on these resources. Ongoing and future actions/trends that affect these resources include oil and gas activities in State waters, commercial shipping (including tankers), dredging and disposal of dredging spoils in OCS waters, and anchoring. State oil and gas activities and future OCS activities could affect seafloor and pelagic habitats; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. Accidental oil spills are also among these actions. Cumulative impacts on benthic and pelagic habitats in the Arctic region are considered to be **moderate** to **major**.	Routine operations under the OCS Program in the Arctic region could result in impacts from ground disturbance during drilling and pipeline and platform placement, as well as the discharge of drilling muds and cuttings and produced water (sensitive habitats could have long-term affects depending on their proximity to these activities). The incremental contribution to cumulative impacts on marine benthic habitats would range from **none** to **medium** and would be limited by existing mitigation measures. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) would range from **none** to **small**, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Large spills (1,000 bbl or greater) would also depend on these factors, and could result in **minor** to **moderate** impacts if they were to occur.	The incremental contribution of the Liberty Development on benthic habitat would include approximately 24 acres of habitat permanently impacted by gravel fill and 10 to 38 acres of benthic habitat temporarily impacted by pipeline installation. The permanently impacted benthos is 2.5 times the benthos estimated to be impacted by platforms in the OCS 5-year program. Total impacted benthos (temporary and permanently) would be less than 13% of that estimated for the OCS 5-year Program. This is considered a small contribution to cumulative impact. Pelagic impacts would be limited to the island structure above the mudline. The maximum impact of the island structure to the pelagic habitat would be approximately 24 acres plus undefined minor current changes. These impacts are considered negligible and would result in negligible to minor cumulative impacts. The incremental impacts of expected accidental oil spills on benthic habitats (most of which are less than 1,000 bbl) would range from **none** to **small** depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic habitat contacted by oil. Large spills (1,000 bbl or greater) would also depend on these factors and could result in **minor** to **moderate** impacts if they were to occur.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
Essential Fish Habitat (EFH)	Cumulative impacts on EFH in the Arctic region result from any activities that kill managed fish species, disturb ocean-bottom habitats, increase sediment suspension (turbidity), degrade water quality, or affect the food supply for fishery resources. Ongoing and future actions/trends that affect these resources include subsistence fishing, commercial shipping (including tankers and other marine vessels), coastal modifications, hardrock mining, dredging and disposal operations, anchoring, and climate change. Commercial fishing does not occur in the Beaufort Sea Planning Area. Sport fishing in the Arctic region is currently a minor activity but could increase if regulations change and warming temperatures allow an increase in marine vessel traffic. State oil and gas activities and future OCS activities could affect EFH; these include the generation of noise, well drilling, pipeline placement, subsea production well and platform placement, and routine discharges. The incremental impacts of accidental oil spills would be **small** to **large**, depending on spill location, timing, duration, and size. Cumulative impacts on EFH in the Arctic region are considered to be **moderate** to **major**.	Routine operations under the OCS Program in the Arctic region could result in **moderate** short- and long-term impacts to EFH and managed species, mainly as a result of bottom disturbance during the placement of pipelines and production platforms. The incremental contribution to cumulative impacts on EFH would be **none** to **medium** and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from **none** to **medium** depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH.	Routine operations from the Liberty Development would result in **negligible** to **minor** short- and long-term localized impacts to EFH and managed species as a result of disturbance from island construction, pipeline trenching and burial, and expansion at the SDI. The incremental contribution to cumulative impacts on EFH would be **small** and would be limited by specific lease stipulations. The incremental impacts of expected accidental oil spills on EFH (most of which are less than 1,000 bbl) would range from **none** to **medium** depending on the size of the spill, its location, environmental factors, and the uniqueness of the affected EFH.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
Marine Mammals	Ongoing and future activities or phenomena that affect marine mammals include oil and gas development in State waters; vessel traffic; commercial, recreational, and subsistence fishing; marine mammal subsistence harvests; pollution (and marine debris); development; climate change (including temporal and spatial changes in sea ice); diseases; and natural catastrophes. The incremental impacts of accidental oil spills would be **small** to **large**, depending on spill location, timing, duration, and size. Cumulative impacts on marine mammals in the Arctic region are considered to be **minor** to **moderate**.	Routine oil and gas-related activities (e.g., seismic surveys, facility construction, normal operations and, eventually, decommissioning) would result in **minor** to **moderate** impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution of OCS Program activities to cumulative impacts would be **none** to **small**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be **none** to **large**, depending on the location, timing, and volume of the spills; the environmental settings of the spills; and the species exposed to the spills. Spill response activities (e.g., vessel traffic, in situ burning, and the use of dispersants) could add to these impacts.	Construction, normal operations, and eventual decommissioning of the Liberty Development would result in **negligible** to **moderate** impacts on marine mammals. Impacts on marine mammals from these activities could include physical injury or death; behavioral disturbances; and loss of a small area of reproductive, nursery, feeding, and resting habitats. The contribution of Liberty Development activities to cumulative impacts on marine mammals would be **none** to **small** and would be minimized by regulatory requirements under the MMPA. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) would be **none** to **small**, with spill response activities potentially adding to impacts.
Terrestrial Mammals	There are about 30 species of terrestrial mammals in the Arctic region. These include brown bear, caribou, muskox, Arctic fox, brown lemming, and wolverine, among others. Ongoing and future activities or phenomena that affect terrestrial mammals include State oil and gas development, aircraft and vehicle traffic; coastal and community development, timber harvests, hunting; pollution, climate change; and natural catastrophes. Cumulative	Routine oil and gas-related activities (e.g., facility construction including onshore pipelines, normal operations including vehicle and aircraft traffic and, eventually, decommissioning) would result in **minor** impacts on terrestrial mammals. Impacts on terrestrial mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects; and loss of reproductive, nursery, feeding, and resting habitats. The contribution	Most routine activities for the Liberty Development would occur offshore at the LDPI, SDI, and at Endicott. **Moderate** impacts on terrestrial mammals would occur during construction of the mine site and from traffic during construction and routine project operations. Impacts on terrestrial mammals from these activities could include physical injury or death; behavioral disturbances; lethal or sublethal toxic effects from fuel spills; and

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	impacts on terrestrial mammals in the Arctic region are considered to be **minor** to **moderate**.	of OCS Program activities to cumulative impacts would be **none** to **small**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) on terrestrial mammals would be **none** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; the timing and nature of spill containment; and the status of the affected animals. Spill response activities (e.g., vessel traffic, in situ burning, and the use of dispersants) could add to these impacts.	the loss of reproductive, nursery, feeding, and resting habitats. The contribution of Liberty Development activities to cumulative impacts on terrestrial mammals would be **small**. The incremental impacts of expected accidental oil spills (most of which are less than 1,000 bbl) on terrestrial mammals would be **none** to **medium**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and other important habitats; and the timing and nature of spill containment. Spill response activities could add to these impacts.
Marine and Coastal Birds	Most of the birds occurring in the Arctic region are migratory, being present for all or part of the period between May and early November. Cumulative impacts result from direct injury or mortality of marine and coastal birds due to collisions with onshore and offshore structures, ingestion of trash or debris, or exposure to discharges or emissions; loss or degradation of habitat due to coastal development, climate change, or construction and operations activities; and behavioral disturbance due to commercial and recreational boating and small aircraft traffic. Many bird species are currently experiencing a loss or degradation of habitat due to land development and climate change, and these impacts are expected to continue into the foreseeable future. Ongoing and future actions/trends that affect marine and coastal	Routine operations may result in localized short-term impacts due to infrastructure construction and marine vessel and aircraft traffic. The contribution of the OCS Program to cumulative impacts on marine and coastal birds therefore would be **none** to **medium**. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the OCS Program on marine and coastal birds would be **small** to **large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Spill response activities (e.g., vessel traffic, in situ burning, and the use of dispersants) could add to these impacts.	Routine operations would primarily occur offshore at the LDPI, SDI, and at Endicott, and may result in localized short-term impacts due to marine vessel and aircraft traffic. Construction would primarily occur during the winter when most birds are not present. Habitat loss would include tundra nesting habitat for a new gravel mine, and marine benthic and pelagic foraging habitats for the LDPI. Project-related impacts to birds from the Liberty Development would be **negligible** to **moderate**. The incremental contribution of the Liberty Development to cumulative impacts on marine and coastal birds would be **small**. The incremental contribution of expected accidental spills (most of which are less than 1,000 bbl) associated with the OCS Program on marine and coastal birds would be **small** to

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	birds include those related to oil and gas development in State waters, coastal development, vessel traffic, and climate change. Cumulative impacts on marine and coastal birds are considered to be **minor** to **moderate**.		**large**, depending on the location, timing, duration, and size of the spill; the proximity of the spill to feeding and nesting areas; the timing and nature of spill containment; and the status of the affected birds. Spill response activities (e.g., vessel traffic, in situ burning, and the use of dispersants) could add to these impacts.
Fish	Fish in the Arctic region must survive extended seasonal periods of frigid and harsh conditions such as reduced light, seasonal darkness, prolonged low temperatures, and ice cover. Food resources tend to be scarce during winter months, so most of a fish's yearly food supply must be acquired during the brief Arctic summer. Many species found in the Beaufort Sea are at the northern limits of their range. Subsistence fishing has a long history in the region (commercial fishing occurred infrequently in the past). Cumulative impacts result from activities that generate lethal or sublethal impacts to individuals as well as the loss or degradation of fish habitat. Ongoing and future actions/trends that affect fish include oil and gas development in State and Federal waters, noise, dredging operations, and the potential effects of climate change such as the loss of sea ice, habitat alteration, and changes in fish productivity and community structure. Cumulative impacts on fish in Arctic waters are considered to be **moderate** to **major**.	The incremental contribution of routine OCS Program activities to cumulative impacts on fish (primarily as a result of disturbance affecting demersal fishes) would be **none** to **small**, with the severity of impacts generally decreasing with distance from the disturbance. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the OCS Program on fish would be **none** to **medium**, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts would be greatest if oil were to reach intertidal habitats.	The Liberty Development would cause short-term habitat degradation and long-term loss of small amounts of fish habitat and short-term disturbances from construction noise and vessel traffic. These impacts would be **negligible** and would have **no** or a **small** incremental contribution to cumulative impacts on fish. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Liberty Development on fish would be **none** to **medium**, depending on the location, timing, duration, and volume of spills; the proximity of spills to particular habitats; and the timing and nature of spill containment and cleanup activities. Impacts would be greatest if oil were to reach nearshore waters during open water.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
Lower Trophic Levels and Invertebrates	Invertebrates (animals without a backbone) occur in various intertidal and deepwater habitats in the Beaufort Sea. Benthic invertebrates are predominantly echinoderms, polychaetes, sponges, anemones, bivalves, gastropods, and bryozoans. The most common water column macroinvertebrates in the Arctic region are the copepods. Zooplankton productivity is highly seasonal. At the lowest trophic levels, microbes such as bacteria and protists are important in Arctic waters for breaking down and recycling nutrients and organic matter. Cumulative impacts on invertebrates and lower trophic organisms result from OCS and non-OCS activities that generate lethal or sublethal impacts to individuals as well as habitat loss or degradation. Ongoing and future actions/trends that affect invertebrates include oil and gas development in State and Federal waters, dredging, trawling, and the potential effects of climate change such as the loss of sea ice, changes in invertebrate habitat, and changes in invertebrate productivity and community structure. Cumulative impacts on invertebrates in Arctic waters are considered to be **moderate** to **major**.	The contribution of the OCS Program to cumulative impacts (mainly due to bottom-disturbing activities) would be **none** to **medium**, with the severity of the impacts generally decreasing with distance from bottom-disturbing activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program on invertebrates would be **none** to **small**, depending on the location of the spill and the season in which the spill occurred. Impacts associated with large spills (1,000 bbl or greater) would also depend on these factors and could range up to **moderate** if they were to occur.	The Liberty Development routine operations would result in **minor** to **moderate** localized impacts to benthic communities from island construction, pipeline trenching and burial, and expansion at the SDI. Sensitive habitats in the Boulder Patch would be exposed to temporarily increased turbidity sedimentation that would reduce productivity for one or more years. The incremental contribution of the Liberty Development on lower trophic levels and the Boulder Patch would be **small**. The incremental impacts of expected accidental oil spills on invertebrates (most of which are less than 1,000 bbl) would range from **none** to **small**, depending on the size, duration, timing, and location of the spill, and the nature (i.e., sensitivity) of the benthic community contacted by oil. Large spills (1,000 bbl or greater) would also depend on these factors and could result in **minor** to **moderate** impacts if they were to occur.
Areas of Special Concern	The Alaska National Interest Lands Conservation Act of 1980 designated certain public lands in Alaska as National Parks, Wildlife Refuges, Wild and Scenic Rivers, and as designated for the National Wilderness Preservation and National	Routine operations under the OCS Program could result in **none** to **medium** incremental increases in effects on national parks and wildlife refuges.	The Liberty Development routine operations would result in no impacts and therefore would not contribute to cumulative impacts for Areas of Special Concern.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	Forest systems. Some of these occur in the Arctic region. Other Areas of Special Concern include MPAs; there are no MUAs, National Estuarine Research Reserves, National Estuary Program Areas, or NOAA-designated HCAs in or adjacent to the Beaufort Sea or Chukchi Sea Planning Areas. Cumulative impacts on these resources result from activities that could potentially cause damage to or degradation of fauna or habitats within these areas. Ongoing and future activities or trends that affect Areas of Special Concern in or near Arctic waters include fishing, diving, dredging operations, marine vessel traffic (and wakes), tankering, trash and debris accumulation (from various sources), onshore infrastructure (e.g., roads and vehicle traffic), and oil and gas development and infrastructure (e.g., pipeline landfalls and onshore facilities). Cumulative impacts on Areas of Special Concern in Arctic waters are considered to be **negligible** to **moderate**. The impacts of activities taking place within the Areas of Special Concern located onshore, such as National Parks and National Forests, are regulated through permitting processes.	Expected oil spills (most of which are less than 1,000 bbl) that occur during the Program could result in **no** to **small** incremental contribution to cumulative impacts on Areas of Special Concern, depending on spill frequency, location, and volume; the type of product spilled; weather conditions; effectiveness of cleanup operations; and other environmental conditions at the time of the spill. Large spills (1,000 bbl and greater) in areas adjacent to the National Parks and Wildlife Refuges, whether from OCS or non-OCS sources, would also depend on these factors, and could result in **moderate** impacts if they were to occur. Such spills could negatively impact coastal habitats and fauna, and could also affect subsistence uses.	Expected oil spills (most of which are less than 1,000 bbl) that occur from the Liberty Development would not be expected to reach or impact any Areas of Special Concern and would not contribute to cumulative impacts.
Population, Employment, and Income	The population in the Beaufort Sea and Chukchi Sea Planning Areas is concentrated in Barrow. It increased at an average annual rate of 3.6% between 1980 and 1990, and 2.1% between 1990 and 2000; it decreased by 1.0% between 2000 and 2009. The components of population increase include the natural increase due to	The cumulative impacts of future OCS program and ongoing and future non-OCS program activities would add to beneficial impacts. The incremental contribution of routine operations under the Program is expected to be **small**, however, because the added employment demands are less than 10% of total Alaska	The Liberty Development would add to beneficial impacts on population, employment, and income; however, the incremental contribution of routine operations under the Liberty Development is expected to be **small**. The incremental contribution of expected

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	births and net positive domestic migration; the population trend is uncertain over the next 50 years and will likely depend on the availability of jobs. Most communities in the Borough have a high percentage of American Indian or Alaska Natives.	employment. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **none** to **small** relative to those associated with future OCS program and ongoing and future non-OCS program activities. Large spills (1,000 bbl or greater) could result in **minor** to **moderate** impacts.	accidental oil spills (most of which are less than 1,000 bbl) associated with the Liberty Development would be **none** to **small**. Large spills (1,000 bbl or greater) could result in **minor** to **moderate** impacts with **small** to **medium** incremental contributions to cumulative effects.
Land Use and Infrastructure	Land use in much of the Arctic region is not intense, with oil and gas-related development (onshore and offshore in State waters) and subsistence being the predominant uses. Nuiqsut and Deadhorse are the only small communities in the area. Transportation-related infrastructure is minimal but concentrated in the Prudhoe Bay oil field area. Marine shipping to North Slope communities is by barge and by lightering of cargo to shore because of the shallow coastal waters and the lack of dredging and heavy-lift equipment. Paved and unpaved roads are generally limited to the area within communities. During the winter, many residents travel by snowmachine. Airports and related service facilities are also limited. Most of the oil and gas-related infrastructure in the Arctic region is along the Beaufort Sea coastline. The Prudhoe Bay/Kuparuk oil field infrastructure is served by about 480 km (300 miles) of interconnected gravel roads, 640 km (400 miles) of pipeline routes, and related processing and	The incremental contribution of routine operations under the OCS Program to cumulative impacts in the Arctic region would be **small** to **medium** because of land use changes needed for new onshore pipeline construction and transportation network. Land use-related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) associated with the OCS Program include stresses of spill response on community infrastructure, increased traffic in the response area (both onshore and offshore), and temporary restricted access to affected lands (while cleanup is conducted). Such spills would result in a **small** incremental contribution to cumulative impacts on land use and existing infrastructure. Large spills (1,000 bbl or greater) could result in **moderate** impacts if they were to occur.	The incremental contribution of routine operations under the Liberty Development to cumulative impacts would be **small** because operations would make use of existing pipeline and SDI infrastructure at Endicott. Land use-related impacts resulting from expected accidental oil spills (most of which are less than 1,000 bbl) would result in a **small** incremental contribution to cumulative impacts on land use and infrastructure. Large spills (1,000 bbl or greater) could result in **moderate** impacts if they were to occur.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	distribution facilities. Cumulative impacts on land use and infrastructure result from demands on roads, utilities, and public services and the need to develop additional onshore facilities to accommodate ongoing and future activities in the region. Oil spill response also places stresses on community infrastructure and increases traffic in the affected area. Cumulative impacts on land use and onshore resources could range from **minor** to **major**, depending on the nature and location of demands.		
Commercial and Recreational Fisheries	There currently is no commercial fishing and little data on recreational fishing in the Beaufort. Subsistence fishing is widespread in coastal areas of the Arctic; fishermen target Pacific herring, Dolly Varden char, whitefish, arctic cod, and sculpin. Given the importance of fishing to local communities in the Arctic, the most important cumulative impacts would result from any activities that cause a decline in fish availability for subsistence harvest. The cumulative impacts on recreational (and subsistence) fisheries in arctic waters are considered to be **moderate** to **major**.	The incremental contribution of routine OCS Program activities to cumulative impacts would be **small**, since routine operations under the Program would not occur in the immediate area where fisheries are located. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be **medium**, depending on the location, timing, and volumes of spills (among other environmental factors). Small spills are unlikely to affect a large number of fish or have a substantial effect on fishing before dilution and weathering reduced concentrations of oil in the water. Impacts associated with large spills (1,000 bbl or greater) could be **moderate** if they were to occur.	The incremental contribution of routine Liberty Development activities to cumulative impacts on commercial and recreational fisheries would be **small** since routine operations of the Liberty Development would not occur in the immediate area where these fisheries are located. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Liberty Development would be **medium**. Small spills are unlikely to affect a large number of fish. Impacts associated with large spills (1,000 bbl or greater) could be **moderate** if they were to occur.
Tourism and Recreation	Tour groups to the North Slope Borough make up most of the nonresidential recreational activity. Most visitors stay in Deadhorse. Travel to these areas is primarily by air, although bus	The incremental contribution of routine operations under the OCS Program to cumulative impacts would be **small**, with potential adverse aesthetic impacts on	The incremental contribution of routine Liberty Development activities to cumulative impacts would be **none** to **small**, with potential **minor** aesthetic impacts on sightseeing from tour

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	tours occasionally arrive via the Dalton Highway. Cruise ships are anticipated to enter the Beaufort Sea in the near future. Cumulative impacts on tourism and recreation result from disruptions to land-based activities, increases in the trash and debris accumulation, and competition between workers and tourists for local services, such as air transport and hotel accommodations; these impacts are expected to be **moderate** to **major**.	sightseeing, hiking, and rafting activities. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the OCS Program on tourism and recreation would be **none** to **small**, depending on the size, location, and timing of the spill (being greatest if it occurred during the peak recreational season). Impacts associated with large spills (1,000 bbl or greater) could range to **moderate**.	buses and cruise ships. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Liberty Development on tourism and recreation would be **none** to **small**, depending on the size, location, and timing of the spill. Impacts associated with large spills (1,000 bbl or greater) could range to **moderate**.
Sociocultural Systems[3]	Most of the sparsely populated rural lands in the Arctic region are inhabited by indigenous Alaskans. The Alaska Natives living in communities along the coast of the Beaufort Sea are primarily Iñupiat Eskimo. Alaska Native communities along the Arctic coast are heavily dependent on subsistence harvesting of sea mammals, fish, and terrestrial fauna. Enclaves of workers at Prudhoe Bay and nearby oil fields are employed by the oil and gas industry. They commute from mostly southcentral Alaska, Fairbanks, and States outside of Alaska. For the most part, these two communities (Alaska Native communities and worker enclaves) have had little interaction because of the physical distance that separates them. Cumulative impacts to sociocultural systems occur when ongoing and future actions (OCS and non-OCS programs) cause changes in local populations and social institutions or when jobs are lost or created. Subsistence harvesting could also be	The incremental contribution of routine operations under the OCS Program to cumulative impacts would range from **small** to **medium**, especially if subsistence-related activities, central to the well-being of Alaska Natives who inhabit the area, are affected. Many of these potential effects are mitigable. Onshore linear features (e.g., pipelines and roads) affect the migration patterns of terrestrial mammals. Because of the high level of dependence on subsistence harvesting, the incremental contribution of the OCS Program to cumulative impacts on subsistence activities near the Beaufort and Chukchi Seas would be expected to be **small** to **medium**. Design stipulations and operational procedures could reduce the impact of onshore development. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be **small** to **medium**, depending on the location, volume,	The Liberty Development may have **negligible** to **minor** potential adverse effects on the Cross Island bowhead whale hunt. The LDPI is located inshore from most bowhead whale subsistence activities and coordination procedures between industry and the Alaska Eskimo Whaling Commission would likely mitigate potential impacts. The Liberty Development would be constructed in an industrialized area near Prudhoe Bay, and the incremental contribution of the Liberty Development to cumulative impacts on sociocultural systems and subsistence activities in the area would be **small**. The incremental impacts of expected accidental spills (most of which are less than 1,000 bbl) associated with the Program would be **small** to **medium**, depending on the location, volume, and timing (i.e., season) of the spill. Impacts associated with large spills (1,000 bbl or greater) could be **major** if they were to occur, especially

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	affected by activities that affect marine fauna, such as increases in airborne or subsea noise (e.g., aircraft or marine vessel traffic, seismic surveys, drilling) or degradation of water quality (e.g., fuel or oil spills, chemical releases, or dredging operations that increase turbidity), or that necessitate changes in subsistence fishing practices. Cumulative impacts on sociocultural systems in the Arctic Planning Areas as a result of ongoing and future OCS and non-OCS activities and natural phenomena could be **moderate** over the next 40 to 50 years.	and timing (i.e., season) of the spill. Impacts associated with large spills (1,000 bbl or greater) could be **major** if they were to occur, especially if they disrupt marine mammal harvest or resulted in the IWC reducing or eliminating whale quotas in the Alaskan Arctic.	if they disrupt marine mammal harvest or resulted in the IWC reducing or eliminating whale quotas in the Alaskan Arctic.
Environmental Justice	Environmental justice impacts occur when any activity or trend (OCS program or non-OCS program related) results in adverse health or environmental impacts that are significantly high and disproportionately affect minority and low-income populations. A large number of minority and low-income individuals are located in the Arctic region, although the number of low-income individuals does not exceed 50% of the total population (thus there is no low-income population in the region). Subsistence hunting and fishing are an important part of the economies in Arctic communities. Cumulative impacts on local communities could result from changes in the proximity of onshore oil and gas infrastructure and to marine vessel and aircraft traffic. Ongoing and future oil and gas development would continue to affect populations in the region by increasing the proximity to existing oil and gas infrastructure	The incremental contribution of routine operations under the OCS Program would be **small**, depending on the proximity of onshore pipelines and offshore infrastructure to communities and their subsistence harvest areas, but are not expected to cause additional environmental justice concerns; their contribution to cumulative impacts on low-income and minority populations therefore would be **small**. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) associated with the Program would be **none** to **small**. Large spills (1,000 bbl or greater) could result in **moderate** to **major** impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements	The incremental contribution of the Liberty Development on low-income and minority populations would be **small** because the project would be constructed within the industrialized area of Prudhoe Bay; and would be supported by existing infrastructure. The incremental contribution of expected accidental oil spills (most of which are less than 1,000 bbl) would be **none** to **small**. Large spills (1,000 bbl or greater) could result in **moderate** to **major** impacts on the Alaska Native population, especially if subsistence resources were diminished or tainted as a result of the spill. Mitigation measures, cooperative agreements between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	and associated health, environmental, and visibility impacts. Given these factors, cumulative impacts on local populations are considered to be **moderate** to **major**.	between Native and industry groups, and government-to-government consultations are designed to limit the effects from oil spills and routine operations.	
Archaeological and Historical Resources	At the height of the late Wisconsonian glacial advance, about 19,000 years ago, the global sea level was much lower than at present and created land bridges between the North American and Asian continents. During this time, large expanses of the OCS were exposed as dry land and shorelines shifted depending on the location of ice. These relict shorelines (and other relevant landforms) are currently inundated. Some studies indicate that ice gouging may have altered the seafloor in the Arctic region, removing all archaeological evidence of the first peoples; however, the extent of the disturbance is not known. To date, more studies have been done in the Beaufort Sea, but more will be needed to fully understand the potential for significant artifacts to be present. Numerous shipwrecks have been documented in the Beaufort Sea. Most of these were associated with commercial whaling, which occurred in the region between 1849 and 192,1 and are likely to be in State waters. There are significant onshore historic sites in the Arctic region; these include Cold War-era outposts, radar stations, and missile sites. Cumulative impacts to these resources occur when operations involving bottom-disturbing activities (e.g., channel dredging) come into physical	Routine operations could affect significant archaeological and historic resources, especially offshore resources, with construction activities such as platform and pipeline construction potentially damaging or destroying affected resources. Onshore impacts could include resource damage or loss, or visual effects and are possible from pipeline landfall, onshore pipeline, and road construction. Anchor drags could adversely affect shipwrecks. The incremental contribution of routine operations under the OCS Program could be **none** to **large**, depending on the presence of significant archaeological or historic resources in the area of potential effect. Archaeological surveys that would identify significant cultural resources to be avoided could reduce these impacts. The incremental contribution of expected oil spills to cumulative impacts on archaeological and historical resources in the Arctic region would be **small** to **large**, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size.	Routine operations could affect archaeological and historic offshore resources by damaging or destroying affected resources during construction of the gravel mine site, LDPI, and subsea pipeline. The incremental contribution of construction and operation of the Liberty Development would be **none** to **small** based on results of archaeological surveys for the project. The incremental contribution of expected oil spills to cumulative impacts on archaeological and historical resources in the Arctic region would be **small** to **large**, depending on the presence of significant resources in the area of potential effect and the spill location, timing, duration, and size.

Table 4.4-5. Summary of Cumulative Impacts with Incremental Contributions of the OCS Arctic Region Program and the Liberty Development

	ANTICIPATED TRENDS AND CUMULATIVE IMPACTS[1]	INCREMENTAL CONTRIBUTIONS OF THE OCS ARCTIC REGION PROGRAM [1,2]	INCREMENTAL CONTRIBUTIONS OF THE LIBERTY DEVELOPMENT
	contact with artifacts or their site context, or as a result of natural phenomena such as high-energy waves and currents, ice gouging, and thermokarst collapse. The cumulative impacts of future OCS and ongoing and future non-OCS activities are not currently known, but could range from **minor** to **moderate**, mainly because activities occurring on the OCS prior to USDOI's survey requirement, which went into effect in 1973, may already have affected (i.e., damaged or destroyed) significant sites.		

Notes:

1. Anticipated trends and Cumulative Impacts and Incremental Contributions of the OCS Arctic Region Program are derived from Table 4.6.6-3 in the 2012-2017 OCS Oil and Gas Leasing Program Final Programmatic EIS (BOEM 2012).
2. Use of the comparative terms "small," "medium," or "large" is the same system used by BOEM to describe the incremental contribution of the proposed 5-year OCS lease sale program to the potential cumulative effects of all past, present, and reasonably foreseeable future actions in the Alaska Arctic Region (BOEM 2012, p. 4-952 and Table 4.6.6-3). The Liberty Project is only one element of the 5-year OCS leasing program; therefore, the term "none" was added for those cases when the relative contribution of the Liberty project to the overall cumulative effect is negligible.
3. Includes cumulative/incremental effect on subsistence.

Key: APDES = Alaska Pollutant Discharge Elimination System; bbl = barrel; CWA = Clean Water Act; EFH = Essential Fish Habitat; HCAs = High Consequence Areas; IWC = International Whaling Commission; km = kilometer; LDPI = Liberty Drilling and Production Island; MMPA =Marine Mammal Protection Act; MPAs = Marine Protected Areas; MUAs = Military Use Areas; NOAA = National Oceanic and Atmospheric Administration; NPDES = National Pollutant Discharge Elimination System; OCS = Outer Continental Shelf; OSRP = Oil Spill Response Plan; SDI = Endicott Satellite Drilling Island; USCG = U.S. Coast Guard; USDOI = U.S. Department of the Interior.

Source: BOEM 2012.

Page intentionally left blank

5. PROPOSED MITIGATION MEASURES

The following mitigation measures were developed to avoid, minimize, or reduce potential environmental impacts of the Liberty Development. This section is intended to describe mitigation measures that have been incorporated into the planning, engineering, construction, and operations of the project.

5.1 LEASE STIPULATIONS

Lease stipulations that include environmental protection measures are discussed in the Development and Production Plan (DPP).

5.2 PROPOSED MITIGATION

Mitigation measures that reduce, avoid, or eliminate environmental and social impacts may take a number of forms including:

- Specific engineering design, construction, and operations measures or practices intended to provide impact mitigation;
- Engineering design, construction, and operations practices that, while not necessarily intended as mitigation, nevertheless have positive environmental or social impact benefits;
- Environmental studies and monitoring, which can also be considered as mitigation since understanding impacts allows the project to adjust, if necessary, design, construction, and operations practices to further reduce impacts or assure that impacts are being appropriately managed and mitigated;
- Mitigation implemented through compliance with regulatory and permit mandated requirements at the federal, state, and local levels; and
- Outer Continental Shelf (OCS) lease sale stipulations (see DPP) that also require lessees to implement mitigation.

As detailed in the following sections, substantial mitigation measures have been incorporated into the Liberty Development. Most importantly, Hilcorp Alaska LLC (HAK) has selected a development option that minimizes environmental impact of the various offshore options while safely meeting project needs including maximizing resource recovery and managing project costs. A review of the options and alternatives considered is summarized in Section 2 of this EIA, including potential impacts that led to their exclusion from further consideration. The facilities option selected for Liberty Development is described in the DPP. The environmental mitigation benefits and features of this development option are summarized below:

- Use of directional drilling tools and techniques to limit the number of drilling pads (i.e., islands) to one.
- Access to a remote offshore site by seasonal ice roads, barges, hovercraft, and aircraft to avoid need for a causeway to the island.
- Selection of a southern pipeline route that avoids sensitive eco-systems and risks of strudel scour to the north.

- The selected Liberty Drilling and Production Island (LDPI) location is outside (inshore) of the mapped Boulder Patch while still facilitating maximum resource recovery and minimizing directional drilling requirements.
- LDPI size and layout, while accommodating worker safety and spill prevention and response, minimizes the gravel requirements and seabed footprint.
- The selection of a pipeline route and design that is similar to the two most recent developments in the Beaufort Sea and has been proven to be safe and reliable.
- Processing on LDPI will use modern and efficient air emission sources compared to existing, older, less efficient processing facilities.
- LDPI will have a mat slope armor protection system that will extend from the island bench to the sea floor with a 3:1 (horizontal to vertical) profile and sheetpile wall. This system minimizes the seabed footprint and overall gravel requirements as well as the need for long-term maintenance. The slope protection may provide substrate for population by kelp and other Boulder Patch organisms.
- Selected pipeline route avoids areas of mapped high density (≥ 25%) Boulder Patch.
- The selection of the routing of the onshore pipeline minimizes impacts to water resources and coastal erosion, and avoids areas of known archaeological sensitivity.
- Pipeline design features will minimize the depth and size of the trench and thus the impacts from excavation and backfill. Engineering optimization has reduced the size of the production pipeline to 12-inch diameter; the minimum backfill thickness required to avoid upheaval buckling has also been optimized. The single phase, pipe-in-pipe (PIP) design maximizes leak detection sensitivities.
- Gravel placement for the island and pipeline construction will occur in winter when under-ice currents are minimal and the plume from temporarily increased total suspended solids (TSS) will likely be localized, and not during the period when Boulder Path flora are fixing carbon and growing due to photosynthesis.
- LDPI operational staffing is minimized. The smaller staff size reduces logistical support needs and, therefore, impacts related to logistics.
- Process modules on LDPI will employ a fit-for-purpose design that matches equipment sizing and emissions sources to the reservoir and production needs of the Liberty reservoir.
- Ocean discharge of wastewaters will be minimized. Drilling muds will not be discharged but will be stored on site and disposed via injection when the disposal well is operational. Wastewater from LDPI sewage treatment and potable water plants will also be discharged to the waste disposal well when the well is operational. Temporary and contingency discharge of wastewater under the National Pollutant Discharge Elimination System (NPDES) will be required when the waste disposal well is not available.
- The waste disposal well will be the first well drilled and completed to facilitate wastewater injection instead of discharge.
- Optimization of the project gravel needs and construction schedule minimizes the size of gravel pit needed and length of time it is operated.

In addition to proposed design parameters and mitigation measures, HAK will comply with mitigation stipulated in the Bureau of Safety and Environmental Enforcement (BOEM) Liberty Development Record of Decision and in permits for project development.

5.2.1 Climate Change (EIA Section 4.1.1)

Section 3.1 of this EIA details meteorological, climate, and oceanographic changes that have been observed in the Alaskan Arctic, including the project area, over the last 30 years. Some of the important changes documented by the report that will be incorporated into Liberty Development design are: decreased cumulative freezing days, increased storm counts during open-water seasons, warmer air temperatures in late summer and early fall, increased fall storms, reduced sea ice thickness, and increased length of open-water seasons. There is a lack of sea level change in the Beaufort Sea.

Climate change concerns for the project include both potential for climate change to affect the project and for the project to affect climate change. These impacts are described in Section 4.1.1.

Mitigation Measures

Climate change-induced oceanographic phenomena principally affect the design of LDPI. Design features of LDPI related to these and other environmental conditions include:

- Island design will include consideration of potential climate change impacts. Should rising sea levels threaten flooding of the island work surface, the island bench and sheetpile wall top can be elevated. Sea level will be monitored during the project life to identify trends of change.

5.2.2 Oceanography (EIA Section 4.1.2)

There is an extensive meteorological database from the Prudhoe Bay area and 20 years of tidal gauge data to support project design with respect to oceanographic parameters. Oceanographic conditions (bathymetry, waves, storm surge, sea ice, strudel scour, etc.) in Stefansson Sound that affect the design basis for the project (mainly LDPI and pipeline) are summarized in Section 3.2.

Oceanographic data have been collected in the Beaufort Sea for over 30 years, providing a sound database for engineering design. Recent Beaufort Sea oil and gas developments, including Endicott (1985), Northstar (2001), Oooguruk (2006), and Nikaitchuq (2008), provide a sound engineering design basis that will be incorporated into the design of LDPI.

Project concerns about oceanographic disturbance generally focus on disturbing currents in the project area.

Sound conservative design based upon available and site-specific data and applying lessons learned from other Beaufort Sea projects provides substantial environmental mitigation of oceanographic impacts.

Mitigation Measures

The project components have been sited and designed with the following design considerations:

- LDPI is setback from the mapped Boulder Patch to minimize the potential for oceanographic current changes affecting the Boulder Patch.

- LDPI is located beyond the 10-foot isobaths, which avoids disturbing the ocean current in important summer fish habitat.
- LDPI is located well away from the coastline (approximately 5 miles) and Endicott (approximately 7 miles), to avoid constricting normal current patterns.
- LDPI is smaller than most barrier islands, minimizing oceanographic current disturbance.
- LDPI is very small compared to the approximately 170,400-acre coastal lagoon bounded by Tigvariak Island, the offshore barrier islands, and Cross Island. The 18-acre LDPI foot print will cover less than 0.01 percent of this lagoon area. The small size relative to the overall current patterns in these bodies of water greatly minimizes any potential effect of the general oceanographic current patterns.
- The offshore pipeline will be buried, avoiding impacts from natural loading conditions.
- Pipeline trench backfill mound would be monitored to confirm return to sea floor level.

5.2.3 Geology (EIA Section 4.1.3)

This section addresses geology (reservoir geology and shallow hazards) and permafrost. In addition to seismic studies and marine hazard surveys, six exploratory wells have been drilled in the Liberty Reservoir area, and extensive drilling has occurred at the Endicott oil field approximately 7 miles to the west. This provides a detailed description and understanding of the marine geology, shallow hazards, reservoir geology, and permafrost. In addition, drilling and producing oil in the Arctic for over 30 years has created a vast knowledge of permafrost and the design, construction, and operations basis for protecting permafrost.

Project impact concerns on the area's geology include safely penetrating through the geological strata above the reservoir and then into the reservoir, encountering shallow hazards (gas pockets, pipelines, etc.), or creating hazards (submarine pipelines, cables, etc.). Injection for oil recovery and/or waste disposal generally raises concerns about underground drinking water supplies. Permafrost thawing can cause mechanical integrity issues and lead to impacting maintenance or repairs.

Mitigation Measures Geology (Reservoir and Shallow Hazards)

- The reservoir characteristics and knowledge of overlying marine geological structures are well known from activities directly intended for the development of Liberty and construction, drilling, and operation in the nearby Endicott oil field. This knowledge will be applied to well design, drilling, facility and well construction, and facility operations. This includes the selection of well and piping materials, and the choice and method of well cementing and integrity testing.
- Design, construction, and operations experience gained from other North Slope oil fields will be applied to facility designs, construction, and operations.
- A primary goal of design construction and operations is to minimize maintenance and repair. High maintenance and repair can cause other temporary impacts.
- Exploration activities have developed an in-depth knowledge of shallow hazards. Drilling into this reservoir and the neighboring Endicott oil field has refined measures to mitigate for shallow hazards. These measures will be applied in the Liberty Development.

- The groundwater above the Liberty Reservoir has total dissolved solids greater than 10,000 parts per million (ppm), making it unsuitable for drinking water.
- Permafrost, and how to build and operate in permafrost, has been studied for over 30 years. The knowledge of how to design structures to minimize thaw includes insulation, building warm structures on gravel pads and pilings, and applying thermosiphons as needed to prevent thaw subsidence.

Mitigation Measures Permafrost

- HAK will apply the extensive knowledge base acquired from building and operating North Slope facilities on permafrost to the design, construction, and operations of Liberty Development.
- Land-Based Design
  - LDPI, gravel pad, and gravel mine site are all designed to manage the risk of permafrost thaw. LDPI will be a gravel island and a small gravel pad will be created onshore at the junction with the Badami pipeline. Gravel roads and pads have been used on the North Slope for over 30 years to prevent thaw subsidence.
  - Heated facilities will be designed to preserve permafrost using proven methods such as elevation above the gravel on pilings or insulated floors to minimize building heat transmission to the permafrost.
  - Thermosiphons will be installed where needed to prevent thaw subsidence.
- Pipeline Design, Installation, and Operation
  - Geotechnical borings have been collected along the pipeline corridor to provide information on the presence of thaw-sensitive versus stable permafrost.
  - Permafrost characteristics of the pipeline route are incorporated into computer modeling to determine pipeline design that will minimize the impact from permafrost below the buried pipeline.
  - Modeling is used to determine the most effective means of preventing unwanted permafrost changes, including insulation design and heat transfer within the pipeline.

5.2.4 Air Quality (EIA Section 4.1.4)

The air quality discussion in Section 4.1.4 uses meteorological data models and ambient air data to evaluate current and potential air quality conditions, as well as potential impacts to air quality that may result from the proposed project.

Potential project impacts include degrading air quality.

Mitigation Measures

HAK has selected a development option that allows the installation of up-to-date emissions sources rather than the use of older, less-efficient emission units at existing facilities for processing.

Air quality permitting requirements for oil and gas projects on the North Slope are very prescriptive at the state (ADEC, program delegated by EPA) and federal (BOEM for the OCS) levels as well as the modeling protocols, ambient data used, and pollutant thresholds triggered for Prevention of Significant Deterioration and best available control technology (BACT). Requirements may include emission controls. The applicant has some flexibility in proposing BACT, operational restrictions, and other ways to meet regulated emission limits as well as

the overall development strategy. As a result, the identification of specific mitigation measures regarding air quality ultimately depends upon a lengthy iterative modeling process, vendor consultations, and BACT analyses.

5.2.5 Acoustic Environment (EIA Section 4.1.8.1)

Information on the acoustic environment noise propagation in the nearshore is provided in Section 3.5, and an assessment of the potential environmental consequences of noise from the project and acoustic effects on marine mammals is provided in Sections 4.1.5 and 4.1.8.1, respectively.

One of the important environmental concerns of Liberty Development is the impact of project noise, particularly underwater noise transmission, on marine mammals in the project area including seals (several species) and whales. Bowhead whales are of particular concern due to their importance for subsistence.

Mitigation Measures

A preliminary list of mitigation measures, focusing on minimizing disturbance from project noise to marine mammals, includes:

- Winter construction noise from the pipeline installation and gravel placement for the island (bowhead whales will be absent but ringed seals will be present in the project area).
- Managing the potential for acoustic disturbance by vessels with a strategy that includes choice of vessel route, timing of vessel traffic, reduction of vessel speed, and operational procedures to maintain appropriate distance.
- Scheduling impact pile driving to avoid or minimize effects on fall bowhead migration and subsistence hunting.

5.2.6 Water Quality (EIA Section 4.1.6)

This section includes a discussion of mitigation measures to reduce potential impacts to water quality in both freshwater and marine environments. A discussion of freshwater and marine water quality can be found in Section 4.1.6.

Concerns about project impacts to water quality relate to the potential to discharge or create pollutants and introduce them to a waterbody. Liberty Development will need to discharge camp wastewater until the disposal well is operational and seawater treatment plant (STP) effluent for the life of the project. Construction of LDPI, pipeline installation, gravel mine development, and hauling all have the potential to introduce TSS to waterbodies. Fuel transfers over water have the potential to create small spills.

Potential waste management impacts to marine water quality result from temporary discharges conducted under an NPDES permit while the planned disposal well is being drilled or is inoperable.

Mitigation Measures

- HAK will not discharge drilling waste to the land or waters in the Alaskan Arctic.
- HAK has included a number of mitigation measures in its design, construction, and operations of Liberty to minimize potential for TSS generation and related impacts. These include:

- LDPI will be located in water depth of approximately 19 feet, inshore and east of the main mapped areas of Boulder Patch. This location was selected for optimal reservoir development and to minimize direct long-term impacts (coverage) and short-term impacts (increase in TSS) to the Boulder Patch.
- Selected pipeline route corridor will minimize direct impacts to the Boulder Patch, as mapped.
- Gravel construction will be conducted in winter from the sea ice when most wildlife is absent from the project area. Ocean currents (under the ice) will be at a minimum, thus limiting the entrainment and transport of TSS away from the island. Winter construction will also minimize the excavation required.
- Construction practices related to handling material excavated from the pipeline trench will seek to minimize the time excavated material will be temporarily staged on the sea ice surface to minimize the backfill of frozen soils.
- LDPI and onshore gravel pad will be designed to manage runoff.
- The slope protection system, which will extend to the seabed with a 3:1 (vertical to horizontal) slope, essentially eliminates the potential for entrainment of TSS into the water column after installation.
- The sheetpile wall around the island (except the dock and ramps) reduces overall gravel quantities needed for the island.
- Installation of the slope protection in the summer following gravel placement will be prioritized to protect the east slopes of the island most prone to impacts from the predominant easterly storms and wave run up.
- Drilling muds, which can create TSS, will not be discharged. They will be stored until the waste disposal well is operational, and then injected for disposal or hauled offsite.
- Mining operations will only occur in winter, minimizing the potential for operations to introduce TSS to waterbodies.

Other potential pollutants will be controlled to minimize their introduction to the waters of Stefansson Sound, including:

- HAK will apply for an NPDES permit for temporary domestic wastewater discharges until the waste disposal well is in operation and when backhaul of wastewater is infeasible (and also as a contingency if the disposal well is unavailable). Such NPDES permits specify treatment requirements, effluent limitations, monitoring, and compliance with a Best Management Practices (BMP) Plan.
- The waste disposal well will be the first well drilled and constructed on LDPI, minimizing the time camp wastewater must be discharged.
- Once operational, camp wastewaters will be injected unless the waste disposal well is not operating or otherwise unavailable.
- Produced water will be separated from the oil and gas on the LDPI and will be used for oil recovery, eliminating the need to discharge produced waters.
- The STP discharge will consist primarily of slightly warmed seawater, with a higher concentration of TSS (all from the Beaufort Sea's natural TSS materials) and minor amounts of total residual chlorine (TRC). The potential for the STP discharge to impact the Beaufort Sea has been monitored extensively at the Prudhoe Bay and Endicott STPs. All impacts were found to be minor to negligible.

- HAK will have strict control over what chemicals can be brought on site. Less hazardous chemicals are chosen when there is an option for substitution.
- HAK will implement strict waste management practices (e.g., waste segregation and designation of dedicated temporary storage systems, waste minimization, etc.), which prevent waste from coming in contact with snow or rainwater.
- HAK will implement strict practices of using drip pads beneath fuel transfers and engines to prevent drips or spills from contacting water or wetlands.

5.2.7 Benthic Communities (EIA Section 4.1.7)

Mitigation measures for protection of macrofaunal communities, infaunal communities and flora (algae), including species in the Boulder Patch, are described in Section 3.7.

The key benthic alga in the Boulder Patch is *Laminaria solidungula*, with this kelp community existing at the extreme range of its distribution. Impacts to light through turbidity can impact *Laminaria solidungula* by decreasing photosynthetic rate. This could lead to benthic community impacts since *Laminaria solidungula* produces a significant amount of biomass for the community. Water pollution also has the potential to change growth rate in benthic communities.

Mitigation Measures

Several mitigation measures in LDPI design, construction, and operation minimize potential impacts to the Boulder Patch. These include mitigations to minimize impacts to oceanography and water quality, such as:

- LDPI and pipeline route location to minimize direct disturbance and sedimentation from construction.
- LDPI and pipeline design to minimize size and footprint impacts.
- Island armoring to reduce erosion.
- The expectation that lower portions of the armor at LDPI may serve as hard-bottom habitat that is likely to attract Boulder Patch community colonization.
- Winter construction that provides a stable work platform (ice), with reduced water turbulence and currents.
- Winter construction to avoid the time when Boulder Patch flora need clearer water to fix carbon by photosynthesis (during the Arctic summer).

5.2.8 Marine Mammals (EIA Section 4.1.8)

Marine mammals that would most likely be present in the summer are polar bears, bearded seals, ringed seals, and whales. In the winter, the two species expected to be present are polar bear and ringed seals. Marine mammals present in the Liberty Development area are described in Section 3.8.

Marine mammals can be disturbed by vessel traffic, noise, and human presence. Disturbance can vary from fatalities for vessel-marine mammal collisions to altering movement and feeding behavior. Marine mammals can be disturbed by loud acoustical signals. Potential impacts to marine mammals are described more fully in Section 4.1.8 (non-ESA listed) and 4.1.12 (Endangered Species Act [ESA]-listed).

Mitigation Measures

The following mitigation measures avoid or minimize impacts to marine mammals:

- The project is located inshore of the barrier islands and inshore of the main fall migration path of the bowhead.
- The principal construction activities—island gravel laying and pipeline installation—are scheduled to occur in the winter when whales are not present.
- As agreed to on similar North Slope projects, unmitigable impact pile driving at LDPI that places sounds in the water above 120 decibels (dB) will not be conducted during the bowhead whale migration in the project area (late August through September).
- Barging and other support marine traffic to LDPI will utilize routes in relatively shallow water inshore of the barrier islands and the main migration path of the bowhead.
- Operational procedures will be in place for project support vessels in transit during bowhead migration.
- HAK's polar bear interaction plan will be implemented, which includes commitments to survey potential denning habitat for maternal dens (e.g., forward-looking infrared [FLIR] or similar technology, aerial surveillance) along ice road routes to avoid active denning areas. Protection, agency reporting, and a stop work order will occur in the event of the discovery of previously unidentified polar bear dens, unless alternative action is approved by the U.S. Fish and Wildlife Service (USFWS).
- The steel sheetpile wall protecting the LDPI work surface will deter access of polar bears to the island work surface.
- Procedures will be in place for approved marine mammal monitors and those licensed to haze and conduct other intentional takes to defend workers.
- Food handling and waste management procedures (to avoid creating attractants) will be in place, such as secure storage of food and proper disposal of chemicals and wastes.
- Training and procedures will be provided to assure safety of worker and animals when working where marine mammals may occur.
- Setback (activity) from active polar bear dens will be 1 mile or as otherwise approved by the USFWS.
- The subsea pipeline route was selected to provide separation from historical polar bear denning sites at Point Brower.
- Ice road management (e.g., traffic controls, re-routings, etc.) will control access in areas where marine mammals may be encountered.

HAK will enter into a Conflict Avoidance Agreement with the Alaska Eskimo Whaling Commission (AEWC) and Nuiqsut Whaling Captains' Association to mitigate impacts to subsistence whaling and bowhead; and HAK will consult the Nuiqsut Whaling Captains' Association on specific routes and traffic frequency for Liberty support vessels.

5.2.9 Coastal and Marine Birds (EIA Section 4.1.9)

Approximately 70 species of birds use marine and coastal environments surrounding the Liberty Development area during some portion of the year. Most of these species are found only during the open-water season during migration and breeding activities. Of these 70 species, three have been designated as endangered or candidate species under the ESA. Habitat in the project area is considered valuable for shorebirds and has recognition as such by USFWS, Alaska Shorebird Group, and Audubon Society.

The principal concerns with respect to coastal and marine birds from the Liberty Development relate to: potential collisions with LDPI structures (e.g., towers), particularly during the fall migrations; lighting attraction; impacts of predatory birds (e.g., ravens) on other birds due to nesting opportunities on structures; loss of nesting habitat (e.g., onshore gravel mine site); disturbance from air traffic; and disturbance to molting waterfowl in Stefansson Sound, as described further in Section 4.1.9.

Mitigation Measures

Experience related to these potential impacts has been gained from Northstar and other projects on the North Slope. Mitigation measures may include:

- A lighting plan to minimize the potential for bird strikes.
- Onshore pipeline infrastructure will be monitored for common raven nesting. If sited and confirmed as a common raven nest, the nest may be removed if no eggs or young are present.
- A survey of the project area to identify active migratory bird nests will be conducted prior to conducting activities that may cause disturbance to birds during the May – September timeframe, such as construction, vegetation clearing, or excavation.
- Onshore pipelines will be designed and operated to minimize sight and sound impacts in areas of important wildlife habitat. The onshore portion of the proposed Liberty pipeline will be of low reflectivity but of a visible shade for prevention of low-flying bird collisions (such as loons).
- No permanent, staffed facilities will be sited within identified waterfowl nesting and brood rearing areas. All staffed permanent facilities for Liberty are offshore, outside of waterfowl nesting and brood rearing areas.
- Towers and other structure on LDPI designed to reduce opportunities for predatory bird nesting.
- Strict food waste control (e.g., animal-proof dumpsters) to avoid attracting predators.
- Marine traffic procedures to avoid encountering concentrations of molting waterfowl.
- Seasonal air traffic controls (e.g., routing and minimum altitudes) over specific nesting and brooding areas (e.g., Sagavanirktok River Delta, Howe Island).
- Consideration of bird use and wetlands mapping in the vicinity of the onshore gravel mine site and gravel pad to avoid high quality habitat, particularly for spectacled eiders and snow geese.
- Equipment may be staged early on-site and passive hazing techniques may be employed (such as flash tape or audible noise deterrents) to deter birds from nesting in areas planned for construction or gravel mining.

5.2.10 Fish and Shellfish (EIA Section 4.1.10)

Fishes inhabiting the Beaufort Sea and the adjoining coastal plain fall into three groups based on life history and salinity tolerance: (1) marine fish that complete their entire life cycle in the marine environment; (2) anadromous and amphidromous fish that migrate between fresh water and marine or brackish waters at some stage of their life cycle; and (3) freshwater fish that are limited primarily to freshwater habitats. Marine fish (arctic cod and fourhorn sculpin) combined with four anadromous fish (arctic cisco, least cisco, Dolly Varden, and broad whitefish) account for most of the total nearshore community. Fish fauna in the Liberty area vary greatly from summer to winter. During the winter the anadromous fish are not present, and fish habitat from about the 6-foot isobath shoreward is not present due to land and bottomfast ice.

Projects in the marine environment affect fish by exchanging soft-bottom habitat for gravel island edge habitat. If ocean currents are disrupted and the pattern of brackish water changes, anadromous and amphidromous fish movements and access to food may be altered. Water pollution has the potential to make polluted areas more attractive or less attractive to fish. Potential impacts to fish are further discussed in Section 4.1.10.

Mitigation Measures

Several mitigation measures in LDPI design, construction, and operation minimize potential impact to the Stefansson sound fish community. These include measures that minimize impacts to the oceanography and water quality including:

- LDPI and pipeline location to avoid impact to habitat and alteration of ocean currents.
- LDPI design to minimize size and footprint, decreasing impacts to fish habitat.
- STP intake structures designed to prevent fish entrainment.
- Island armoring to reduce erosion and the spread of silt or gravel over fish habitat.
- Winter construction with fewer fish species present and low water currents, which reduce TSS distribution.

5.2.11 Vegetation Wetlands and Terrestrial Mammals (EIA Section 4.1.11)

This section contains information on vegetation, wetlands, and terrestrial mammals. Detailed information on these resources is provided in Section 3.11, and potential impacts from the Proposed Project are discussed in Section 4.1.11.

Species of terrestrial mammals that are present vary greatly from winter to summer in the Arctic. In the winter only red and arctic fox are typically active. Grizzly bears are hibernating. Caribou migrate into the coastal areas in summer.

Most Liberty Development facilities, construction activities, and operations are located offshore. Further, most construction will be conducted in winter when many terrestrial mammal species are not expected to be in the Liberty Development area, including caribou.

The proposed gravel mine site in the vicinity of the Kadleroshilik River and the onshore elevated pipeline and associated pad are the only project components with expected impacts to tundra wetlands. Access to the mine site will be via onshore and offshore ice roads (no gravel road is planned). It is not possible to avoid impacts to the

tundra wetlands from mining at the proposed mine site. There are no existing gravel sources within an economical hauling distance and no upland gravel sources near the project.

Access to the onshore pipeline will also be via ice roads, and no gravel access road is planned. The location of the gravel pad at the Badami tie-in location will be sited to avoid higher value wetland types to the extent feasible. The gavel pad will be minimal in size, reducing impacts to wetlands and terrestrial mammals. The onshore pipeline will be placed on vertical support members (VSMs) and elevated approximately 7 feet above tundra after daylighting, allowing free passage of terrestrial mammals and reducing impacts to tundra.

Mitigation Measures

Mitigation measures in LDPI design, construction, and operation features that reduce wetlands and terrestrial wildlife impacts include:

- Wetlands mapping conducted in the vicinity of candidate mine sites and gravel pad site to avoid higher value wetland types to the extent feasible.
- Winter construction that avoids conflict with summer migrants, the majority of animals that utilize the North Slope.
- Controlled access and strict anti-hunting, anti-harassment, and anti-feeding policies to restrict impacts during summer.
- No overland access to LDPI in summer (it is surrounded by water).
- Implementation of North Slope BMPs to provide long-term habitat enhancement by converting the former mine site into a water resource for fish and wildlife.
- Elevation of the pipeline onshore approximately 7 feet to reduce impediments to terrestrial mammals.

5.2.12 Threatened and Endangered Species (EIA Section 4.1.12)

Threatened and Endangered Species (TES), including Candidate species, likely to occur in the project area were described in Section 3.12. They include one species of marine birds (spectacled eider) and three marine mammals (polar bear, ringed seal, and bowhead whale). Other TES have the potential to occur but are typically outside their normal range and not likely to occur (Steller's eider, Pacific walrus, and humpback whale).

Concerns about impact to these species include disturbance through noise; human presence; collision with structures, vehicle, or vessels; alteration of predator-prey balances; and habitat changes. Potential impacts to TES are described in Section 4.1.12.

Mitigation Measures

Several mitigation measures in LDPI design, construction, and operation that minimize potential impact to the project area also serve as measures that minimize impact to TES. These mitigations have been described in the following sections: 5.2.8 Marine Mammals, 5.2.9 Coastal and Marine Birds, and 5.2.11 Vegetation Wetlands and Terrestrial Mammals. These measures may include:

- Siting for LDPI, the gravel mine site, pipeline, gravel pad, ice road, vessel, and aircraft routes to avoid or minimize potential to disturb TES.

- Construction timing to lessen the potential to disturb TES. Winter construction avoids the time period when the TES birds and whales are present.
- Foregoing sealift of modules to avoid conflict with TES by designing truckable modules.
- Enhanced detection and surveys of TES and TES habitat (e.g., route survey for den habitat).
- Procedures and worker training to reduce impacts in areas where TES may be encountered.
- Food handling and waste management procedures to avoid creating attractants (i.e., secure storage of food, chemicals, and wastes).
- Ice road management (e.g., traffic controls, re-routings) to control access to areas where TES may be encountered.
- Lighting plans to minimize the potential for bird strikes.
- Towers and other structure on LDPI designed to reduce opportunities for predatory bird nesting.
- Wetlands mapping in the vicinity of the onshore gravel mine site and gravel pad to avoid impacts to high quality habitat.

5.2.13 Sensitive Biological Resources (EIA Section 4.1.13)

Sensitive biological resources near the Liberty Development area are discussed in Section 3.13. They include:

- The Boulder Patch in Stefansson Sound
- Cross Island (subsistence)
- Pole Island (polar bear denning)
- Sagavanirktok River Delta (overwinter fish habitat, bear denning habitat, migratory bird use for nesting, brood rearing, molting, and/or staging for migration)
- Howe Island (snow goose nesting)

Other sensitive biological resources include fresh water and nearshore and marine waters that provide Essential Fish Habitat (EFH). These mitigations would be similar to those described for fish in 5.2.10. Protective measures associated with subsistence are included under Marine Mammals (5.2.8); Coastal and Marine Birds (5.2.9); Fish and Shellfish (5.2.10); Vegetation, Wetlands, and Terrestrial Mammals (5.2.11); and Threatened and Endangered Species (5.2.12). Pole Island is approximately 11 miles to the northeast of LDPI, and relevant mitigation for potential polar bear impacts would be described under Marine Mammals (5.2.8) and Threatened and Endangered Species (5.2.12). Howe Island is in the Sagavanirktok River Delta, west of the Endicott causeway, and associated mitigation for snow geese would be as described under Coastal and Marine Birds (5.2.9) and the Sagavanirktok River Delta below.

Mitigation Measures

<u>Boulder Patch</u>

- Boulder Patch mitigations are described in Section 5.2.2 Oceanography, 5.2.3 Geology, 5.2.6 Water Quality, and 5.2.7 Benthic Communities. These include:

- LDPI location selected to optimize reservoir development and to minimize direct impacts (coverage) and indirect impacts (e.g., increased TSS) to the Boulder Patch, as mapped.
- Pipeline route selected to avoid areas of currently mapped high concentration Boulder Patch areas (greater than 25% cover).
- LDPI slope protection system designed to essentially eliminate the potential for entrainment of fine sediments (TSS) into the water column.
- Sheetpile wall around the LDPI (except the dock and ramps) reduces overall gravel quantities for the island.
- Drilling muds, which create TSS, will not be discharged. They will be stored until the waste disposal well is operational, and then injected for subsurface disposal or hauled offsite.

Sagavanirktok River

- LDPI is located more than 5 miles from East Fork Sagavanirktok River Delta, and the pipeline was routed to minimize proximity to the Sagavanirktok River Delta. These features greatly diminish the potential to affect fish and migratory bird habitat.
- No permanent project facilities are planned in the Sagavanirktok River Delta. Only a winter ice road is planned to cross the river to connect the gravel mine and the Endicott road, and this is expected to be for only one winter season. The daylighting of the pipeline is located to the east of the Sagavanirktok River Delta.
- Mine site operations and gravel haul will occur in winter, minimizing the potential to affect fish and wildlife habitat.

5.2.14 Archaeological Resources (EIA Section 4.1.14)

Archaeological surveys of marine and onshore (ice road and potential mine site) project locations have been conducted. Archaeological surveys of the onshore ice roads and gravel pad associated with the pipeline will be conducted. The results of the marine survey and onshore archaeological surveys will be provided to BOEM and the State Historic Preservation Office.

No archaeological resources were identified that would be impacted by the Liberty Development, including ice road routes (onshore and offshore), gravel mine site, and offshore pipeline and LDPI. In the event of an unanticipated archaeological discovery, HAK will develop an Archaeological Discovery Plan prior to construction. The Plan will include monitoring policies and procedures, staffing requirements, training and preconstruction briefing requirements, communication protocols, and work stoppage protocols. The Plan will provide for discovery, documentation and notification procedures, specific protocols related to the discovery of human remains, prohibited activities (including removal of cultural materials without consultation), confidentiality requirements, and contact information for HAK, Agency, and Tribal Officials. In the rare event of a catastrophic discharge, HAK will comply with processes of a Unified Command to prioritize and protect archaeological resources from the spill and response activities.

Mitigation Measures

- HAK will continue to consult with knowledgeable organizations and individuals about the project, develop protocols to protect known existing sites or sites discovered during the project, and train the Liberty workforce on the importance of recognizing and protecting archaeological and cultural resources.

5.2.15 Sociocultural Resources (EIA Section 4.1.15 and 4.1.16)

This section discusses the mitigation measures for potential sociocultural and subsistence impacts. The socioeconomics section of this EIA (Section 3.15) describes social systems, economic land use, coastal and marine uses, and environmental justice issues of the project area. Section 3.16.2 describes subsistence issues of the project area. Liberty is primarily offshore, and the only onshore components are the single season gravel mine and elevated pipeline with one associated small gravel pad. The closest communities are Nuiqsut and Kaktovik, approximately over 80 and 90 miles away, respectively. The nearest infrastructure and population is the North Slope oil production area.

Potential socioeconomic resource impacts include creation of employment, tax revenues, and royalty revenues. While a small percentage of total employment is expected to be North Slope residents, Alaska Native Claims Settlement Act (ANCSA) corporations will be among the organizations requested to bid on construction and operations work associated with Liberty Development. The isolation of the Liberty Development area will minimize direct population impacts. No impacts to recreational or commercial fisheries are expected (Section 4.1.15). Subsistence activities in the Liberty Development area are mainly limited to the hunting of bowhead, as reported in Section 3.16.2 of this EIA. Impacts to bowhead are discussed in Section 4.1.8 and 4.1.12. Impact to subsistence activity is discussed in Section 4.1.16.2.

Mitigation Measures – Socioeconomic Impacts

Project-specific socioeconomic mitigation measures will include:

- Provide contracting and employment opportunities to local and state organizations.
- Support State and North Slope Borough (NSB) educational and job training opportunities.
- Provide training and control activities of oilfield workers to protect relations with local residents.
- Develop protocols and communications for emergency assistance at LDPI.

Mitigation Measures – Subsistence

Project-specific subsistence mitigation measures will be developed during consultations with the NSB, AEWC, and community of Nuiqsut. HAK will take measures to avoid impacts from vessel traffic (marine and aircraft) to the Cross Island bowhead whale hunt. HAK has consulted with subsistence users, including potentially affected whaling captains' associations and the Alaska Eskimo Whaling Commission (AEWC) to obtain input about how to carry out proposed activities in a manner to avoid impacts to the hunt. In addition, HAK plans to sign Conflict Avoidance Agreements (CAAs) between Industry Participants and the AEWC during Liberty construction, operation, and production activities. The CAA identifies measures to be taken to mitigate impacts from oil and gas operations on the subsistence bowhead whale hunt, including limitations on activities during the whale hunt and using agreed-upon communication protocol. These and other mitigation measures may include:

- Describe criteria for island siting and design with Nuiqsut Whaling Captains' Association and consult on supporting marine traffic (routes, frequency, schedule).
- Employ local subsistence representatives during appropriate project phases.
- Execute and implement a Conflict Avoidance Agreement, which may include supporting communications centers during the whaling season and operational procedures, among other mitigation measures.

- Employ personnel skilled at protected species identification on support vessels, when warranted, to prevent vessel-marine mammal interaction during the open-water season.
- Establish preferred marine routes for transport of facilities and supplies to LDPI.
- Establish minimum aircraft altitudes and routes for helicopters and other support aircraft to avoid disturbing bowhead whales and other subsistence resources, consistent with safety requirements and weather considerations.
- Train HAK and contract personnel on the importance of subsistence and measures to avoid conflicts.

5.2.16 Land Use (EIA Section 4.1.15.5)

Land use in the project area is primarily oil development activity and subsistence use.

Several Native allotments are located along the shore of Foggy Island Bay. The proposed ice road to the Kadleroshilik mine site and the proposed pipeline route and associated infrastructure will be routed to avoid these allotments with an appropriate buffer. Ice road surveys will mark allotment boundaries, and ice road management procedures and worker training will address protection of these properties. HAK will consult with the Native allotment owners, where possible, and the Iñupiat Community of the Arctic Slope (ICAS) about the project and protection of their properties.

Impacts to land use will be limited to the VSM elevated pipeline and development of the gravel mine site from tundra, with restoration to an aquatic resource. Due to the limited land use in the area, and identification and avoidance of private land and land claims, impacts are expected to be negligible.

Mitigation Measures

- Survey and identify private land-owner boundaries before starting construction.
- Train employees on the rights of land ownership in the area and the location of private land.

5.2.17 Coastal and Marine Uses (EIA Section 4.1.15.5)

In addition to subsistence use described above, the principal offshore coastal and marine uses in the project area are vessel and barge traffic through Stefansson Sound to support oil and gas operations to the east (e.g., Badami and Point Thomson) and barge traffic to transport fuel and supplies to the community of Kaktovik. Some of this traffic may travel outside the barrier islands depending upon ice and weather conditions and subsistence whaling activities. There may be cruise ships, and other commercial and naval vessel traffic outside the barrier islands during the open-water season. HAK, through the course of implementing cooperative agreement obligations and doing business, may alert other marine users of on-going subsistence whaling.

Concerns about impacts are created by the potential for project vessel traffic to interrupt wildlife movement and local vessel use patterns. Coordinating project vessel use is expected to avoid conflicts of vessel traffic and wild life impacts.

Mitigation Measures

The mitigation measures discussed for minimizing subsistence use disturbance in Section 5.2.15 above also serve to mitigate coastal and marine use disturbance.

5.2.18 Visual Resources (EIA Section 4.1.16.1)

The project is located in a greater area already developed for oil and gas, including the Endicott facilities located approximately 7 miles to the west of the planned LDPI. After drilling is complete, LDPI will have a very low visual profile when compared to Endicott and many other North Slope facilities; LDPI will have well houses, manifolds, fuel storage, and a small camp among other facilities. The onshore pipeline will be designed according to established North Slope specifications and will have a minimal impact on visual resources.

Mitigations that are typically the result of permits or regulations are discussed in each applicable section of Environmental Consequences.

The DPP lists the major permits and authorizations required for the project that will most likely involve some sort of environmental monitoring. The type of monitoring requirements can be estimated based on past project experience related to both shallow water Beaufort Sea, onshore North Slope projects, and the environmental issues related to the Liberty Development. This is not intended to be comprehensive of all monitoring that may be required but focuses on the monitoring HAK expects. It is a snapshot of previous experience. The BOEM Record of Decision and permits will not be issued for several years. Regulations, permitting authority, and permit requirements may change by the time some of the permits are issued.

Page intentionally left blank

6. CONSULTATIONS

Hilcorp Alaska LLC (HAK) expects to complete consultations with regulatory agencies and other stakeholders prior to and subsequent to the decision to develop from the Liberty Production Island. These consultations are expected to include informal meetings and briefings, and formal pre-application meetings. The purpose of these consultations will be to solicit and obtain comments and input on potential development alternatives, provide project progress updates, and clarify regulatory requirements. Consultations to date (December 30, 2014) are listed in **Table 6-1.**

Table 6-1. Liberty Development Stakeholder Consultation

CATEGORY/DESCRIPTION	DATE	STAKEHOLDER
DPP/OSRP:		
Liberty SOP Meeting with BSEE	10-Feb-13	BSEE
Meeting with Jim Lusher of BSEE	19-Feb-13	BSEE
Liberty BSEE OSRP Meeting	20-Jun-13	BSEE
Liberty BOEM/BSEE Meeting – DPP Expectations & Staff introductions	21-Jun-13	BOEM/BSEE
Liberty BOEM Air Quality – Liberty Quality Plan Development & Resourcing Discussion	18-Jul-13	BOEM
BOEM Shallow Hazard Survey	12-Nov-13	BOEM
Liberty BSEE OSRP Follow-Up Meeting – Discuss OSRP Approach & BSEE's Expectations/Answer BSEE Outstanding Questions	18-Feb-14	BSEE
ADEC Air Permitting Jurisdiction	13-Mar-14	ADEC
BOEM Waste Management/NPDES Meeting	18-Mar-14	BOEM
BOEM Air Permitting	15-Apr-14	BOEM
EPA NPDES Permitting Telecom	22-Apr-14	EPA NPDES
BSEE Waste Management and Downhole Disposal Meeting	6-May-14	BSEE
EPA Oil & Gas Sector R10	8-May-14	EPA
BOEM Air Permitting Construction Activities	21-May-14	BOEM
Meeting with BSEE for OSRP	28-May-14	BSEE
BSEE – Platform Verification Program	23-Jun-14	BSEE
BOEM/BSEE DPP requirements and BSEE Authorizations for wells and H_2S Classification	10-Jul-14	BOEM/BSEE
BOEM – Hilcorp Introduction	25-June-14	BOEM
BOEM Liberty DPP Requirements – How to include new preferred option.	23-Jul-14	BOEM/BSEE
BSEE – Wellhead burn efficiency review with Boots and Coots	18-Aug-14	BSEE

Table 6-1. Liberty Development Stakeholder Consultation

CATEGORY/DESCRIPTION	DATE	STAKEHOLDER
BOEM/BSEE – WCD Drilling and Production calculation	28-Aug-14	BOEM/BSEE
BOEM WCD Calculation Workshop	11-Sep-14	BOEM
ADNR OPMP – Hilcorp Intro and Liberty Overview	22-Sep-14	ADNR
BOEM/BSEE – BP Transition	24-Sep-14	BOEM
BSEE - Herndon, VA – Wellhead burn efficiency	10-Oct-14	BSEE
ADNR SPCO – Hilcorp Intro and Liberty Pipeline	15-Oct-14	ADNR SPCO
BOEM-Hilcorp Intro and Liberty Overview	24-Oct-14	BOEM
BOEM – Review geology, basis, methodology for WCD calculation	30-Oct-14	BOEM
BSEE – OSRP Status Update, follow-up to DC meeting	18-Nov-14	BSEE
USACE – Hilcorp and Liberty Introduction with Mike Salyer	21-Nov-14	USACE
USDOI – Interagency Working Group Presentation	3-Dec-14	Federal Agencies
BOEM – Part I DPP Presentation	8-Dec-14	BOEM/BSEE
BOEM – Part II DPP Presentation	15-Dec-14	BOEM/BSEE
BOEM – DPP Presentation to Federal Agencies	18-Dec-14	BOEM & Federal Agencies
ANCILLARY:		
USFWS with Craig Perham, with Mike Brock	7-May-13	USFWS
USFWS, ADNR, and ADF&G (Fairbanks)	17-Jun-13	USFWS
Liberty Shallow Hazard's Survey (BOEM Meeting)	2-Jul-13	BOEM
ADF&G and USFWS	17-Aug-13	ADF&G and USFWS
Liberty BOEM Meeting – Discuss survey grid design with the intent of fulfilling new NTL revisions	28-Aug-13	BOEM
ADF&G – Liberty was mentioned/discussed	22-Nov-13	ADF&G
ADF&G	5-Dec-13	ADF&G
USACE Preapplication (slides)	13-Jan-14	USACE
NSB – Proposed Liberty Shallow Geohazard Project Overview	17-Jan-14	NSB
USFWS in Fairbanks	6-Feb-14	USFWS
BOEM Geohazard (slides)	6-Mar-14	BOEM
BOEM – Discuss 2013 Geotech Archaeological Report (Mike Tilleman and Mike Brock)	6-Mar-14	BOEM

Table 6-1. Liberty Development Stakeholder Consultation

CATEGORY/DESCRIPTION	DATE	STAKEHOLDER
USFWS (ESA and Conservation Planning Groups)	13-Mar-14	USFWS
Met with ADF&G and ADNR	13-Mar-14	ADF&G and ADNR
BOEM OCS Coring Data – No NPDES Permit Available	17-Mar-14	BOEM
OPMP meeting (ADNR)	24-Mar-14	ADNR
EPA NPDES Geotechnical Permit	8-May-14	EPA
USFWS MMMO – Meeting with Craig Perham	3-Jun-14	USFWS
BOEM Geotech	2-Jul-14	BOEM
BOEM Geohazard	6-Aug-14	BOEM
BOEM Geotech – Pre-Application Meeting with David Johnston	3-Nov-14	BOEM
USFWS – Den Detection Meeting	13-Nov-14	USFWS
BOEM/SHPO – Archaeological Clearance	17-Dec-14	BOEM
EXTERNAL AFFAIRS:		
Nanuq Commission Meeting (BP Building, Anchorage)	17-Oct-13	Nanuq Commission
Alaska Eskimo Whaling Commission (AEWC)	1-Dec-13	AEWC
AEWC	1-Feb-14	AEWC
NSB Planning Commission	27-Feb-14	NSB
Kuukpik President in Nuiqsut	28-Mar-14	Kuukpik
Nuiqsut Whalers Meeting	27-Jun-14	NWCA (Nuiqsut)
AEWC	17-Jul-14	AEWC
NSB Planning Commission	31-Jul-14	NSB
AEWC – Discuss CAA and operational/logistical concerns	12-Dec-14	AEWC

Key: ADEC = Alaska Department of Environmental Conservation; ADF&G = Alaska Department of Fish and Game; ADNR = Alaska Department of Natural Resources; AEWC = Alaska Eskimo Whaling Commission; BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; CAA = Conflict Avoidance Agreement; DPP = Development and Production Plan; EPA = Environmental Protection Agency; ESA = Endangered Species Act; H_2S = hydrogen sulfide; MMMO = Marine Mammals Management Office; NPDES = National Pollutant Discharge Elimination System; NSB = North Slope Borough; NWCA = Nuiqsut Whaling Captains' Association; OCS = Outer Continental Shelf; OPMP = Office of Project Management and Permitting; OSRP = Oil Spill Response Plan; SHPO = State Historic Preservation Office; SOP = Suspension of Production; SPCO = State Pipeline Coordinator's Office; USACE = U.S. Army Corps of Engineers; USDOI = U.S. Department of the Interior; USFWS = U.S. Fish and Wildlife Service; WCD = Worst Case Discharge.

HAK expects to coordinate with following agencies and organizations based on experience with the previous Liberty Development projects and the Liberty ultra-Extended Reach Drill Project:

Federal Agencies

- Bureau of Ocean Energy Management (BOEM; Anchorage and Washington, D.C. offices)

- Bureau of Safety and Environmental Enforcement (BSEE; Anchorage and Washington, D.C. offices)
- U.S. Army Corps of Engineers (USACE)
- U.S. Environmental Protection Agency (EPA; Anchorage and Seattle offices)
- National Marine Fisheries Service (NMFS)
- U.S. Fish and Wildlife Service (USFWS)

State Agencies

- Alaska Department of Natural Resources, Office of Project Management and Permitting (Anchorage)
- Alaska Department of Natural Resources, Division of Oil and Gas (Anchorage)
- Alaska Department of Environmental Conservation, Division of Spill Prevention and Response (Anchorage)
- Alaska Department of Environmental Conservation, Division of Air Quality (Juneau)
- Alaska Department of Natural Resources, Division of Mining, Land, and Water (Anchorage and Fairbanks)
- Alaska Oil and Gas Conservation Commission

North Slope Borough (Local) Agencies and Organizations

- North Slope Borough Planning and Community Affairs Department
- North Slope Borough Wildlife Department
- North Slope Borough Planning Commission
- North Slope Borough Mayor's Office
- City of Barrow
- Iñupiat Community of the Arctic Slope
- Native Village of Barrow
- Arctic Slope Regional Corporation
- Kuukpik Corporation
- Alaska Eskimo Whaling Commission

7. REFERENCES

74 FR 56260. 2010. Final Rule for the Mandatory Reporting of Greenhouse Gases. Environmental Protection Agency, U.S. Department of Interior. 56260-56511.

75 FR 74458. Final Rule for the Mandatory Reporting of Greenhouse Gases: Petroleum and Natural Gas Systems. Environmental Protection Agency, U.S. Department of the Interior. 74458-74515.

Aagaard, K. 1984. The Beaufort Undercurrent. In: The Alaskan Beaufort Sea, Ecosystems and Environments. P.W. Barnes, D.M. Schell, and E. Reimnitz, eds. Orlando, FL: Academic Press, Inc., pp. 47-71.

ACFEC (Alaska Commercial Fisheries Entry Commission). 2013a. Fishery Statistics - Participation & Earnings. Available online at http://www.cfec.state.ak.us/fishery_statistics/earnings.htm. Accessed August 8, 2013.

ACFEC (Alaska Commercial Fisheries Entry Commission). 2013b. Fishery Statistics - Permits & Permit Holders. Available online at http://www.cfec.state.ak.us/fishery_statistics/permits.htm. Accessed August 8, 2013.

Adams, L.G., R.W. Stephenson, B.W. Dale, R.T. Ahgook, and D.J. Demma. 2008. Population dynamics and harvest characteristics of wolves in the central Brooks Range, Alaska. Wildlife Monographs 170:1-25.

ADCCED (Alaska Department of Commerce, Community and Economic Development). 2013a. Alaska Taxable Database. Available online at http://www.commerce.state.ak.us/dca/osa/osa_summary.cfm. Accessed August 8, 2013.

ADCCED (Alaska Department of Commerce, Community and Economic Development). 2013b. Financial Documents Delivery System. Available online at http://www.commerce.state.ak.us/dca/commfin/CF_FinRec.cfm. Accessed August 8, 2013.

ADEC (Alaska Department of Conservation). 2012. Water Quality Standards. Amended April 8, 2012. 18 AAC 70. Available online at http://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2070.pdf. Accessed July 30, 2013.

ADEC (Alaska Department of Environmental Conservation). 2008. Draft Summary Report of Improvements to the Alaska Greenhouse Gas Emission Inventory. Juneau, Alaska.

ADEC (Alaska Department of Environmental Conservation). 2010. Alaska's Final 2010 Integrated Water Quality Monitoring and Assessment Report. July 15, 2010. Available online at http://dec.alaska.gov/water/wqsar/Docs/2010_Integrated_Report_Final_20100715_corrected_july_19.pdf. Accessed March 4, 2014.

ADEC (Alaska Department of Environmental Conservation). 2010. Alaska's Final 2010 Integrated Water Quality Monitoring and Assessment Report. July 15, 2010. Available online at http://dec.alaska.gov/water/wqsar/Docs/2010_Integrated_Report_Final_20100715_corrected_july_19.pdf. Accessed March 4, 2014.

ADEC (Alaska Department of Environmental Conservation). 2012a. Water Quality Standards. Amended April 8, 2012. 18 AAC 70. Available online at http://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2070.pdf. Accessed July 30, 2013.

ADEC (Alaska Department of Environmental Conservation). 2012b. Drinking Water. Amended August 20, 2012. 18 AAC 80. Available online at https://dec.alaska.gov/commish/regulations/pdfs/18%20AAC%2080.pdf. Accessed July 1, 2014.

ADEC (Alaska Department of Environmental Conservation). 2015. Drinking Water Protection Map. Available online at http://dec.alaska.gov/eh/dw/DWP/protection_areas_map.html. Accessed February 17, 2015.

ADF&G (Alaska Department of Fish and Game). 2006. Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources. Alaska Department of Fish and Game, Juneau, Alaska. xviii+824 pp. Available online at http://www.adfg.alaska.gov/index.cfm?adfg=species.wapabout. Accessed January 13, 2014.

ADF&G (Alaska Department of Fish and Game). 2013a. Atlas to the catalog of waters important to the spawning, rearing, or migration of anadromous fishes. Alaska Department of Fish and &Game, Division of Sport Fish, Anchorage, Alaska. Available online at http://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=data.GIS. Accessed January 2014.

ADF&G (Alaska Department of Fish and Game). 2013b. North Slope Management Area: Harvest. Available online at http://www.adfg.alaska.gov/index.cfm?adfg=ByAreaInteriorNorthSlope.fishingInfo#/harvest. Accessed September 17, 2013.

ADF&G (Alaska Department of Fish and Game). 2013c. Alaska Department of Fish and Game Community Subsistence Information System. Constantly updated website (as studies are finalized). Available online at www.adfg.alaska.gov/sb/CSIS/. Accessed September 17, 2013.

ADLWD (Alaska Department of Labor and Workforce Development). 2013a. Population Estimates. Research & Analysis Section, Juneau, AK. Available online at http://laborstats.alaska.gov/pop/popest.htm. Accessed August 7, 2013.

ADLWD (Alaska Department of Labor and Workforce Development). 2013b. Alaska Local and Regional Information (ALARI). Research & Analysis Section, Juneau, AK. Available online at http://labor.alaska.gov/research/alari/. Accessed August 7, 2013.

ADLWD (Alaska Department of Labor and Workforce Development). 2013c. Residency of Alaska Workers: 2011. Research and Analysis Section, Juneau, AK.

ADNR (Alaska Department of Natural Resources). 1975. Beaufort Island Area Lease Sale Public Hearing: Barrow. Alaska Department of Natural Resources: np. Transcript does not indicate transcriber. Hearings were conducted only in Barrow and Fairbanks. Testimony from Thomas Napageak of Nuiqsut.

ADNR (Alaska Department of Natural Resources). 1998. Oil and Gas Lease Sale 87, North Slope Areawide, Final Finding of the Director. Volume I.

ADNR (Alaska Department of Natural Resources). 2001. Oil and Gas Lease Sale, North Slope Foothills Areawide 2001, Final Finding of the Director.

ADNR, OHA (Alaska Department of Natural Resources, Office of History and Archaeology). 2005. Alaska Heritage Resource Survey. Database maintained by Office of History and Archaeology. Anchorage, AK.

ADNR (Alaska Department of Natural Resources). 2010. Dalton Highway Scenic Byway Corridor Partnership Plan, Prepared for Alaska Department of Transportation and Public Facilities, State Scenic Byways Program. Available online at http://www.dot.state.ak.us/stwdplng/scenic/daltoncpp/DaltonHighwayScenicBywayCorridorPartnershipPlan_FINAL.pdf. Accessed March 4, 2014.

ADNR (Alaska Department of Natural Resources). 2013. Beaufort Sea Areawide 2013, Competitive Oil and Gas Lease Sale, Mitigation Measures and Lessee Advisories. Lease Sale Document: BS2013W_Mitigation_Measures.pdf, Available online at http://dog.dnr.alaska.gov/leasing/Documents/BeaufortSea/2013W/BS2013W_Mitigation_Measures.pdf. Accessed February 13, 2014. 12 pp.

Aerts, L., M. Blees, S. Blackwell, C. Greene, K. Kim, D. Hannay, and M. Austin. 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 Report P1011-1. Report by LGL Alaska Research Associates Inc., LGL Ltd., Greeneridge Sciences Inc. and JASCO Applied Sciences for BP Exploration Alaska. 199 p. Available online at http://www.nmfs.noaa.gov/pr/pdfs/permits/bp_liberty_monitoring.pdf. Accessed March 4, 2014.

AKNHP (Alaska Natural Heritage Program). 2013. Alaska Exotic Plant Information Clearinghouse Database. Alaska Natural Heritage Program, University of Alaska, Anchorage. Available online at http://aknhp.uaa.alaska.edu/maps/akepic/. Accessed September 8, 2014.

ADR (Alaska Department of Revenue). 2013. Revenue Sources Book: Spring 2013 Revenue Forecast. State of Alaska, Department of Revenue, Tax Division, Juneau, AK. Available online at http://www.tax.alaska.gov/programs/documentviewer/viewer.aspx?975r. Accessed March 4, 2014.

Allen, B. M. and R. P. Angliss. 2011. Alaska marine mammal stock assessments, 2010. U.S. Dep. Commerce, NOAA Technical Memo. NMFSAFSC-223, 292 p.

Allen, B.M., and R.P. Angliss. 2012. Alaska marine mammal stock assessment, 2011. U.S. Department of Commerce, NOAA Technical Memorandum No. NMFS–AFSC–234.

Allen, B.M., and R.P. Angliss. 2013. Alaska marine mammal stock assessment, 2012. U.S. Department of Commerce, NOAA Technical Memorandum No. NMFS-AFSC-245.

Allen, J.A. 1912. The probable recent extinction of the Muskox in Alaska. Science 36:720-722.

AMS (American Meteorological Society). 2013. Glossary of Meteorology. Available online at http://glossary.ametsoc.org/ ?id=climate-change1. Accessed October 14, 2013.

Amstrup, S.C. 1993. Human disturbances of denning polar bears in Alaska. Arctic46(3):246–250.

Amstrup, S.C. 2000. Polar bear. Pages 133-157 in J.C. Truett and S.R. Johnson, eds. The Natural History of an Arctic Oilfield: Development and the Biota. Academic Press, New York.

Amstrup, S.C. 2003. Polar bear maternal den distribution in northern Alaska, unpublished report extracted from the Alaska Biological Science Center Polar Bear Research Database. Anchorage, AK: U.S. Geological Survey, Biological Resources Division.

Amstrup, S.C. and C. Garner. 1994. Polar bear maternity denning in the Beaufort Sea. The Journal of Wildlife Management 58:1–10.

Amstrup, S.C., G.M. Durner, I. Stirling, N.J. Lunn, and F. Messier. 2000. Movements and distribution of polar bears in the Beaufort Sea. Canadian Journal of Zoology 78:948–966.

Amstrup, S.C. G.M. Durner, I. Stirling, and T.L. McDonald. 2005. Allocating harvests among polar bear stocks in the Beaufort Sea. Arctic 58:247–259.

Amstrup, S.C., G.M. Durner, T.L. MacDonald, and W.R. Johnson. 2006. Estimating potential effects of hypothetical oil spills on polar bears. U.S. Geological Survey, Alaska Science Center, Anchorage, AK. Final report to U.S. Minerals Management Service. Anchorage, AK.

Anderson, C.M., and R.P. LaBelle. 2000. Update of Comparative Occurrence Rates for Offshore Oil Spill. Spill Science and Technology 65(6):303–321. Available online at http://www.boem.gov/Environmental-Stewardship/Environmental-Assessment/Oil-Spill-Modeling/AndersonAndLaBelle2000-pdf.aspx

Anderson, C.M., M. Mayes, and R. LaBelle. 2012. Update of Occurrence Rates for Offshore Oil Spill. OCS Report. BOEM 2012-069. Available online at http://www.boem.gov/uploadedFiles/BOEM/Environmental_Stewardship/Environmental_Assessment/Oil_Spill_Modeling/AndersonMayesLabelle2012.pdf

Anthony, R.M., N.M. Barten, and P.E. Seiser. 2000. Foods of arctic foxes (Alopex lagopus) during winter and spring in western Alaska. Journal of Mammalogy 813:820-828.

AOGA (Alaska Oil and Gas Association). 2013. 2011 North Slope Borough. Available online at http://www.aoga.org/facts-and-figures/economic-impact-reports/2011-north-slope-borough. Accessed August 7, 2013.

AOGCC (Alaska Oil and Gas Conservation Commission). 2013. Oil and Gas Pool Statistical Reports. Available online at http://doa.alaska.gov/ogc/annual/current/18_Oil_Pools/Badami%20-%20Oil/Badami,%20Badami%20-%20Oil/1_Oil_1.htm. Accessed August 7, 2013.

APFC (Alaska Permanent Fund Corporation). 2009. An Alaskan's Guide to the Permanent Fund. Available online at http://www.apfc.org/home/Media/publications/2009AlaskansGuide.pdf. Accessed August 7, 2013.

Arnold, R.D. 1978. Alaska Native land Claims. Alaska Native Foundation: Anchorage.

Arthur, S.M. and P.A. Del Vecchio. 2009. Effects of oilfield development on calf production and survival in the Central Arctic caribou herd. Alaska Department of Fish and Game. Federal Aid in Wildlife Restoration. Final Research Technical Report. Grans W-27-5, and W-33-1 through W-33-4, Project 3.46. Juneau, Alaska.

Arthur, S.M. and P.A. Del Vecchio. 2013. Population dynamics of muskoxen in northeastern Alaska. Alaska Department of Fish and Game, Final Wildlife Research Report ADF&G/DWC/WRR-2013-1, Project 10.10, Juneau, Alaska. 30 pp.

ASG (Alaska Shorebird Group). 2008. Alaska Shorebird Conservation Plan. Version II. Alaska Shorebird Group, Anchorage, AK. 84 pp.

ASRC (Arctic Slope Regional Corporation). 2013. Companies. Available online at http://www.asrc.com/companies/Pages/Companies.aspx. Accessed August 8, 2013.

ASRC (Arctic Slope Regional Corporation). 2014. Oil. Available online at http://www.asrc.com/lands/pages/oil.aspx. Accessed June 2, 2014. Audubon Alaska. 2013. Important Bird Areas. Available online at: http://ak.audubon.org/important-bird-areas-4. See also: Nominated Globally Important Bird Areas of the Arctic Ocean. Available online at http://ak.audubon.org/sites/default/files/documents/arctic_ocean_nominated_global_ibas.jpg. Accessed January 29, 2014.

Aumack, C.F., K.H. Dunton, A.B. Burd, D.W. Funk, and R.A. Maffione. 2007. Linking light attenuation and suspended sediment loading to benthic productivity within an arctic kelp bed community. Journal of Phycology 43(5):853-863.

Baird, R. 2001. Status of killer whales, *Orcinus orca*, in Canada. The Canadian Field Naturalist 115:676–701.

Ballard, W.B., L.E. Ayres, D.J. Reed, S.G. Fancy, and K.E. Roney. 1993. Demography of Grizzly Bears in Relation to Hunting and Mining Development in Northwest Alaska. Scientific Monograph NPS/NRARO/NRSM-93/23. U.S. Department of the Interior, National Park Service, Anchorage, Alaska.

Ballard, W.B., M.A. Cronin, R. Rodrigues, R.O. Skoog, and R.H. Pollard. 2000. Arctic Fox, *Alopex lagopus*, den densities in the Prudhoe Bay Region, Alaska. Canadian Field-Naturalist 114:453-456.

Ballard W.B., E.H. Follmann, D.G. Ritter, M.D. Robards, and M.A. Cronin. 2001. Rabies and canine distemper in an arctic fox population in Alaska. Journal of Wildlife Diseases 37:133-137.

Ban, S. M., J. Colonell, K.H. Kunton, and B. Gallaway. 1999. Liberty Development: Construction Effects on Boulder Patch Kelp Production. Draft report prepared for BP Exploration Alaska Inc. Anchorage, AK.

Barboza, P.S., K.L. Parker, and I.D. Hume. 2009. Integrative wildlife nutrition. Springer Verlag Berlin Heidelberg

Barnes, P. W. and E. Reimnitz. 1974. Sedimentary process on arctic shelves off the northern coast of Alaska. In: The Coast and Shelf of the Beaufort Sea. Reed, J.C., and Sater, J.E. (eds.). Arlington, VA: Arctic Institute of North America. 436-479.

Barrie, L., and R.M. Hoff. 1985. Five years of air chemistry observations in the Arctic, Atmospheric Environment, 19, pp 1995-2010.

Bélanger, L. and J. Bédard. 1989. Responses of staging greater snow geese to human disturbance. Journal of Wildlife Management 53: 713–719.

Bengtson, J.L., P.L. Boveng, L.M. Hiruki-Raring, K.L. Laidre, C. Pungowiyi, and M.A. Simpkins. 2000. Abundance and distribution of ringed seals (*Phoca hispida*) in the coastal Chukchi Sea. pp. 149-160. In A.L. Lopez and D.P. DeMaster. Marine Mammal Protection Act and Endangered Species Act Implementation Program 1999. AFSC Processed Rep. 2000-11, Alaska Fisheries Science Center, Seattle, WA.

Bengtson, J.L., L.M. Hiruki-Raring, M.A. Simpkins, and P.L. Boveng. 2005. Ringed and bearded seal densities in the eastern Chukchi Sea, 1999-2000. Polar Biology 28: 833-845.

Berger, T.R. 1985. Village Journey - The Report of the Alaska Native Review Commission. Hill and Wang. New York.

Bilello, M. 1960. Formation, Growth, and Decay of Sea Ice in the Canadian Arctic Archipelago. In: SIPRE Research Report 65. Wilmette, IL.

Bittner, J.E. 1993. Cultural Resources and the Exxon Valdez Oil Spill. In: Exxon Valdez Oil Spill Symposium, Program and Abstracts, B.J. Spies, L.J. Evans, B. Wright, M. Leonard, and C. Holba, eds. and comps., pp. 13-15. Exxon Valdez Oil Spill Trustee Council, Alaska Sea Grant College Program, American Fisheries Society, Alaska Chapter. Anchorage, AK.

Blackwell, S.B., C.R. Greene, Jr., and W.J. Richardson. 2004a. Drilling and operational sounds from an oil production island in the ice-covered Beaufort Sea. Journal of the Acoustical Society of America 116(5): 3199-3211.

Blackwell, S.B., J.W. Lawson, and M.T. Williams. 2004b. 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(5): 2346-2357.

Blackwell, S.B. and C.R. Greene, Jr. 2005. Underwater and in-air sounds from a small hovercraft. Journal of the Acoustical Society of America 118(6): 6.

Blackwell, S.B. and C.R. Greene, Jr. 2006. Sounds from an oil production island in the Beaufort Sea in summer: Characteristics and contribution of vessels. Journal of the Acoustical Society of America 119(1): 182-196.

Blees, M.K., R. Rodrigues, and M.L. Bourdon. 2010. Howe Island Snow Goose and Brant nest monitoring, Sagavanirktok River delta area, Alaska, 2010. Report for BP Exploration (Alaska), Inc., by LGL Alaska Research Associates, Inc., Anchorage, AK. 16 pp.

BLM (Bureau of Land Management). 1979a. Federal/State Proposed Oil and Gas Lease Sale (Sale BF) Public Hearings: Kaktovik I-III. May 15, 1979. Prepared by Alaska-Wide Court Reporters for USDOI, BLM OCS Office, Anchorage Alaska. Includes public hearing (I), submitted written comments (II), and Village Council meeting the same day as the hearing (III).

BLM (Bureau of Land Management). 1979b. Federal/State Proposed Oil and Gas Lease Sale (Sale BF) Public Hearings: Nuiqsut. May 16, 1979. Prepared by Alaska-Wide Court Reporters for USDOI, BLM, Anchorage.

BLM (Bureau of Land Management). 1980. BLM VRM Manual H-8400, Visual Resource Management. Washington, DC: U.S. Bureau of Land Management.

BLM (Bureau of Land Management). 1982a. Proposed Oil and Gas Lease Sale in the Diapir Field (Sale 71) Public Hearings: Nuiqsut. February 3, 1982. Prepared by Alulaw Court Reporting for USDOI, BLM, Anchorage.

BLM (Bureau of Land Management). 1982b. Proposed Oil and Gas Lease Sale in the Diapir Field (Sale 71) Public Hearings: Kaktovik. February 4, 1982. Prepared by Alulaw Court Reporting for USDOI, Bureau of Land Management: Anchorage.

BLM (Bureau of Land Management). 1984. BLM Handbook H-8410-1, Visual Resource Inventory. Washington, DC: U.S. Bureau of Land Management.

BLM (Bureau of Land Management). 1986. BLM VRM Manual H-8431, Visual Resource Contrast Rating. Washington, DC: U.S. Bureau of Land Management.

BLM (Bureau of Land Management). 2004a. Alpine Satellite Development Plan Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management. BLM/AK/PL-94-017.

BLM (Bureau of Land Management). 2004b. Northwest National Petroleum Reserve-Alaska, Final Integrated Activity Plan/Environmental Impact Statement. In cooperation with the U.S. Department of the Interior, Minerals Management Service. BLM/AK/PL – 04/008+3130+931. Anchorage, AK.

BLM (Bureau of Land Management). 2005. Northeast National Petroleum Reserve-Alaska, Final Amended Integrated Activity Plan/Environmental Impact Statement. BLM/AK/PL – 05/006+1610+930. Anchorage, AK.

BLM (Bureau of Land Management). 2008. Northeast National Petroleum Reserve-Alaska Final Supplemental Integrated Activity Plan/Environmental Impact Statement. Washington, DC: U.S. Bureau of Land Management.

BLM (Bureau of Land Management). 2012. National Petroleum Reserve Alaska-Integrated Activity Plan/Environmental Impact Statement. In cooperation with the North Slope Borough, U.S. Bureau of Ocean Energy Management, U.S. Fish and Wildlife Service.

Boehm, P.D., J. Brown, H. Camp, L. Cook, J. Trefry, R.P. Trocine, R.D. Rember, and G. Shepard. 2001. ANIMIDA Phase I: Arctic Nearshore Characterization and Monitoring of the Physical Environment in the Northstar and Liberty Development Areas. Final Report, OCS Study MMS 2001-104, MMS, Anchorage, Alaska.

BOEM (Bureau of Ocean Energy Management). n.d. Leasing 101: Oil and Gas Leasing on the Outer Continental Shelf. Available online at http://www.boem.gov/uploadedFiles/BOEM/Oil_and_Gas_Energy_Program/Leasing/5BOEMRE_Leasing101.pdf. Accessed April 22, 2014.

BOEM (Bureau of Ocean Energy Management). 2011a. Programmatic Five Year Environmental Impact Statement BOEM Public Hearing: Nuiqsut. December 6, 2011. Prepared by Midnight Sun Court Reporters for USDOI, BOEM: Anchorage.

BOEM (Bureau of Ocean Energy Management). 2011b. Programmatic Five Year Environmental Impact Statement BOEM Public Hearing: Kaktovik. December 7, 2011. Prepared by Midnight Sun Court Reporters for USDOI, BOEM: Anchorage.

BOEM (Bureau of Ocean Energy Management). 2012. Outer Continental Shelf Oil and Gas Leasing Program: 2012-2017. Final Programmatic Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management. BOEM 2012-030.

BOEM Ocean Science Vol. 9, Issue 2, April/May/June 2012 – MAS to investigate publishing info and complete this ref. Also globally change BOEM 2012 to 2012a/ this one is 2012b.

BOEM (Bureau of Ocean Energy Management). 2014. Environmental Assessment: BP Exploration (Alaska) Inc. 2014 Liberty Ancillary Activities Shallow Geohazard Seismic Survey, Beaufort Sea, Alaska. U.S. Department of the Interior, Bureau of Ocean Energy Management. BOEM 2014-056.

BOEM (Bureau of Ocean Energy Management). 2015. Chukchi Sea Planning Area Oil and Gas Lease Sale 193 In the Chukchi Sea, Alaska. Final Second Supplemental Environmental Impact Statement. U.S. Department of the Interior, Bureau of Ocean Energy Management. BOEM 2015-669.

BOEMRE (Bureau of Ocean Energy Management, Regulation, and Enforcement). 2011a. 2012-2017 Five Year Scoping Meetings for Programmatic Environmental Impact Statement: Nuiqsut. February 22, 2011. Prepared by Midnight Sun Court Reporters for USDOI, BOEM: Anchorage.

BOEMRE (Bureau of Ocean Energy Management, Regulation, and Enforcement). 2011b. 2012-2017 Five Year Scoping Meetings for Programmatic Environmental Impact Statement: Kaktovik. February 23, 2011. Prepared by Midnight Sun Court Reporters for USDOI, BOEM: Anchorage.

BOEMRE (Bureau of Ocean Energy Management, Regulation, and Enforcement). 2011c. Beaufort Sea Planning Area, Shell Offshore Inc. 2012 Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska Environmental Assessment. BOEMRE Report No. 2011-039. Available online at http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2011_039.pdf. Accessed January 20, 2014.

BOEMRE (Bureau of Ocean Energy Management, Regulation, and Enforcement). 2011d. Biological Evaluation for Oil and Gas Activities on the Beaufort and Chukchi Sea Planning Areas. Prepared for the Fish and Wildlife Service 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. Alaska Outer Continental Shelf. September.

Boggs, K., T.V. Boucher, T.T. Kuo, D. Fehringer, and S. Guyer. 2012. Vegetation Map and Classification: Northern, Western and Interior Alaska. Draft. November 2012 Version. Alaska Natural Heritage Program, University of Alaska Anchorage, Anchorage, Alaska. 88 pp.

Booth, S., D. Zeller, and D. Pauly. 2008. Baseline Study of Marine Fisheries Catches from Arctic Alaska: 1950-2006. Fisheries Centre, University of British Columbia, Vancouver, BC, Canada.

Born, E.W., F.F. Riget, R. Dietz, and D. Andriashek. 1999. Escape responses of hauled out ringed seals (*Phoca hispida*) to aircraft disturbance. Polar Biology 21(3):171-178.

Boveng, P.L., J.L. Bengtson, T.W. Buckley, M.F. Cameron, S.P. Dahle, B.A. Megrey, J.E. Overland, and N.J. Williamson. 2008. Status review of the ribbon seal (*Histriophoca fasciata*). U.S. Department of Commerce., NOAA Technical Memorandum NMFS-AFSC-191.

Boveng, P.L., J.L. Bengtson, T.W. Buckley, M.F. Cameron, S.P. Dahle, B.P. Kelly, B.A. Megrey, J.E. Overland, and N.J. Williamson. 2009. Status review of the spotted seal (*Phoca largha*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS–AFSC–200.

BPXA (BP Exploration (Alaska) Inc.). 2000. Liberty Development Project Development and Production Plan. July 2000. Prepared by BP Exploration (Alaska) Inc. for U.S. Minerals Management Service, Alaska OCS Region, Anchorage, Alaska.

BPXA (BP Exploration (Alaska) Inc.). 2007. Liberty Development Project Environmental Impact Analysis. April 2007. Liberty Development and Production Plan: Attachment A. Prepared by BP Exploration (Alaska) Inc. for U.S. Minerals Management Service, Alaska OCS Region, Anchorage, Alaska. 302 pp.

BPXA (BP Exploration (Alaska) Inc. 2013a. "Final report – 2013 Geotechnical investigation in Foggy Island Bay, Alaska: LOA for Incidental take of polar bear and Pacific walrus (13-07)" 28 October 2013.

BPXA (BP Exploration (Alaska) Inc. 2013b. Slope-wide Polar bear – walrus monitoring report for BPXA area of operation: Endicott, Prudhoe Bay, Milne Point, Northstar, and the 2013-2014 Liberty Development Project" 20 December 2013.

Bradner, T. 2005a. Oil patch is big business for Alaska Native firms. Alaska Journal of Commerce. Available online at http://classic.alaskajournal.com/stories/101605/foc_20051016027.shtml. Accessed August 8, 2013.

Bradner, T. 2005b. BP to restart Badami production. Alaska Journal of Commerce. Available online at http://classic.alaskajournal.com/stories/061205/oil_20050612025.shtml. Accessed August 8, 2013.

Bradner, T. 2014. Point Thomson field on schedule for 2016 startup, cost pegged at $4B. Alaska Journal of Commerce. Available online at http://www.alaskajournal.com/Alaska-Journal-of-Commerce/January-Issue-3-2014/Point-Thomson-field-on-schedule-for-2016-startup-cost-pegged-at-4B/. Accessed June 2, 2014.

Braem, N.M., S. Pedersen, J. Simon, D. Koster, T. Kaleak, P. Leavitt. J. Patkotak, and P. Neakok. 2011. Monitoring of Annual Caribou harvests in the National Petroleum Reserve in Alaska: Atqasuk, Barrow, and Nuiqsut, 2003-2007. Technical Paper No. 361, Alaska Department of Fish and Game, Division of Subsistence: Fairbanks.

Braham, H.W., J.J. Burns, G.A. Fedoseev, B.D. Krogman. 1984. Habitat partitioning by ice-associated pinnipeds: distribution and density of seals and walruses in the Bering Sea, April 1976. In: Fay F.H., Fedoseev GA (eds) Soviet-American cooperative research on marine mammals, Vol. 1. Pinnipeds. U.S. Dept. Commerce, NOAA Tech Rep NMFS 12, pp. 25–47.

Bricelj, V.M. and Malouf, R.E. 1984. Influence of algal and suspended sediment concentrations on the feeding physiology of the hard clam *Mercenaria mercenaria*. Marine Biology 84:155-165.

Brower, H., Sr. 2004. The Whales, They Give Themselves: Conversations with Harry Brower, Sr. Edited by Karen Brewster. University of Alaska Press: Fairbanks.

Brower, Jr., W.A., R.G. Baldwin, C.N. Williams, Jr., J.S. Wise, L.D. Leslie. 1988. Climatic Atlas of the Outer Continental Shelf Waters and Coastal Regions of Alaska. Vol. 3, Chukchi-Beaufort Sea. Arctic Environmental Information Data Center, University of Alaska, Anchorage, AK.

Brower, H.K. and R. “Taqulik” Hepa. 1998. North Slope Borough Subsistence Harvest Documentation Project: Data for Nuiqsut, Alaska for the Period July 1, 1994, to June 30, 1995. North Slope Borough Department of Wildlife Management: Barrow. (revised version).

Brower, H.K.; T.P. Olemaun; and R. “Taqulik” Hepa. 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.

Brown, W.E. 1979. Nuiqsut Paisanich: Nuiqsut Heritage, A Cultural Plan. Prepared for the Village of Nuiqsut and the North Slope Borough Planning Commission on History and Culture. University of Alaska, Arctic Environmental Information and Data Center: Anchorage.

Brown, J., P. Boehm, L. Cook, J. Trefry, and W. Smith. 2004. ANIMIDA Task 2: Hydrocarbon and Metal Characterization of Sediments, Bivalves and Amphipods in the ANIMIDA Study Area. Final Report. OCS Study, MMS 2004-024. Anchorage, AK: U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region.

Brown, J., P. Boehm, L. Cook, J. Trefry, W. Smith, and G. Durell. 2010. cANIMIDA Task 2: Hydrocarbon and Metal Characterization of Sediments in the cANIMIDA Study Area. Final Report. OCS Study MMS 2010-004. Anchorage, AK: U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region.

Brown, S., J. Bart, R.B. Lanctot, J.A. Johnson, S. Kendall, D. Payer, and J. Johnson. 2007. Shorebird abundance and distribution on the coastal plain of the Arctic National Wildlife Refuge. The Condor 109:1-14.

Brown, S., S. Kendall, R. Churchwell, A. Taylor, and A.-M. Benson. 2012. Relative shorebird densities at coastal sites in the Arctic National Wildlife Refuge. Waterbirds 35(4):546-554.

Brueggeman, J., B. Watts, M. Wahl, P. Seiser, and A. Cyr. 2009. Marine mammal surveys at the Klondike and Burger survey areas in the Chukchi Sea during the 2008 open water season. Report for ConocoPhillips Alaska, Inc., and Shell Exploration and Production by Canyon Creek Consulting, LLC, Seattle, WA.

Burgess, R.M. 2000. Arctic fox. Pages 159-178 in J.C. Truett and S.R. Johnson, eds. The Natural History of an Arctic Oilfield: Development and the Biota. Academic Press, New York.

Burgess, R. M., T. Obritschkewitsch, R. J. Ritchie, J. E. Shook, A. K. Prichard, and L. B. Attanas. 2012. Surveys for nesting and brood-rearing Brant and Lesser Snow Geese, Barrow to Fish Creek Delta, Alaska, 2011. Report prepared for North Slope Borough, Barrow, AK, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK. 75 pp.

Burns, J.J. 1970. Remarks on the distribution and natural history of pagophilic pinnipeds in the Bering and Chukchi seas. Journal of Mammalogy 51(3):445–454.

Burns, J.J. 1981. Bearded seal *Erignathus barbatus* Erxleben, 1777. In Ridgeway, S.H. and R.J. Harrison (eds.) Handbook of marine mammals, Seals. Academic Press, London, 2:145–170.

Burns, J.J., and S.J. Harbo. 1972. An aerial census of ringed seals, northern coast of Alaska. Arctic 25(4): 279–290.

Burns, J.J., B.P. Kelly, L.D. Aumiller, K.J. Frost, and S. Hills. 1982. Studies of ringed seals in the Alaskan Beaufort Sea during winter: Impacts of seismic exploration. Report from Alaska Department of Fish and Game, Fairbanks, AK. for Outer Continental Shelf Environmental Assessment Program, NOAA

Busdosh, M., Beehler, C.L., Robilliard, G.A. and Tarbox, K.R. 1985. Distribution and abundance of kelp in the Alaskan Beaufort Sea near Prudhoe Bay. Arctic 38:18-22.

Caikoski, J.R. 2010. Units 25A, 25B, 25D, 26 B, and 26C furbearer. Pages 329-347 in P. Harper, editor. Furbearer management report of survey and inventory activities 1 July 2006–30 June 2009. Alaska Department of Fish and Game. Project 7.0. Juneau Alaska.

Cameron, R.D., W.T. Smith, R.G. White, and B. Griffith. 2005. Central Arctic caribou and petroleum development: distributional, nutritional, and reproductive implications. Arctic 58(1):1-9.

Cameron, M.F., J.L. Bengtson, P.L. Boveng, J.K. Jansen, B.P. Kelly, S.P. Dahle, E.A. Logerwell, J.E. Overland, C.L. Sabine, G.T. Waring, and J.M. Wilder. 2010. Status review of the bearded seal (*Erignathus barbatus*). U.S. Department of Commerce, NOAA Technical Memorandum No. NMFS-AFSC-211.

Campbell, J.M. 1974. Report of an Archaeological Reconnaissance of the Arctic Coast of Alaska and Neighboring Islands between the mouths of the Colville and Canning Rivers in 1974. For Covington and Burling.

Cannon, P.J. and S.E. Rawlinson. 1978. The Environmental Geology and Geomorphology of the Barrier Island-Lagoon System Along the Beaufort Sea Coastal Plain from Prudhoe Bay to the Colville River. Annual Report. Boulder, CO: NOAA/OCSEAP.

Carey Jr., A.G. and P.A. Montagna. 1982. Arctic Sea Ice Faunal Assemblage: first approach to description and source of the underice meiofauna. Marine Ecological Progress Series 8:1-8.

Cater, T.C. 2010. Tundra Treatment Guidelines: A Manual for Treating Oil and Hazardous Substance Spills to Tundra, 3rd edition. Alaska Department of Environmental Conservation, Juneau, Alaska. 66 pp.

Case, D. 1984. Alaska Natives and American Laws. University of Alaska Press, Fairbanks, Alaska. [new and revised editions 2002, 2012].

Case, D. 1989. Subsistence and self-determination: can Alaskan natives have a more "effective voice"? University of Colorado Law Review 60(4).

Caulfield, R. and T. Brelsford. 1991. Alaska: Subsistence Policy History. Native Net, Vol. 1999.

CEQ (Council on Environmental Quality). 2010. Memorandum for heads of federal Departments and Agencies, February 18, 2010. Available online at http://www.whitehouse.gov/sites/default/files/microsites/ceq/20100218-nepa-consideration-effects-ghg-draft-guidance.pdf. Accessed November 18, 2013.

Chapin, F. S., III, S. F. Trainor, P. Cochran, H. Huntington, C. Markon, M. McCammon, A. D. McGuire, and M. Serreze. 2014: Ch. 22: Alaska. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, T.C. Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 514-536. http://nca2014.globalchange.gov/report/regions/alaska

Chesemore, D.L. 1967. Ecology of the Arctic Fox in Northern and Western Alaska. M.S. Thesis. University of Alaska, Fairbanks. 148 pp.

CH2M Hill. 1990. Summary of Results of Toxicity Test for ARCO, Prudhoe Bay STP. Prepared by CH2M Hill for ARCO Alaska, Inc.. Anchorage, AK.

Clarke, J.T., C.L. Christman, A.A. Brower, M.C. Ferguson, and S.L. Grassia. 2011a. Aerial surveys of endangered whales in the Beaufort Sea, fall 2010. NOAA/NMFS, National Marine Mammal Laboratory, Seattle, WA. Annual report, OCS Study BOEMRE 2011–035.

Clarke, J.T., C.L. Christman, M.C. Ferguson, and S.L. Grassia. 2011b. Aerial surveys of endangered whales in the Beaufort Sea, fall 2006–2008. NOAA/NMFS, National Marine Mammal Laboratory, Seattle, WA. Final report, OCS Study BOEMRE 2010–033.

Clarke, J.T., C.L. Christman, S.L., Grassia, A.A. Brower, and M.C. Ferguson. 2011c. Aerial surveys of endangered whales in the Beaufort Sea, fall 2009. NOAA/NMFS, National Marine Mammal Laboratory, Seattle, WA. Final report, OCS Study BOEMRE 2010–40.

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort seas, 2011. NOAA/NMFS, National Marine Mammal Laboratory, Seattle, WA. Annual Report, OCS Study BOEM 2012009.

Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. Ferguson. 2013. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2012. Annual Report, OCS Study BOEM 2013-00117. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Coastal Frontiers Corporation. 1996. Coastal Stability Analysis: Northstar Pipeline Shore Crossing. In: Northstar Development Project Preliminary Engineering Report. Anchorage, AK: BPXA.

Coastal Frontiers Corporation. 1997. Personal communication with P. Gadd and C. Leidersdorf regarding observations made during yearly summer offshore surveys conducted in the Stefansson Sound and Prudhoe Bay region from 1982 through 1996. Chatsworth, CA.

Coastal Frontiers Corporation. 1998. Liberty Development 1997 Pipeline Route Survey. Anchorage, AK: BPXA, 62 pp.

Coastal Frontiers Corporation. 1999a. Climatic Data Pertaining to River Overflood and Strudel Drainage in the Liberty Development Project Area. Memorandum Dated August 26, 1999. Anchorage, AK: BPXA.

Coastal Frontiers Corporation. 1999b. Liberty Development 1998 Pipeline Route Survey. Anchorage, AK: BPXA, 54 pp.

Coastal Frontiers Corporation. 2000. Liberty Development Strudel Drainage Feature and Overflood Limit Comparison Map. BPXA Cartography, File # Bs14336a.dgn.

Coastal Frontiers Corporation. 2003a. 2003 Liberty Development River Overflood Reconnaissance. Memorandum Dated July 18, 2003. Anchorage, AK: BPXA.

Coastal Frontiers Corporation. 2003b. Northstar Development 2003 Gravel Berm Replenishment Program Water Quality Monitoring. Anchorage, AK. BPXA.

Coastal Frontiers Corporation. 2013a. Winter “Through-Ice” Seabed Reconnaissance. Project Report dated May 15, 2013. Anchorage, AK: BPXA.

Coastal Frontiers Corporation. 2013b. Summer 2013 Bathymetric Survey Program. Project Report Dated December 31, 2013. Anchorage, AK: BPXA.

Coastal Frontiers Corporation and LGL Ecological Research Associates. 1998. Liberty Development 1997-98 Boulder Patch Survey. Prepared for BP Exploration (Alaska), Inc. Chatsworth, CA.

Coffing, M.W. and S. Pedersen. 1985. Caribou Hunting: Land Use Dimensions, Harvest Level, and Cultural Aspects of the Regulatory Year 1983-1984 in Kaktovik, Alaska. Technical Paper No. 120. Alaska Department of Fish and Game. Fairbanks, AK.

Colarco, P.R., M.R. Schoeberl, B.G. Doddridge, L.T. Marufu, O. Torres, and E.J. Welton. 2004. Transport of smoke from Canadian forest fires to the surface near Washington, D.C.: injection height, entrainment, and optical properties, Journal of Geophysical Research, 109, D06203, doi:10.1029/2003JD004248.

Colony, R. 1979. Dynamics of Nearshore Ice. In: Environmental Assessment of the Alaskan Continental Shelf. Final Reports. Vol. 2. pp. 156-180.

Cornett, S. and R. Kowalchuk. 1985. Statistical Analysis of Ice Movement in the Beaufort Sea Using ARGOS Buoy Data. APOA Project 222. Calgary, Alberta, Canada: Canadian Marine Drilling Ltd.

Cortes-Burns, J., M.S. Carlson, R. Lipkin, L. Flagstad, and D. Yokel. 2009. Rare Vascular Plants of the North Slope A Review of the Taxonomy, Distribution, and Ecology of 31 Rare Plant Taxa that Occur in Alaska's North Slope Region. BLM Alaska Technical Report 58. U.S. Department of the Interior, Bureau of Land Management. 124 pp.

Cox, G. 1976. Sea Ice Conditions Along the North Coast of Alaska, Cape Halkett to Camden Bay, June through October, 1953-75. AOGA Project 35. Tulsa, OK: Amoco Production Company.

Craig, P.C. 1984. Fish use of coastal waters of the Alaskan Beaufort Sea: a review. Transactions of the American Fisheries Society 113:265-282.

Craig, P.C. 1987. Subsistence Fisheries at Coastal Villages in the Alaskan Arctic, 1970-1986. Technical Report No. 129, Alaska OCS Socioeconomic Studies Program. Prepared by LGL Ecological Research Associates, Inc. for the USDOI, MMS, Alaska OCS Region: Anchorage, Alaska.

Craig, P.C. 1989. An introduction to anadromous fishes in the Alaskan Arctic. BioI. Pap. Univ. Alaska 24:27-54.

Craig, P.C. and L. Haldorson. 1981. Beaufort Sea barrier island- lagoon process studies: Final Report, Simpson Lagoon, Part 4, Fish. In: Environmental Assessment of the Alaskan Outer Continental Shelf. BLM/NOAA OCSEAP, Final Reports of Principal Investigators, Vol. 7:384-678.

Craig, P.C., and P.J. McCart. 1974. Fall spawning and overwintering areas of fish populations along routes of proposed pipeline between Prudhoe Bay, AK, and the Mackenzie Delta. Arctic Gas Biological Report Series 15.36 pp.

Craig, P.C., W.B. Griffiths, L. Haldorson, and H. McElderry. 1982. Ecological studies of Arctic cod (*Boreogadus saida*) in Beaufort Sea coastal waters, Alaska. Canadian Journal of Fisheries and Aquatic Science 39:395-406.

Croll, D.A., C.W. Clark, J. Calambokidis, W.T. Ellison, and B.R. Tershy. 2001. Effect of anthropogenic low-frequency noise on the foraging ecology of Balaenoptera whales. Animal Conservation 4:13-27.

Cronin, M.A., B.J. Pierson, S.R. Johnson, L.E. Noel, and W.B. Ballard. 1997. Caribou population density in the Prudhoe Bay region of Alaska. Journal of Wildlife Research 2:59–68.

Cronin, M.A., H.A. Whitlaw, and W.B. Ballard. 2000. Northern Alaska oilfields and caribou. Wildlife Society Bulletin 28:919–922.

Cronin, M.A., R. Shideler, L. Waits, and R.J. Nelson. 2005. Genetic variation and relatedness in grizzly bears in the Prudhoe Bay region and adjacent areas in northern Alaska. Ursus 16(1):70-84.

Cronin, M.A., W.B. Ballard, J. Truett, and R. Pollard. 1994. Mitigation of the Effects of Oil Field Development Transportation Corridors on Caribou. Prepared for the Alaska Caribou Steering Committee by LGL Alaska Research Associates, Inc., Anchorage, AK.

Cusson, M., P. Archambault, and A. Aitken. 2007. Biodiversity of benthic assemblages on the Arctic continental shelf: historical data from Canada. Marine Ecological Progress Series 331:291-304.

Dames and Moore. 1989. Shallow neritic fish of the central Beaufort Sea. For: British Petroleum Exploration.

Dau, C.P., and K.S. Bollinger. 2009. Aerial population survey of Common Eider and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 1–5 July 2009. Report prepared by U.S. Fish and Wildlife Service, Anchorage, AK. 20 pp.

Dau, C.P. and K.S. Bollinger. 2012. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 2–7 July 2011. Report prepared by U.S. Fish and Wildlife Service, Anchorage, AK. 20 pp.

Dau, C.P. and W.W. Larned. 2008. Aerial population survey of common eiders and other waterbirds in near shore waters and along barrier islands of the Arctic Coastal Plain of Alaska, 24-26 June 2008. Report prepared by U.S. Fish and Wildlife Service, Anchorage, AK. 21 pp.

Davidson, A. (ed.). 1974. Education and the Subsistence Way of Life in *Does One Way of Life Have to Die so Another Can Live? A Report on Subsistence and the Conservation of the Yupik Life-Style.* Presented/Published by Yupiktak Bista:np. Available online at www.ankn.uaf.edu/Curriculum/Books/DoesOneWay/EDUCATION.html. Accessed April 22, 2014.

Day, R.H., A.K. Prichard, and J.R. Rose. 2005. Migration and collision avoidance of eiders and other birds at Northstar Island, Alaska, 2001–2004. Report for BP Exploration (Alaska), Inc., Anchorage, AK, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK. 142 pp.

Dekin, A.A., Jr. 1993. Exxon Valdez Oil Spill Archaeological Damage Assessment, Management Summary, Final Report. U.S. Department of Agriculture, Forest Service. Juneau, AK.

Delarue, J., B. Martin, D. Hannay, and C.L. Berchok. 2013. Acoustic occurrence and affiliation of fin whales detected in the northeastern Chukchi Sea, July to October 2007–2010. Arctic 66:159–172.

DeMaster, D.P. and I. Stirling. 1981. *Ursus maritimus*. pp. 1-7 in Mammalian Species No. 145. American Society of Mammalogists, Lawrence, KS.

DF Dickens (D.F. Dickens and Associates Ltd.). 1999. Sea Ice Overflood Limits Affecting the Liberty Pipeline Route: Results of a Literature Search and Satellite Image Analysis. Anchorage, AK: BPXA, 13 pp.

Divoky G. J., G. A. Sanger, S. A. Hatch, and J.C. Haney. 1988. Fall migration of Ross's Gull (Rhodostethia rosea) in Alaskan Chukchi and Beaufort seas. Report prepared by U.S. Fish and Wildlife Service, Anchorage, AK, for Minerals Management Service, Anchorage, AK. Report No. MMS 88-0023. 120 pp.

Doneker, R.L. and G.H. Jirka. 2012. CORMIX User Manual - A Hydrodynamic Mixing Zone Model and Decision Support System for Pollutant Discharges into Surface Waters. Prepared for U.S. Environmental Protection Agency. EPA-823-K-07-001 – 2012 update.

Dorsey, E.M., S.J. Stern, A.R. Hoelzel, and J. Jacobsen. 1990. Minke whale (*Balaenoptera acutorostrata*) from the west coast of North America: individual recognition and small scale site fidelity. Report of the International Whaling Commission (Special Issue 12):357–368.

Duane Miller and Associates. 1997. Geotechnical Exploration, Liberty Development Project, Foggy Island Bay, Alaska. Report for BP Exploration (Alaska) Inc., Anchorage, AK.

Duane Miller and Associates. 1998. Geotechnical Exploration, Liberty Development North Slope, Alaska. Prepared for BP Exploration (Alaska) Inc., Anchorage, Alaska.

Dunton, K.H. 1990. Growth and production in *Laminaria solidungula*: relation to continuous underwater light levels in the Alaskan High Arctic. Marine Biology 98:277-285.

Dunton K.H. 1992. Arctic biogeography: the paradox of the marine benthic fauna and flora. Trends in Ecology & Evolution 7:183-189.

Dunton, K.H. and D.M. Schell. 1986. Seasonal carbon budget and growth of *Laminaria solidungula* in the Alaskan High Arctic. Marine Ecological Progress Series 31:57-66

Dunton, K.H. and D.M. Schell. 1987. Dependence of consumers on macroalgal (*Laminaria solidungula*) carbon in an arctic kelp community: δ13C evidence. Marine Biology 93:615-625.

Dunton, K.H and S.V. Schonberg. 2000. The Benthic Faunal Assemblage of the Boulder Patch Kelp Community. In: Truett, J. C., and Johnson S.R. (eds.) The Natural History of an Arctic Oil Field. Academic Press. pp 371-397.

Dunton, K.H., E. Reimnitz, and S.V. Schonberg. 1982. An arctic kelp community in the Alaskan Beaufort Sea. Arctic 36(4): 495-464.

Dunton, K.H., C. Aumack, and P. Bucolo. 2013. Affected Environment and Preliminary Environmental Impact Assessment of the Boulder Patch Kelp Bed Community. Prepared for BP Exploration (Alaska) Inc. January 15.

Dunton, K.H., S.V. Schonberg, and D.W. Funk. 2009. Interannual and spatial variability in light attenuation: evidence from three decades of growth in the Arctic Kelp, *Laminaria solidungula*. In: Krupnik, I., Lang, M. A., and Miller, S.E. (eds.) Smithsonian at the Poles. Washington D.C. pp 274-284.

Durner, G.M. and S.C. Amstrup. 1995. Movements of a polar bear from northern Alaska to northern Greenland. Arctic 48(4)338–341.

Durner, G.M., S.C. Amstrup, and K.J. Ambrosius. 2001. Remote identification of polar bear maternal den habitat in northern Alaska. Arctic 54:115–121.

Durner, G.M., S.C. Amstrup, and A.S. Fischbach. 2003. Habitat characteristics of polar bear terrestrial maternal den sites in northern Alaska. Arctic 56:55–62.

Durner, G.M., S.C. Amstrup, R. Neilson, and T. McDonald. 2004. The use of sea ice habitat by female polar bears in the Beaufort Sea. U.S. Geological Survey, Alaska Science Center, Anchorage, Alaska. OCS study, MMS. 2004–014.

Durner, G.M., S.C. Amstrup, and K.J. Ambrosius. 2006. Polar bear maternal den habitat in the Arctic National Wildlife Refuge, Alaska. Arctic 59:31–36.

Durner, G.M., D.C. Douglas, R.M. Nielson, S.C. Amstrup, T.L. McDonald, I. Stirling, M. Mauritzen, E.W. Born, Ø. Wiig, E. DeWeaver, M.C. Serreze, S.E. Belikov, M.M. Holland, J. Maslanik, J. Aars, D.A. Bailey, and A.E. Derocher. 2009. Predicting 21st-century polar bear habitat distribution from global climate models. Ecological Monographs 79:25–58.

Durner, G.M., A.S. Fischbach, S.C. Amstrup, and D.C. Douglas. 2010. Catalogue of polar bear (*Ursus maritimus*) maternal den locations in the Beaufort Sea and neighboring regions, Alaska, 1910–2010. U.S. Geological Survey Data Series 568.

Duval, W.S. 1993. Proceedings of a workshop on Beaufort Sea beluga: February 3-6, 1992. Vancouver, BC. Env. Studies Res. Found. Rep. No. 123. Calgary. 33 pp. + appendices.

Earnst, S.L. 2004. Status assessment and conservation plan for the yellow-billed loon (*Gavia adamsii*). Scientific Investigations Report 2004-5258, by U.S. Department of the Interior, U.S. Geological Survey, Reston, VA, 42 pp.

Earnst, S.L., R. Platte, and L. Bond. 2006. A landscape-scale model of Yellow-billed Loon (*Gavia adamsii*) habitat preferences in northern Alaska. Hydrobiologia 567: 227–236.

EBASCO (EBASCO Environmental). 1990. Integration of Circulation Data in the Beaufort Sea. Final Report: MMS and NOAA, 93 pp.

Eberhardt, L.E., R.A. Garrott, and W.C. Hanson. 1983a. Den use by arctic foxes in northern Alaska. Journal of Mammalogy 64:97-102.

Eberhardt, L.E., R.A. Garrott, and W.C. Hanson. 1983b. Winter Movements of Arctic Foxes in a Petroleum Development Area. Canadian Field-Naturalist 97:66-70.

Ellanna, L. J. and G.K. Sherrod. 1984. The Role of Kinship Links in Subsistence Production: Some Implications for Community Organization. Alaska Department of Fish and Game, Division of Subsistence: Juneau.

Ellison, W.T., B.L. Southall, C.W. Clark, and A.S. Frankel. 2012. A new context-based approach to assess marine mammal behavioral responses to anthropogenic sounds. Conservation Biology 26(1): 21-28.

Entrix Inc.. 1985. Prudhoe Bay Waterflood Project Seawater Treatment Plant, Main Outfall Effluent Dispersion Study, 9-19 April 1985. Final Report. Prepared for ARCO Alaska, Inc. by Entrix, Inc. Anchorage, AK.

Environment Canada. 2011. Canada's Emissions Trends. Available online at http://www.ec.gc.ca/doc/publications/cc/COM1374/ec-com1374-en-es.htm. Accessed June 12, 2014.

EPA (Environmental Protection Agency). 2003. Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures. Available online at http://www.epa.gov/nheerl/download_files/publications/PAHESB.pdf. Accessed January 6, 2014.

EPA (Environmental Protection Agency). 2011. PSD and Title V Permitting Guidance for Greenhouse Gases, March 2011. Available online at http://www.epa.gov/nsr/ghgdocs/ghgpermittingguidance.pdf. Accessed December 13, 2013.

EPA (Environmental Protection Agency). 2012a. Our Nation's Air, Status and Trends Through 2010, Climate Change and Air Quality, February 2012. Available online at http://www.epa.gov/airtrends/2011/report/climatechange.pdf. Accessed October 14, 2013.

EPA (Environmental Protection Agency). 2012b, National Ambient Air Quality Standards (NAAQS), Available at http://epa.gov/air/criteria.html, last updated December 14, 2012. Accessed March 10, 2014.

EPA (Environmental Protection Agency). 2013a. 78 Federal Register 230, 40 CFR 98. 2013 Revisions to the Greenhouse Gas Reporting Rule and Final Confidentiality Determinations for New or Substantially Revised Data Elements; Final Rule, November 29, 2013, pp. 71904 - 71981. Available online at http://www.gpo.gov/fdsys/pkg/FR-2013-11-29/pdf/2013-27996.pdf. Accessed June 12, 2014.

EPA (Environmental Protection Agency). 2013b. Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2011, April 12, 2013. Available online at http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf. Accessed October 15, 2013.

EPA (Environmental Protection Agency). 2014. EPA, Climate Impacts in Alaska. Available online at http://www.epa.gov/climatechange/impacts-adaptation/alaska. Accessed June 12, 2014Greenhouse.

ERCE Bioassay Laboratory. 1990. Acute Toxicity of Chemlink 4835 and Nalclear 7768 to Mysis litoralis. Prepared for ARCO Alaska, Inc. by ERCE Bioassay Laboratory, San Diego, CA.

ERCE Bioassay Laboratory. 1991. 1990 Kuparuk Seawater Treatment Plant NPDES Bioassays, Final Report. Prepared for ARCO Alaska, Inc. by ERCE Bioassay Laboratory, San Diego, CA.

Estensen, J.L., S. Hayes, S. Buckelew, D. Green, and D. J. Bergstrom. 2012. Annual Management Report Yukon and Northern Areas 2010. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Anchorage, AK.

Fay, F.H. 1982. Ecology and biology of the Pacific walrus, *Odobenus rosmarus divergens* Illiger. North American Fauna: No. 74.

Fechhelm, R.G., W.B. Griffiths, and W.J. Wilson. 1995. Background information on fish species inhabiting the Northstar Unit, Beaufort Sea, Alaska. For: BP Exploration Inc., Anchorage, AK.

Fechhelm, R.G., B. Streever, and B. J. Gallaway. 2007. The Arctic Cisco (*Coregonus autumnalis*) Subsistence and Commercial Fisheries, Colville River, Alaska: a conceptual model. Arctic. 60(4): 421-429.

Fechhelm, R. G., A. M. Baker, B. E. Haley, and M. R. Link. 2009. Year 27 of the Long-Term Monitoring of Nearshore Beaufort Sea Fishes in the Prudhoe Bay Region: 2009 Annual Report. Report for BP Exploration (Alaska) Inc., by LGL Alaska Research Associates, Inc., Anchorage, AK. 84 pp.

Fischbach, A.S., S.C. Amstrup, and D.C. Douglas. 2007. Landward and eastward shift of Alaskan polar bear denning associated with recent sea ice changes. Polar Biology 30:1395–1405.

Fischer, J.B. and W.W. Larned. 2004. Summer distribution of marine birds in the western Beaufort Sea. Arctic 57(2):143-159.

Fischer, J.B., T.J. Tiplandy, and W.W. Larned. 2002. Monitoring Beaufort Sea waterfowl and marine birds aerial survey component. OCS Study MMS 2002-002. U.S. Fish and Wildlife Service, Division of Migratory Bird Management, Anchorage, Alaska.

Fredrickson, L.H. 2001. Steller's Eider (*Polysticta stelleri*). The Birds of North America Online (A. Poole, ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from http://bna.birds.cornell.edu/bna/species/571. Accessed on March 22, 2014.

Fried, N. 2011. The Trends 100, 25th Edition. Alaska Economic Trends 31 (7):4-11.

Fried, N. 2013. Alaska's Oil and Gas Industry. Alaska Economic Trends 33 (6):4-11.

Frost, G.V., R.J. Ritchie, and T. Obritschkewitsch. 2007. Spectacled and Steller's Eiders Surveys at U.S. Air Force Radar Sites in Northern Alaska, 2006. Final Report. Prepared for U.S. Air Force, Elmendorf Air Force Base by ABR, Inc.—Environmental Research and Services, Fairbanks, Alaska. 68 pp.

Frost, K.J. and L.F. Lowry. 1983. Demersal fishes and invertebrates trawled in the northeastern Chukchi and western Beaufort Seas, 1976-77. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Report NMFS SSRF-764.

Frost, K.J. and L.F. Lowry. 1988. Effects of industrial activities on ringed seals in Alaska, as indicated by aerial surveys. Pp. 15-25 IN W. M. Sackinger, M.O. Jefferies, J.L. Imm and S.D. Treacy (eds). Port and Ocean Engineering Under Arctic Conditions. Volume II. Symposium on Noise and Marine Mammals. Geophysical Institute, University of Alaska, Fairbanks, Fairbanks, AK. 111 pp.

Frost, K.J., L.F. Lowry, and J.J. Burns. 1988. Ringed seals in the Beaufort Sea. Pp. 41–49 in P. R. Becker (ed.). Beaufort Sea (Sale 97) information update. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Anchorage, AK, and U.S. Department of the Interior, Minerals Management Service, Anchorage, AK. OCS Study MMS 86-0047.

Frost, K.J., L.F. Lowry, and G. Carroll. 1993. Beluga whale and spotted seal use of a coastal lagoon system in the northeastern Chukchi Sea. Arctic 46:8–16.

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2002. Monitoring distribution and abundance of ringed seals in northern Alaska. Final report from the Alaska Department of Fish and Game, Juneau, AK., for U.S. Minerals Management Service, Anchorage, AK. OCS Study No. MMS 2002–043.

Frost, K.J., L.F. Lowry, G. Pendleton, and H.R. Nute. 2004. Factors affecting the observed densities of ringed seals, *Phoca hispida*, in the Alaska Beaufort Sea, 1996–99. Arctic 57(2): 115–128.

Fuller, A.S. and J.C. George. 1997. Evaluation of Subsistence Harvest Data from the North Slope Borough 1993 Census for Eight North Slope Villages: for the Calendar Year 1992. North Slope Borough Department of Wildlife Management: Barrow.

Funk, D.W., D. S. Ireland, R. Rodrigues, and W. R. Koski (eds.). 2010. Joint Monitoring Program in the Chukchi and Beaufort seas, open-water seasons, 2006–2008. LGL Alaska Report P1050-3, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Research, Ltd., for Shell Offshore, Inc. and other industry contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. Available online at http://s01.static-shell.com/content/dam/shell-new/local/country/usa/downloads/alaska/report-2006-2008jmpcomprehensivereportdraftfinal.pdf. Accessed January 27, 2014

Funk, D.W., D.S. Ireland, R. Rodrigues, and W.R. Koski (eds.). 2011. Joint monitoring program in the Chukchi and Beaufort seas, open-water seasons, 2006–2009. LGL Alaska Report P1050-2, Report from LGL Alaska Research Associates, Inc., LGL Ltd., Greeneridge Sciences, Inc., and JASCO Applied Sciences, for Shell Offshore, Inc. and other industry contributors, and National Marine Fisheries Service, U.S. Fish and Wildlife Service. Available online at ftp://ftp.lgl.com/Public/2009JMP/2006-2009_JMP_Draft_Comprehensive_Report.pdf. Accessed January 27, 2014.

Gadd, P.E., D.H. Gibson, R.H. Nagel, and C.J. Sonu. 1982. Barrier Island Migration and Change, No Name Island, Beaufort Sea, Alaska", In: Proceedings, Offshore Technology Conference, Houston, Texas. Vol. 1. pp. 673 – 688.

Galginaitis, M. 1990a. Subsistence Resource Harvest Patterns: Nuiqsut. Social and Economic Studies Program Special Report No. 8. Alaska OCS Region, MMS: Anchorage, AK.

Galginaitis, M. 1990b. Subsistence Resource Harvest Patterns: Kaktovik. Social and Economic Studies Program Special Report No. 9. Alaska OCS Region, MMS: Anchorage.

Galginaitis, M. 2007. Annual Assessment of Subsistence Bowhead Whaling near Cross Island, 2006: cANIMIDA Task 7 Final Report. OCS Study MMS Contract Numbers 1435-01-04-CT-32149 and M04PC00032. Report prepared by ASR for the Minerals Management Service, Anchorage, AK.

Galginaitis, M. 2008. Annual Assessment of Subsistence Bowhead Whaling near Cross Island, 2005: Annual Report. OCS Study MMS Contracts 1435-01-04-CT-32149 and M04PC00032. Report from ASR, Anchorage AK prepared for the Minerals Management Service, Anchorage, AK.

Galginaitis, M. 2009. Annual Assessment of Subsistence Bowhead Whaling near Cross Island, 2001-2007: Final Report. OCS Study MMS Contract Numbers 1435-01-04-CT-32149 and M04PC00032. Report prepared by ASR for the Minerals Management Service, Anchorage, AK.

Galginaitis, M. 2013a. Annual Assessment of Subsistence Bowhead Whaling near Cross Island, 2012: Abstract with Tables (and data submission). OCS Study BOEM Contract M08PC20029. Report from ASR, Anchorage AK prepared for the Bureau of Ocean Energy Management, Anchorage, AK.

Galginaitis, M. 2013b. Liberty Project Field Study Report – Subsistence. Prepared by Applied Sociocultural Research for SLR International Corporation: Anchorage, Alaska.

Galginaitis, M. 2013c. Summary of the Subsistence Whaling Season at Cross Island. In: Richardson, W.J. and K.H. Kim (eds.). Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar Oil Development, Alaskan Beaufort Sea, 2012: Annual Summary Report. LGL Rep P1259. LGL Alaska Research Associates Inc. (Anchorage, AK), Greeneridge Sciences Inc. (Santa Barbara, CA), and Applied Sociocultural Resources (Anchorage, AK) for BP Exploration (Alaska) Inc. (Anchorage, AK).

Galginaitis, M. 2014a. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska, 2008-2012: Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). USDOI, BOEM Alaska Region: Anchorage, Alaska. OCS Study BOEM 2013-212. 208 pp.

Galginaitis, M. 2014b. Subsistence Resource Uses Report, BPXA Liberty Development EIA and DPP. Report to SLR and BPXA from Applied Sociocultural Research.

Galginaitis, M., C. Chang, K.M. MacQueen, A.A. Dekin, Jr., and D. Zipkin. 1984. Ethnographic Study and Monitoring Methodology of Contemporary Economic Growth, Socio-Cultural Change and Community Development in Nuiqsut, Alaska. Social and Economic Studies Program Technical Report No. 96. Alaska OCS Region, Minerals Management Service. Anchorage, AK.

Galginaitis, M., C. Gerlach, P. Bowers, and C. Wooley. 2001. Subsistence. In Environmental Report for Trans-Alaska Pipeline System Right-of-Way, Volume 1. Trans Alaska Pipeline System Owners.

Galginaitis, M.S. and W.R. Koski. 2002. Kaktovikmiut whaling: historical harvest and local knowledge of whale feeding behavior. p. 2-1 to 2-30 In Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information, vol. 1, edited by W.J. Richardson and D.H. Thomson. OCS Study MMS 2002-012; LGL Rep. TA2196-7. Rep. from LGL Ltd., King City, Ont., for U.S. Minerals Management Service, Anchorage, AK, and Herndon, VA.

Gallaway, B.J., W. Griffiths, P. Craig, W. Gazey, and J. Helmericks. 1983. An assessment of the Colville River Delta stock of Arctic cisco - Migrants from Canada? Biological Papers of the University of Alaska No. 21:4-23.

Garlich-Miller, J., J.G. MacCracken, J. Snyder, R. Meehan, M. Myers, J.M. Wilder, E. Lance, and A. Matz. 2011. Status review of the Pacific walrus (*Odobenus rosmarus divergens*). U.S. Fish and Wildlife Service, Anchorage, AK.

Garner, G.W., S.T. Knick, and D.C. Douglas. 1990. Seasonal movements of adult female polar bears in the Bering and Chukchi seas, p. 219–226 In Bears: Their biology and management, Vol. 8, a selection of papers from the Eighth International Conference on Bear Research and Management, Victoria, British Columbia, Canada, February 1989.

Garrott, R.A. and L.E. Eberhardt. 1982. Mortality of Arctic Fox Pups in Northern Alaska. Journal of Mammalogy 63:173-174.

George, J.C., L.M. Philo, K. Hazard, D. Withrow, G.M. Carroll, and R. Suydam. 1994. Frequency of killer whale (*Orcinus orca*) attacks and ship collisions based on scarring on bowhead whales (*Balaena mysticetus*) of the Bering–Chukchi–Beaufort seas stock. Arctic 47:247–255.

Geraci, J.R. and D.J. St. Aubin. 1990. Sea mammals and oil: Confronting the risks. Academic Press, Inc. San Diego, CA.

Givens, G.H., S.L. Edmondson, J.C. George, R. Suydam, R.A. Charif, A. Rahaman, D. Hawthorne, B. Tudor, R.A. DeLong, and C.W. Clark. 2013. Estimate of 2011 abundance of the Bering–Chukchi–Beaufort seas bowhead whale population. Presented to the 65th International Whaling Commission, SC/65a/BRG01.

Goetz, K.T., D.J. Rugh, and J.A. Mocklin. 2007. Aerial surveys of bowhead whales in the vicinity of Barrow, Alaska, August–September 2007. In Bowhead whale feeding ecology study (BOWFEST) in the western Beaufort Sea, 2007 Annual Report.

Goetz, K.T., D.J. Rugh, and J.A. Mocklin. 2008. Aerial surveys of bowhead whales in the vicinity of Barrow, Alaska, August–September 2008. In Bowhead whale feeding ecology study (BOWFEST) in the western Beaufort Sea, 2008 Annual Report.

Goetz, K.T., D.J. Rugh, and J.A. Mocklin. 2009. Aerial surveys of bowhead whales in the vicinity of Barrow, Alaska, August–September 2009. In Bowhead whale feeding ecology study (BOWFEST) in the western Beaufort Sea, 2009 Annual Report.

Goetz, K.T., D.J. Rugh, L.V. Brattström, and J.A. Mocklin. 2010. Aerial surveys of bowhead whales near Barrow in late summer 2010. In Bowhead whale feeding ecology study (BOWFEST) in the western Beaufort Sea, 2010 Annual Report.

Goldsmith, S. 2007. How North Slope Oil Has Transformed Alaska's Economy. Institute for Social and Economic Research, University of Alaska, Anchorage. Anchorage, AK.

Goldsmith, S. 2010. The Alaska Permanent Fund Dividend: A Case Study in Implementation of a Basic Income Guarantee. Institute for Social and Economic Research, University of Alaska, Anchorage. Anchorage, AK.

Green, J.E. and S.R. Johnson. 1983. The distribution and abundance of ringed seals in relation to gravel island construction in the Alaskan Beaufort Seal. Pp. 1–28 *In* B.J. Gallaway (ed.), Biological studies and monitoring at Seal Island, Beaufort Sea, Alaska 1982. Report from LGL Ecological Research Associates, Inc. Bryan, TZ. For Shell Oil Co., Houston, TX.

Greene, C.R., Jr. 1997. Underice drill rig sound transmission loss, and ambient noise near Tern Island, Foggy Island Bay, Alaska, February 1997. Greeneridge Report 187-1. Greeneridge Sciences Inc., Santa Barbara, CA, and LGL Alaska Res. Assoc. Inc., Anchorage, AK, for BP Exploration (Alaska) Inc. 22 p.

Greene, C.R., Jr. 1998. Underwater acoustic noise and transmission loss during summer at BP's Liberty Prospect in Foggy Island Bay, Alaskan Beaufort Sea. Greeneridge Report 189-1. Report from LGL Ltd., King City, ON, and Greeneridge Sciences Inc., Santa Barbara, CA, for BP Exploration (Alaska) Inc., Anchorage, AK. 44 p.

Greene, C.R., Jr., S.B. Blackwell, and M.W. McLennan. 2008. Sounds and vibrations in the frozen Beaufort Sea during gravel island construction. Journal of the Acoustical Society of America 123(2): 687-695.

Greer, R. D., R. H. Day, and R. S. Bergman. 2010. Literature review, synthesis, and design of monitoring of ambient artificial light intensity on the OCS regarding potential effects on resident marine fauna. Unpublished report prepared for U.S. Minerals Management Service, Anchorage, AK, by Golder Associates, Mount Laurel, NJ, ABR, Inc.—Environmental Research & Services, Fairbanks, AK, and Rolf Bergman Consulting, Cleveland Height, OH. Contract No. 1435-01-05-CT-39072. 93 pp. <http://www.boem.gov/uploadedFiles/BOEM/BOEM_Newsroom/Library/Publications/MMS_2007-055.pdf>

Griffith, B., D.C. Douglas, N.E. Walsh, D.D. Young, T.R. McCabe, D.E. Russell, R.G. White, R.D. Cameron, and K.R. Whitten. 2002. The porcupine caribou herd. Pages 8–37 in D.C. Douglas, P.E. Reynolds, and E.B. Rhode, editors. Arctic Refuge coastal plain terrestrial wildlife research summaries. U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR–2002-0001.

Gurevich, V.S. 1980. Worldwide distribution and migration patterns of the white whale (beluga), *Delphinapterus leucas*. Rep. International Whaling Commission. 30:465-480.

Guyer, S. and B. Keating. 2005. The impact of ice roads and ice pads on tundra ecosystems, National Petroleum Reserve-Alaska. BLM-Alaska Open File Report 98, April 2005. U.S. Department of the Interior, Bureau of Land Management.

Hannay, D.E., J. Delarue, X. Mouy, B.S. Martin, D. Leary, J.N. Oswald, and J. Vallarta. 2013. Marine mammal acoustic detections in the northeastern Chukchi Sea, September 2007–July 2011. Continental Shelf Research 67:127–146.

Harcharek, R. 1995. North Slope Borough 1993-1994 Economic Profile and Census Report Volume VII. George N. Ahmaogak, Sr. Mayor. North Slope Borough Department of Planning & Community Services, Barrow, Alaska.

Harper, J. and E. Owens. 1981. Analysis of Ice-Override Potential along the Beaufort Seacoast of Alaska. POAC-81. Quebec City, Quebec, Canada.

Harrington, S. 2012. Top 49ers: Gems of the North. Alaska Business Monthly. Available online at http://www.akbizmag.com/Alaska-Business-Monthly/October-2012/Top-49ers-Gems-of-the-North/. Accessed August 8, 2013.

Harris, R.E., G.W. Miller, and W.J. Richardson. 2001. Seal responses to airgun sounds during summer seismic surveys in the Alaskan Beaufort Sea. Mar. Mamm. Sci. 17(4):795-812.

Harwood, L.A. and T.G. Smith. 2002. Whales of the Inuvialuit settlement region in Canada's western Arctic: an overview and outlook. Arctic 55 (Supplement 1):77–93.

Harwood, L.A., S. Innes, P. Norton, and M.C.S. Kingsley. 1996. Distribution and abundance of beluga whales in the Mackenzie Estuary, Southeast Beaufort Sea, and the west Amundsen Gulf during late July 1992. Canadian Journal of Fisheries and Aquatic Sciences 53:2262–2273.

Harwood, L.A., F. McLaughlin, R.M. Allen, J. Illasiak Jr., and J. Alikamik. 2005. First-ever marine mammal and bird observations in the deep Canada Basin and Beaufort/Chukchi Seas: Expeditions during 2002. Polar Biology 23: 250–253.

Hashagen, K.L., G.A. Green, and B. Adams. 2009. Observation of humpback whales in the Beaufort Sea, Alaska. Northwest Naturalist 90:160–162.

Hauser, D.D.W., V.D. Moulton, K. Christie, C. Lyons, G. Warner, C. O'Neill, D. Hannay, and S. Inglis. 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. LGL Rep. P1065-1. Report from LGL Alaska Research Associates Inc. and JASCO Research Ltd., for Eni US Operating Co. Inc., PGS Onshore, Inc., NMFS, and USFWS. 180 p.

Hazard, K. 1988. Beluga whale, *Delphinapterus leuca.* Pp. 195-235, *In* J. W. Lentfer (ed), Selected marine mammals of Alaska. Species accounts with research and management recommendations. Marine Mammal Commission, Washington, D.C.

HDR (HDR, Inc.). 2012. Marine Mammal Monitoring and Mitigation during BP Simpson Lagoon OBC Seismic Survey, Beaufort Sea, Alaska: 90-day Report. Report from HDR, Inc., Anchorage, Alaska for BP Exploration (Alaska) Inc., Anchorage, Alaska.

Hemming, C.R. 1996. Fish surveys of selected coastal streams – Sagavanirktok River to Bullen Point. Alaska Dept. of Fish and Game, Habitat and Restoration Division. Tech. Report No. 96-3.

Henley, W.J. and Dunton, K.H. 1995. A seasonal comparison of carbon, nitrogen, and pigment content in *Laminaria solidungula* and *L. saccharina* (Laminariales, Phaeophyta) in the Alaskan Arctic. Journal of Phycology 31:325-331.

Hershey, A.E., W.B. Bowden, L.A. Deegan, J.E. Hobbie, B.J. Peterson, G.W. Kipphut, G.W. Kling, M.A. Lock, R.W. Merritt, M.C. Miller, J.R. Vestal, and J.A. Schuldt. 1997. The Kuparuk River: a long-term study of biological and chemical processes in an arctic river. pp. 107-130. In A.M. Milner and M.W. Oswood (eds.). Freshwaters of Alaska. Springer-Verlag, New York, NY.

Hobbs, R.C., and J.M. Waite. 2010. Abundance of harbor porpoise (*Phocoena phocoena*) in three Alaskan regions, corrected for observer errors due to perception bias and species misidentification, and corrected for animals submerged from view. Fishery Bulletin 108:251–267.

Hodges, M. and T. Coolbaugh. 2009. Oil spill response summary of in-situ burn practitioners workshop. Freshwater spills symposium. St. Louis, April, 2009.

Hoffman, D., D. Libby, and G. Spearman. 1988. Nuiqsut: Land Use Values Over Time in the Nuiqsut area. North Slope Borough and the Anthropology and Historic Preservation Section of the Cooperative Park Studies Unit, Occasional Paper No. 12. University of Alaska. Fairbanks, AK.

Hopkins, D.M. 1979. The Flaxman formation on the northern Alaska: record of early Wisconsonian shelf glaciation in the High Arctic? XIVth Pacific Science Congress, Khabarovsk, USSR. Abstracts 15:6.

Hopkins, D.M., and R.W. Hartz, 1978, "Shoreline History of Chukchi and Beaufort Seas as an Aid to Predicting Offshore Permafrost Conditions", Environmental Assessment of the Alaskan Continental Shelf, Vol. 12, pp. 503-549.

Hopson. 1976. Mayor Eben Hopson's Warning to the People of the Canadian Arctic. Testimony to the Berger Commission. www.ebenhopson.com/papers/1976/BergerSpeech.html.

Hopson, E. 1978. Mayor Eben Hopson's Testimony, Public Hearing on Proposed Pt. Thompson Lease Sale, July 25.

Huntington, H.P. 2013.Traditional Knowledge Regarding Bowhead Whales and Camden Bay, Beaufort Sea, Alaska. Prepared for the North Slope Borough Department of Wildlife Management: Barrow, Alaska.

IAI (Impact Assessment, Inc.). 1985. Summary: Nuiqsut Field Investigation, November 1985. In Workshop Proceedings: Monitoring Sociocultural and Institutional Change in the Aleutian-Pribilof Region. Alaska OCS Sociocultural Studies Program Technical Report No. 126. Alaska OCS Region, Minerals Management Service. Anchorage, AK.

IAI (Impact Assessment, Inc.). 1988. Village Economies in Rural Alaska. Alaska OCS Environmental Studies Program Technical Report 132. USDOI, MMS, Alaska OCS Region: Anchorage.

IAI (Impact Assessment, Inc.). 1989. Point Lay Case Study. Social and Economic Studies Program Technical Report No. 139. Minerals Management Service, Alaska OCS Office: Anchorage, Alaska.

IAI (Impact Assessment, Inc.). 1990. Subsistence Resource Harvest Patterns: Nuiqsut. Social and Economic Studies Program Special Report No. 8. For USDOI, Minerals Management Service, Alaska OCS Region. Anchorage, AK.

Iken, K., B. Konar, and K.H. Dunton. (submitted) Unique community composition in isolated Alaskan Arctic nearshore rocky habitats. Marine Ecology Progress Series submitted.

Inman, D.L. 2003. Littoral Cells. In: The Encyclopedia of Coastal Science. Dordrecht, The Netherlands: Kluwer Academic Publishers.

Ireland, D., R. Rodrigues, D. Funk, W.R. Koski, and D. Hannay. 2009. Marine mammal monitoring and mitigation during open water seismic exploration by Shell Offshore Inc. in the Chukchi and Beaufort seas, July—November 2007, 90–day report. LGL report P1049–1. Report from LGL Alaska Research Associates, Inc.,

LGL Ltd., and JASCO Research Ltd. For Shell Offshore, Inc., National Marine Fisheries Service, and U.S. Fish and Wildlife Service. Available online at http://www.nmfs.noaa.gov/pr/pdfs/permits/shell_seismic_monitoring_mitigation.pdf. Accessed January 27, 2014.

Ito-Adler, J.P. and E.S. Hall. 1986. The Ones That Are Dead, I Can Call Their Names: Cultural Resource Sites Documented by the Beaufort Sea Coastal Survey. Technical Memorandum No. 23. Edwin Hall and Associates. Brockport, NY.

IWC (International Whaling Commission). 2007. Report of the Scientific Committee. Annex K. Report of the Standing Working Group on Environmental Concerns. Journal of Cetacean Research and Management (Suppl) 9:227-296.

IUCN (International Union for Conservation of Nature. 2006. Status of the polar bear. pp. 33–56. In: J. Aars, N.J. Lunn, and A.E. Derocher. Proceedings of the 14th Working Meeting of the IUCN/SSC Polar Bear Specialist Group, Seattle, United States. IUCN, Gland, Switzerland, and Cambridge, U.K.

Jacob, D.J., J.H. Crawford, H. Maring, A.D. Clarke, J.E. Dibb, L.K. Emmons, R.A. Ferrare, C.A. Hostetler, P.B. Russell, H.B. Singh, A.M. Thompson, G.E. Shaw, E. McCauley, J.R. Pederson, and J.A. Fisher. 2010. The Arctic Research and Composition of the Troposphere from Aircraft and Satellites (ARCTAS) mission: design, execution, and first results, Atmospheric Chemistry and Physics, 10, pp 5191-5212, 2010.

Jacobson, C. n.d. Our Lives and the Beaufort Seacoast: A Kaktovik Historical and Land Use Perspective. Prepared for the NSB Coastal Zone Management Program. Unpublished manuscript dated 1979, on file at the NSB Commission on Language, Culture, and History. Barrow, Alaska.

Jacobson, M. and C. Wentworth. 1982. Kaktovik Subsistence – Land Use Values Through Time in the Arctic National Wildlife Refuge Area. U.S. Fish and Wildlife Service, Northern Alaska Ecological Services. Fairbanks, AK.

Jay, C.V., A.S. Fischbach, and A.A. Kochnev. 2012. Walrus areas of use in the Chukchi Sea during sparse sea ice cover. Marine Ecology Progress Series 468:1–13.

JMM (James M. Montgomery Consulting Engineers). 1989. Kuparuk Waterflood NPDES Receiving Water Monitoring, May 1989. Data Report. Prepared for ARCO Alaska, Inc. by James M. Montgomery Consulting Engineers (JMM), Bellevue, WA.

JMM (James M. Montgomery Consulting Engineers). 1991. 1990 Kuparuk Waterflood NPDES Receiving Water Monitoring. Draft Final Analysis Report. Prepared for ARCO Alaska, Inc. by James M. Montgomery Consulting Engineers (JMM), Bellevue, WA.

Johnson, C.B., A.M. Wildman, and P.E. Seiser. 2010. Point Thomson Project: eider and loon surveys, 2010. Report prepared for URS Corporation, Anchorage, AK, and ExxonMobil Corporation, Anchorage, AK, by ABR, Inc.—Environmental Research & Services, Anchorage, AK. 12 pp.

Johnson, C.S., M.W. McManus, and D. Skaar. 1989. Masked tonal haring thresholds in the beluga whale. Journal of the Acoustical Society of America 85(6):2651–2654.

Johnson J.A., R.B. Lanctot, B.A. Andres, J.R. Bart, S.C. Brown, S.J. Kendall, and D.C. Payer. 2007. Distribution of breeding shorebirds on the Arctic Coastal Plain of Alaska. Arctic 60: 277–293.

Johnson, S.R. 2000. Lesser Snow Goose. Pages 233-257 in J.C. Truett and S.R. Johnson (eds.). the Natural History of an Arctic Oil Field: Development and the Biota. Academic Press, San Diego, California.

Johnson, S.R., and D.R. Herter. 1989. The Birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Environmental and Regulatory Affairs, Anchorage, Alaska. 372 pp.

Johnson, S. R. and L. E. Noel. 2005. Temperature and predation effects on abundance and distribution of Lesser Snow Geese in the Sagavanirktok River Delta, Alaska. Waterbirds 28: 292–300.

Johnson, S.R., L.E. Noel, W.J. Gazey, and V.C. Hawkes. 2005. Aerial monitoring of marine waterfowl in the Alaskan Beaufort Sea. Environmental Monitoring and Assessment 108(2005):1-43.

Jolles, C. 2002. Faith, Food, and family in a Yupik Whaling Community. University of Washington Press: Seattle.

Joly, K., D.R. Klein, D.L. Verbyla, T.S. Rupp, and F.S. Chapin III. 2011. Linkages between large-scale climate patterns and the dynamics of Arctic caribou populations. Ecography 34:345-352.

Kaleak, J. 1996. History of Whaling by Kaktovik Village *in* Proceedings of the 1995 Arctic Synthesis Meeting. OCS Study MMS 95-0065, pages 69-71. United States Department of the Interior, Minerals Management Service, Alaska OCS Region: Anchorage.

Kastak, D., B.L. Southall, R.J. Schusterman, and C.R. Kastak. 2005. Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. Journal of the Acoustical Society of America 118(5): 3154-3163.

Kancewick, M. and E. Smith. 1991. Subsistence in Alaska: Towards a Native Priority. UMKC Law Review 59 (3): 645-677.

Katlai, B., D. Hannay, and S. Carr. 2009. BP Liberty Well On-Shore Drilling 2009-2012. Preliminary modeling study to predict in-water sound levels. Version 2.0. JASCO Applied Sciences, Halifax, NS.

Kelly, B.P. 1988. Ribbon seal, *Phoca fasciata*. pp. 96–106 In: Selected marine mammals of Alaska. Species accounts with research and management recommendations. Lentfer, J.F. (ed). Marine Mammal Commission, Washington, D.C.

Kelly, B.P., J.L. Bengston, P.L. Boveng, M.F. Cameron, S.P. Dahle, J.K. Jansen, E.A. Logerwell, J.E. Overland, C.L. Sabine, G.T. Waring, and J.M. Wilder. 2010. Status review of the ringed seal (*Phoca hispida*). U.S. Department of Commerce, NOAA Technical Memorandum No. NMFS-AFSC-212.

Kelly, B.P., L.T. Quakenbush, and J.R. Rose. 1986. Ringed seal winter ecology and effects of noise disturbance. Outer Continental Shelf Environmental Assessment Program, Final Report of the Principal Investigators, NOAA, Anchorage, AK 61:447–536.

Kelso, D. 1981. Technical Overview of the State's Subsistence Program. Technical Paper No. 64, Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

Kelso, D. 1982. Subsistence Use of Fish and Game Resources in Alaska: Considerations in Forming Effective Management Policies. Technical Paper No. 65, Alaska Department of Fish and Game, Division of Subsistence. Juneau, Alaska.

Kendall, S., C. Villa, and J. Liebezeit. 2007. Nesting ecology of tundra-nesting birds at the Canning River delta, Arctic National Wildlife Refuge, Alaska, June–July 2006. Report by U.S. Fish and Wildlife Service, Fairbanks, AK, and Wildlife Conservation Society, Portland, OR. 59 pp.

Kendall, S., D. Payer, S. Brown, and R. Churchwell. 2011. Impacts of climate change and development on shorebirds of the arctic national wildlife refuge. Pages 91–100 in R.T. Watson, T. J. Cade, M. Fuller, G. Hunt and E. Potapove (eds.). Gyrfalcons and Ptarmigan in a changing World, Volume I. The Peregrine Fund, Boise, ID.

Konar, B. and K. Iken. 2005. Competitive dominance among sessile marine organisms in a high Arctic boulder community. *Polar Biology* 29:61-64.

Ketten DR. 1998. Marine mammal auditory systems: a summary of audiometric and anatomical data and its implications for underwater acoustic impacts. NOAA-TM-NMFS-SWFSC-256. 74p.

KLI (Kinnetic Laboratories, Inc.). 1986a. Kuparuk Waterflood Project Seawater Treatment Plant, Winter Diffusion and Dispersion Study, April 1986. Final Report. Prepared for ARCO Alaska, Inc. and Kuparuk River Unit by Kinnetic Laboratories, Inc., Anchorage, AK.

KLI (Kinnetic Laboratories, Inc.). 1986b. Kuparuk Waterflood Project Seawater Treatment Plant, Summer Diffusion and Dispersion Study, August-September 1986. Final Report. Prepared for ARCO Alaska, Inc. and Kuparuk River Unit by Kinnetic Laboratories, Inc., Anchorage, AK.

KLI (Kinnetic Laboratories, Inc.). 1987. Kuparuk Waterflood Project Seawater Treatment Plant, NPDES Receiving Water Monitoring Program 1986-1987. Final Report. Prepared for ARCO Alaska, Inc. and Kuparuk River Unit by Kinnetic Laboratories, Inc., Anchorage, AK.

KLI (Kinnetic Laboratories, Inc.). 1989. Endicott Development Project – 1989 NPDES Monitoring Program, Volume I, Sediment Quality and Benthic Macroinvertebrate Monitoring. October 1989.

KLI (Kinnetic Laboratories, Inc.). 1990a. Endicott Development Project – 1989 NPDES Monitoring Program, Volume III, STP Dispersion and Filter Backwash Monitoring Studies. January 1990.

KLI (Kinnetic Laboratories, Inc.). 1990b. Endicott Development Project – 1989 NPDES Monitoring Program, Annual Report. January 1990.

KLI (Kinnetic Laboratories, Inc.). 1990c. Prudhoe Bay Waterflood Project, Sediment Quality and Benthic Infauna. 1990 NPDES Monitoring Program. Final Report. Prepared for ARCO Alaska, Inc. by Kinnetic Laboratories, Inc., Anchorage, AK.

KLI (Kinnetic Laboratories, Inc.). 1995. Prudhoe Bay Seawater Treatment Plant - 1994 NPDES Environmental Monitoring Program. Draft Final Report. Prepared for ARCO Alaska, Inc. and the Prudhoe Bay Unit Owners, Anchorage, AK by Kinnetic Laboratories, Inc., Anchorage, AK.

KLI (Kinnetic Laboratories, Inc.). 1997. Prudhoe Bay Seawater Treatment Plant - 1996 NPDES Environmental Monitoring Program. Draft Final Report. Prepared for ARCO Alaska, Inc. and the Prudhoe Bay Unit Owners, Anchorage, AK by Kinnetic Laboratories, Inc., Anchorage, AK.

Konar, B. 2012. Lack of recovery from disturbance in high-arctic boulder communities. Polar Biology 36:8 1205-1214.

Kondratyev, K. Y. 1954. Radiant solar energy. Gidrometeoizdat, Leningrad, Russia [cited in Kirk (1983)].

Koski, W.R., J.C. George, G. Sheffield, and M. S. Galginaitis. 2005. Subsistence harvests of bowhead whales (*Balaena mysticetus*) at Kaktovik, Alaska (1973-2000). Journal of Cetacean Research and Management 7(1):33–37.

Kovacs, A. 1983. Shore Ice Ride-Up and Pile-Up Features, Part I: Alaska's Beaufort Sea Coast. CRREL Report 83-9. Hanover, NH.

Kovacs, A. 1984. Shore Ice Ride-Up and Pile-Up Features, Part II: Alaska's Beaufort Sea Coast. CRREL Report 84-26, Hanover, NH.

Kovacs, A. and D. Sodhi. 1980. Shore Ice Pileup and Rideup. Cold Regions Science and Technology 2: 209-288.

Kovacs, A. and D. Sodhi. 1988. Onshore Ice Pile-Up and Ride-Up: Observations and Theoretical Assessment. Arctic Coastal Processes and Slope Protection Design, A. Chen and C. Leidersdorf, eds. New York, NY: ASCE.

Kovacs, K.M., M. Kit, and C. Lydersen. 2008. Climate change impacts on seals and whales in the North Atlantic Arctic and adjacent shelf seas. Science Progress 91(2):117–150.

Kruse, J.A. 1978. Subsistence: A Discussion of Relevant Concepts and Some Observations on Patterns of Change in Alaska. In *The Subsistence Lifestyle in Alaska Now and in the Future*. Carol E. Lewis, Seminar Leader and Mayo Murray, editor. The School of Agriculture and Land Resources Management Seminar Series, Special Publication 1. University of Alaska Fairbanks. Available online at www.iser.uaa.alaska.edu/Publications/1979_03-SubsistenceLifestyleInAlaskaNowAndFuture.pdf. Accessed ????

Kruse, J.A. 1982. Subsistence and the North Slope Iñupiat: The Effects of Energy Development. Institute of Social and Economic Research, University of Alaska: Anchorage. Man in the Arctic Monograph No. 4, ISER Report Series No. 56.

Kruse, J.A. 1991. Alaska Iñupiat Subsistence and Wage Employment Patterns: Understanding Individual Choice. Human Organization. Vol. 50, No. 4.

Kruse, J., J. Klienfeld, and R. Travis. 1981. Energy Development and the North Slope Iñupiat: Quantitative Analysis of Social and Economic Change. Institute of Social and Economic Research, University of Alaska: Anchorage. Man in the Arctic Monograph No. 1, ISER Report Series No. 49.

Kryter K.D. 1985. The effects of noise on man. 2nd ed. Academic Press, Orlando, FL. 688pp.

Kuukpik Corporation. 2014. About us. Available online at http://www.kuukpik.com/about-us/. Accessed June 2, 2014.

Lacroix, D. L., R. B. Lanctot, J. A. Reed, and T. L. McDonald. 2003. Effects of underwater seismic surveys on molting male Long-tailed Ducks in the Beaufort Sea, Alaska. Canadian Journal of Zoology 81: 1862–1875.

Laidre, K.L., I. Stirling, L.F. Lowry, Ø. Wiig, M.P. Heide-Jørgensen, and S.H. Ferguson. 2008. Quantifying the sensitivity of Arctic marine mammals to climate—induced habitat change. Ecological Applications 18(2) Supplement:S97–S125.

Laist, D.W., Knowlton, A.R., Mead, J.G., Collet, A.S., and Podesta, M. 2001. Collisions between ships and whales. *Marine Mammal Science*, *17*(1), 35-75.

LAMA (LAMA ecological). 2014. Incidental Harassment Authorization Request for the Non-lethal harassment of marine mammals during the Liberty Geohazard Survey, Beaufort Sea, Alaska, 2014. February 4, 2014. Prepared by LAMA ecological, Anchorage, Alaska; submitted by BP Exploration (Alaska) Inc., Anchorage, Alaska

Lanctot, R. B. and J. S. Gleason. 2006. Letters to the Editor: Alaskan Oilfield Development and Glaucous Gulls. Arctic 59:334-336.

Langdon, S. and R. Worl. 1981. Distribution and Exchange of Subsistence Resources in Alaska. Prepared by the University of Alaska, Arctic Environmental Information and Data Center for the U.S. Department of Fish. Technical Paper No.55. Alaska Department of Fish and Game: Anchorage.

Larned, W. and K. Bollinger. 2010. Steller's Eider spring migration surveys, 2010. Report by Waterfowl Management, U.S. Fish and Wildlife Service, Soldotna and Fairbanks, AK. 23 pp.

Larned, W., R. Stehn, and R. Platte. 2008. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2007. Report prepared by U.S. Fish and Wildlife Service, Anchorage, AK. 45 pp.

Larned, W., R. Stehn, and R. Platte. 2009. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2008. Report prepared by Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, AK. 42 pp.

Larned, W., R. Stehn, and R. Platte. 2010. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2009. Report prepared by Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, AK. 42 pp.

Larned, W., R. Stehn, and R. Platte. 2011. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2010. Report prepared by Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, AK. 45 pp.

Larned, W., K. Bollinger, and R. Stehn. 2012a. Late winter population and distribution of Spectacled Eiders (Somateria fischeri) in the Bering Sea, 2009 & 2010. Report by U.S. Fish and Wildlife Service, Anchorage, AK. 23 pp.

Larned, W., R. Stehn, and R. Platte. 2012b. Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2011. Report prepared by Migratory Bird Management, U.S. Fish and Wildlife Service, Anchorage, AK. 51 pp.

Lawhead, B.E., J.P. Parrett, A.K. Prichard, and D.A. Yokel. 2006. A Literature Review and Synthesis on the Effect of Pipeline Height on Caribou Crossing Success. U.S. Department of the Interior, Bureau of Land Management, Fairbanks, AK.

Leatherwood, J.S. and M.E. Dahlheim. 1978. Worldwide distribution of pilot whales and killer whales. Navel Ocean Systems Center, Technical Report. 443:1–39.

Leatherwood, S., R.R. Reeves, W.F. Perrin, and W.E. Evans. 1982. Whales, dolphins, and porpoises of the eastern North Pacific and adjacent Arctic waters: A guide to their identification. U.S. Department of Commerce, NOAA Technical Report. NMFS Circular 444.

Lee, R.K., and L.J. Toimil. 1985. Distribution of sea-floor boulder in Stafansson Sound, Beaufort, Sea, Alaska. Report prepared for Soma Petroleum Company, by Harding Lawson Associates (HLA Job No. 5507,041.01), Novato CA, 24 pp.

Leffingwell, E. 1919. The Canning River Region, Northern Alaska. U.S. Geological Survey Professional Paper 109. 251 pp.

Leidersdorf, C., P.E. Gadd, and K.D. Vaudrey. 1996. Design Considerations for Coastal Projects in Cold Regions. In: Proceedings, 25th International Conference on Coastal Engineering. NY, NY: ASCE, pp. 4397-4410.

Lenart, E.A. 2003. Units 26B and 26C muskox. Pages 54-71 in C. Healy, ed. Muskox management report of survey and inventory activities 1 July 2000–30 June 2002. Alaska Department of Fish and Game. Project 16.0. Juneau, Alaska.

Lenart, E.A. 2007. Central Arctic Caribou Parturition and Post Calving Distribution Maps 2007. Prepared by E.A. Lenart, Management Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks, Alaska. 2 pp.

Lenart, E.A. 2008. Central Arctic Caribou Field Work Summary for 2008. Prepared by E.A. Lenart, Management Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks, Alaska. 10 pp.

Lenart, E.A. 2009. Central Arctic Caribou Field Work Summary for 2009. Prepared by E.A. Lenart, Northeast Alaska Area Wildlife Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks, Alaska. 10 pp.

Lenart, E.A. 2010. Central Arctic Caribou Field Work Summary for 2010. Prepared by E.A. Lenart, Northeast Alaska Area Wildlife Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks, Alaska. 10 pp.

Lenart, E.A. 2011a. Units 26B and 26C caribou. Pages 315-345 in P. Harper, ed. Caribou management report of survey and inventory activities 1 July 2008–30 June 2010. Alaska Department of Fish and Game. Project 3.0. Juneau, Alaska.

Lenart, E.A. 2011b. Units 26B and 26C muskox. Pages 63-84 in P. Harper, ed. Muskox management report of survey and inventory activities 1 July 2008–30 June 2010. Alaska Department of Fish and Game. Project 16.0. Juneau, Alaska.

Lenart, E.A. 2011c. Units 25A, 25B, 25D, 26B and 26C brown bear. pp. 299-322 in P. Harper, ed. Brown bear management report of survey and inventory activities 1 July 2008–30 June 2010. Alaska Department of Fish and Game. Project 4.0. Juneau, Alaska.

Lenart, E.A. 2011d. Central Arctic Caribou Field Work Summary for 2011. Prepared by E.A. Lenart, Northeast Alaska Area Wildlife Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks, Alaska. 10 pp.

Lenart, E.A. 2012. Central Arctic Caribou Field Work Summary for 2012. Prepared by E.A. Lenart, Northeast Alaska Area Wildlife Biologist, Alaska Department of Fish and Game, Division of Wildlife Conservation, Fairbanks, Alaska. 10 pp.

Lenart, E.A. 2014a. 2013 Central Arctic Caribou Photocensus Results. August 3, 2013 Memorandum. To Doreen Parker McNeil, Management Coordinator, Region III, from E.A. Lenart, Northeast Alaska Area Wildlife Biologist, Alaska Department of Fish and Game, Division of Wildlife conservation, Fairbanks, Alaska. 7 pp.

Lenart, E.A. 2014b. CAH Count. Personal email communication. August 28, 2014. From E.A. Lenart, Alaska Department of Fish and Game to L. Noel, Cardno ENTRIX, Anchorage, Alaska.

Lent, P.C. 1998. Alaska's indigenous muskoxen: a history. Rangifer 18:133-144.

LGL Alaska (LGL Alaska Research Associates, Inc.). 2006. Vegetation mapping spatial data. Compilation of vegetation data created by LGL Alaska Research Associates, Inc. between 1994 and 2006 for BP Exploration (Alaska) Inc., Anchorage, Alaska.

LGL Alaska (LGL Alaska Research Associates, Inc.), Woodward-Clyde Consultants, and Applied Sociocultural Research. 1998. Liberty Development Project Environmental Report. Prepared for: BP Exploration (Alaska) Inc., Anchorage, Alaska.

LGL Ecological Research and K.H. Dunton. 1999. Construction Effects of the Liberty Development Project on Boulder Patch Kelp Production. Prepared for BP Exploration (Alaska), Inc. January 11, 1999. Anchorage, AK.

Libbey, D., G. Spearman, and D. Hoffman. 1979. Nuiqsut Synopsis in *Native Livelihood & Dependence: A Study of Land Use Values Through Time. National Petroleum Reserve in Alaska Work Group 1 in Cooperation with the North Slope Borough, Field Study 1. U.S. Department of the Interior: Anchorage.*

Liebezeit, J.R., S.J. Kendall, S. Brown, C.B. Johnson, P. Martin, T.L. McDonald, D.C. Payer, C.L. Rea, B. Streever, A.M. Wildman, and S. Zack. 2009. Influence of human development and predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska. Ecological Applications 19(6):1628-1644.

Liebezeit, J.R., G.C. White, and S. Zack. 2011. Breeding ecology of birds at Teshekpuk Lake: a key habitat site on the Arctic Coastal Plain of Alaska. Arctic 64: 32–44.

Liebezeit, J., E. Rowland, M. Cross, and S. Zack. 2012. Assessing climate change vulnerability of breeding birds in arctic Alaska. Report prepared for the Arctic Landscape conservation Cooperative by Wildlife Conservation Society, North America Program, Bozeman, MT. 167 pp. Available online at http://arcticlcc.org/assets/products/ARCT2011-11/reports/Vulnerability_Assessment_report_WCS_2012.pdf. Accessed January 31, 2014.

Liebezeit, J.R., K.E.B. Gurney, M. Budde, S. Zack, and D. Ward. 2014. Phenological advancement in arctic bird species: relative importance of snowmelt and ecological factors. Polar Biology, Vol. 37, Issue 9, pp. 1309-1320. Published online May 31, 2014.

Link, M.R., T.L. Olson, and M.T. Williams. 1999. Ringed seal distribution and abundance near potential oil development sites in the central Alaskan Beaufort Sea, spring 1998. Report P-9-36 430 by LGL Alaska Research Associates, Inc., Anchorage, AK, for BP Exploration (Alaska), Inc., Anchorage, AK.

Linnell, J.D., Swenson, J.E., Andersen, R., and Barnes, B. (2000). How vulnerable are denning bears to disturbance? *Wildlife Society Bulletin*, 400-413.

Linxwiler, J.D. 2007. The Alaska Native Claims Settlement Act at 35: Delivering on the Promise. 53rd Annual Rocky Mountain Mineral Law Institute, Vancouver, Canada, July 19-21, 2007.

Lobdell, J.E. 1980. Coastal and Barrier Island Archaeological Localities in the Beaufort Sea Coast of Alaska: Colville to Staines Rivers. ARCO Environmental Conservation Department. Anchorage, AK.

Lobdell, J.E. 1985. The Putuligayuk River Delta Overlook Site: Fragile Traces of Ancient Man at Prudhoe Bay, Beaufort Sea, Alaska. ARCO Alaska, Inc. Anchorage, AK.

Lobdell, J.E. 1986. The Kuparuk Pingo Site: A Northern Archaic Hunting Camp of the Arctic Coastal Plain, North Alaska. Arctic 39(1):47-51.

Lobdell, J.E. 1990. A Cultural Resources Reconnaissance of the Badami Exploration Well, North Slope, Alaska. For Conoco Inc. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E. 1991. Badami D & E Exploration Wells Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For Conoco Inc. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E. 1993. Badami F & H Exploration Wells Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E. 1995. North Alaska Pingos: Ephemeral Refugia in Prehistory. Arctic Anthropology 32(1):62-81.

Lobdell, J.E. 1996. Gwydyr Bay Exploration Well Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E. 1998a. Liberty Project Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E. 1998b. Supplemental Report: Liberty Project Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E. 1998c. PTAC 1998/99 Exploration and Appraisal Well Sites Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E., and G.E. Lobdell 1999. 1998 and 1999 NPRA Exploration Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For ARCO Alaska, Inc. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E., and G.E. Lobdell 2000a. 1999 NPR-A Exploration Program Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Lobdell, J.E., and G.E. Lobdell 2000b. Final Report: Point Thomson Unit Archaeological and Cultural Resources Reconnaissance, North Slope, Alaska. For BPXA. Lobdell & Associates. Anchorage, AK.

Loescher, R. 1999. Native Subsistence Rights - Where we stand now in State and National Politics? Speech/paper presented to The Alaska Federation of Natives Political Leadership Summit, February 16, 1999. www.kinyradio.com/juneaunews/archives/week_of_02-15-99/loescher.html

Long, F., Jr. 1996. History of Subsistence Whaling by Nuiqsut *in* Proceedings of the 1995 Arctic Synthesis Meeting. OCS Study MMS 95-0065, pp. 73-76. United States Department of the Interior, Minerals Management Service, Alaska OCS Region: Anchorage.

Long, E.R., D.D. Macdonald, S.L. Smith, and F.D. Calder. 1995. Incidence of Adverse Biological Effects within Ranges of Chemical Concentrations in Marine and Estuarine Sediments. In: Environmental Management. Vol. 19. pp. 81-97.

Lonner, T.D. 1980. Subsistence as an Economic System in Alaska: Theoretical and Policy Implications. Technical Paper Series No. 67, Alaska Department of Fish and Game, Division of Subsistence. Anchorage, Alaska.

Lowry, L.F., K.J. Frost, R. Davis, D.P. DeMaster, and R.S. Suydam. 1998. Movements and behavior of satellite-tagged spotted seals (*Phoca largha*) in the Bering and Chukchi seas. Polar Biology 19:221–230.

MacDonald, S.O., and J.A. Cook. 2009. Recent Mammals of Alaska. University of Alaska Press, Fairbanks, Alaska. 387 pp.

MacGillivray, A.O., D.E. Hannay, and C.J. Perham. 2009. Measurements of industrial noise and vibration in artificial polar bear (*Ursus maritimus*) dens, Flaxman Island, Alaska. *The Journal of the Acoustical Society of America*, *125*, 2519.

MacGillivray, A.O., D.E. Hannay, R.G. Racca, C.J. Perham, S.A. MacLean, and M.T. Williams. 2003. Assessment of industrial sounds and vibrations received in artificial polar bear dens, Flaxman Island, Alaska. Final report to ExxonMobil Production Co by JASCO Research Ltd., Victoria, BC, Canada and LGL Alaska Research Associates, Inc., Anchorage, AK. 60 pp. http://www.nmfs.noaa.gov/pr/pdfs/permits/ shell_90dayreport_draft2012_appendices.pdf.

Madsen, P.T. 2005. Marine mammals and noise: Problems with root mean square sound pressure levels for transients. Journal of the Acoustical Society of America 117(6): 3952-3957.

Madsen, P.T., B. Mohl, B.K. Nielsen, M. Wahlberg. 2002. Male sperm whale behaviour during exposures to distant seismic survey pulses. Aquatic Mammals 28(3):231-240.

MAG (Mitigation Advisory Group). 2009. Alaska Climate Change Strategy Mitigation Advisory Group Executive Summary. Available online at http://www.climatechange.alaska.gov/mit/O97F21941.pdf.Aaccessed October 16, 2013.

Mallek, E.J., R. Platte, and R. Stehn. 2007. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska, 2006. Report by U.S. Fish and Wildlife Service, Fairbanks, AK. 25 pp.

Malme, C.I. and R. Mlawski. 1979. Measurements of Underwater Acoustic Noise in the Prudhoe Bay area. Technical Memo 513. Report from Bolt Beranek & Newman Inc., Cambridge, MA for Exxon Prod. Res. Co. Houston, TX. 74 pp.

Manget, S. 2010. Native Corporations Dominate top 49 Alaska-owned Businesses. Alaska Business Monthly. Available online at http://classic.alaskajournal.com/stories/101410/loc_ncd.shtml. Accessed August 8, 2013.

Marmaduke, W., and W.D. Watson. 1998. Liberty, Cultural Resources Assessment, Foggy Island Bay in Stefansson Sound, Alaska. For BPXA. Watson Company. Anchorage, AK.

Martin, L.R. and Gallaway, B.J. 1994. The effect of the Endicott Development Project on the Boulder Patch, an Arctic kelp community in Stefansson Sound, Alaska. Arctic 47(1):54-64.

Massel, S.R. 1996. Ocean Surface Waves: Their Physics and Prediction, World Scientific, Singapore, 692 pp.

Mathis, J.T. 2011. The Extent and Controls on Ocean Acidification in the Western Arctic Ocean and Adjacent Continental Shelf Areas [in Arctic Report Card 2011]. http://www.arctic.noaa.gov/reportcard.

McCart, P., P. Craig, and H. Bainl. 1972. Report on fisheries investigations in the Sagavanirktok River and neighboring drainages. For: Alyeska Pipeline Service Company.

McDonald, T.L., W.J. Richardson, C.R. Greene, Jr., S.B. Blackwell, C.S. Nations, R.M. Nielson, and B. Streever. 2012. Detecting changes in the distribution of calling bowhead whales exposed to fluctuating anthropogenic sounds. Journal of Cetacean Research Management 12(1): 91-106.

McDowell Group, Inc. 2012. Oil and Gas Industry Employment on Alaska's North Slope. Prepared for Senate Finance Committee, Alaska State Legislature. Juneau, AK.

McKendrick, J.D. 1999. Arctic Tundra Recovery from Crude Oil after 24 Years, Prudhoe Bay. Agroborealis 31(1):28-35.

McPherson, C. and G. Warner. 2012. Sound Source Characterization for the 2012 Simpson Lagoon OBC Seismic Survey 90-Day Report. JASCO Document 00443. Technical Report by JASCO Applied Sciences for BP Exploration (Alaska) Inc.

Miller, D. 1996. Spray Ice Island Design for the Liberty Exploration Well. Anchorage, AK: BPXA.

Miller, D. and Phillips, W. 1995. Geotechnical Investigation, Badami Development; DM&A Job No. 4119.11. August 7, 1995.

Miller, M.C. and P.E. Gadd. 1983. Shoreline Processes Near Flaxman Island, U.S. Beaufort Sea. In: Proceedings, Workshop on Arctic Regional Coastal Erosion and Sedimentation. Calgary, Alberta, Canada: pp. 69-92.

Miller, M.W., K. C. Jensen, W. E. Grant and M. W. Weller. 1994. A simulation model of helicopter disturbance of molting Pacific black brant. Ecological Modelling 73: 293–309.

Miller, S., S. Schliebe, and K. Proffitt. 2006. Demographics and behavior of polar bears feeding on bowhead whale carcasses at Barter and Cross islands, Alaska, 2002–2004. Final report. OCS Study MMS 2006–14. U.S. Department of the Interior, Minerals Management Service, Alaska Outer Continental Shelf Region.

MMS (Minerals Management Service). 1986a. Proposed Beaufort Sea Oil and Gas Lease (Sale 97) Public Hearings: Kaktovik. December 10, 1986. Prepared by Accu-Type Depositions, Inc. for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1986b. Proposed Beaufort Sea Oil and Gas Lease (Sale 97) Public Hearings: Nuiqsut. December 12, 1986. Prepared by Accu-Type Depositions, Inc. for USDOI, MMS OCS Office, Anchorage, Alaska

MMS (Minerals Management Service). 1990a. Beaufort Sea Oil and Gas Lease (Sale 124) Public Hearings: Kaktovik. April 18, 1990. Prepared by Executary for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1990b. Beaufort Sea Oil and Gas Lease (Sale 124) Public Hearings: Nuiqsut. April 19, 1990. Prepared by Executary for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1990c. Beaufort Sea Planning Area; Oil and Gas Lease Sale 124. Final Environmental Impact Statement. OCS EIS/EA OCS EIS/EA MMS 90-0063.

MMS (Minerals Management Service). 1995a. Beaufort Sea Oil and Gas Lease Sale 144 Public Hearing: Nuiqsut. November 6, 1995. Prepared by Executary Court Reporting for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1995b. Beaufort Sea Oil and Gas Lease Sale 144 Public Hearing: Kaktovik. November 7, 1995. Prepared by Executary Court Reporting for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1996a. Proceedings of the 1995 Arctic Synthesis Meeting. OCS Study MMS 95-0065. Prepared by MBC Applied Environmental Services for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1996b. Beaufort Sea Planning Area; Oil and Gas Lease Sale 144. Final Environmental Impact Statement. OCS EIS/EA OCS EIS/EA MMS 96-0012.

MMS (Minerals Management Service). 1997a. Arctic Seismic Synthesis and Mitigation Measures Workshop Proceedings. March 5 and 6, 1997. Prepared by MBC Applied Environmental Sciences for USDPI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1997b. Beaufort Sea Oil and Gas Lease Sale 170 Public Hearing: Nuiqsut. June 24, 1997. Prepared by Executary Court Reporting for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1997c. Beaufort Sea Oil and Gas Lease Sale 170 Public Hearing: Kaktovik. July 9, 1997. Prepared by Executary Court Reporting for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 1998. Beaufort Sea Planning Area Oil and Gas Lease Sale 170: Final Environmental Impact Statement. MMS-98-0007. USDOI, MMS, Alaska OCS Region: Anchorage, Alaska.

MMS (Minerals Management Services). 1999. Beaufort Sea oil and gas development/Northstar Project. Final Environmental Impact Statement. BSOGD/NP EIS. U.S. Department of the Interior.

MMS (Minerals Management Service). 2000. Beaufort Sea Information Update Meeting Proceedings, March 28 and 29, 2000. Prepared by MBS Applied Environmental Sciences for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2001a. Liberty Development and Production Plan OCS EIS/EA MMS 2001-001 Public Hearing: Nuiqsut. March 19, 2001. Prepared by Executary Court Reporting for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2001b. Liberty Development and Production Plan OCS EIS/EA MMS 2001-001 Public Hearing: Kaktovik. March 20, 2001. Prepared by Executary Court Reporting for USDOI, MMS Anchorage.

MMS (Minerals Management Service). 2002a. Beaufort Sea Multiple Sale Proposed Oil and Gas Lease Sales (Sales 186, 195, and 202) Public Hearings: Kaktovik. Pages VII-309 through VII-343 of Beaufort Sea Multiple Sale Proposed Oil and Gas Lease Sales (Sales 186, 195, and 202) Public Hearings. Prepared by Computer Matrix Court Reporters, LLC for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2002b. Beaufort Sea Multiple Sale Proposed Oil and Gas Lease Sales (Sales 186, 195, and 202) Public Hearings: Nuiqsut. Pages VII-285 through VII-305 of Beaufort Sea Multiple Sale Proposed Oil and Gas Lease Sales (Sales 186, 195, and 202) Public Hearings. Prepared by Computer Matrix Court Reporters, LLC for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2002c. Liberty Development and Production Plan, Final Environmental Impact Statement. May 2002. OCS EIS/EA MMS 2002-019. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region with U.S. Army Corps of Engineers, Alaska District Office, and U.S. Environmental Protection Agency, Region 10. Anchorage, Alaska. 4 volumes.

MMS (Minerals Management Service). 2003a. Beaufort Sea Planning Area Oil and Gas Lease Sales 186, 195, and 202: Final Environmental Impact Statement. USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2003b. Proceedings of a Workshop on the Variability of Arctic Cisco (Qaaktaq) in the Colville River. November 18-20, 2003. Prepared by MBC Environmental Sciences for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2006a. Draft Environmental Impact Assessment, Oil & Gas Lease Sale 193 and Seismic Surveying Activities in the Chukchi Sea. MMS OCS EIS/EA MMS 2006-060. Anchorage, AK.

MMS (Minerals Management Service). 2006b. Environmental Assessment, Proposed OCS Lease Sale 202, Beaufort Sea Planning Area. MMS OCS EIS/EA MMS 2006-001. Anchorage, AK.

MMS (Minerals Management Service). 2006c. Year OCS Oil and Gas Proposed Leasing Program for 2007-2012 Nuiqsut Public Hearing/Meeting. November 8, 2006. Prepared by Valerie Martinez for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2007a. Programmatic DEIS Seismic Surveys in the Beaufort and Chukchi Seas Public Hearing/Meeting: Nuiqsut. April 17, 2007. Prepared by Mary A. Vavrik for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2007b. Liberty Development and Production Plan Ultra Extended Reach Drilling From Endicott-Satellite Drilling Island (SDI) – Environmental Assessment. OCS EIS/EA 2007-054. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region. Anchorage, Alaska.

MMS (Minerals Management Service). 2007c. Final Report for the Nearshore Beaufort Sea Meteorological Monitoring and Data Synthesis Project, Contract 1435-01-05-CT-39037. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region. Anchorage, Alaska.

MMS (Minerals Management Service). 2008. Beaufort Sea and Chukchi Sea Planning Areas, Oil and Gas Lease Sales 209, 212, 217, and 221. Draft Environmental Impact Statement. MMS OCS EIS/EA MMS 2008-0055. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region. Anchorage, AK.

MMS (Minerals Management Service). 2009a. Proposed Arctic Multi-Sale Public Hearing: Nuiqsut. February 4, 2009. Prepared by Midnight Sun Court Reporters for USDOI, MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2009b. Proposed Arctic Multi-Sale Public Hearing: Kaktovik. February 7, 2009. Prepared by Midnight Sun Court Reporters for USDOI MMS OCS Office, Anchorage, Alaska.

MMS (Minerals Management Service). 2012. Beaufort Sea Planning Area; Oil and Gas Lease Sale 202. Final Environmental Impact Statement. OCS EIS/EA OCS EIS/EA MMS 2006-001.

MMPA (Marine Mammal Protection Act) of 1972 as Amended. 2007. United States Pub. L. No. 92-522, 16 U.S.C. 1361 (Oct. 21, 1972). Available online at http://www.nmfs.noaa.gov/pr/laws/mmpa/text.htm. Accessed July 1, 2014.

Mittelbach, G.G., C.F. Steiner, K.L. Scheiner, H.L. Gross, R.B. Reynolds, R.B. Waide, S I. Dodson, and L. Gough. 2001. What is observed relationship between species richness and productivity? Ecology 82:2281-2396.

Mobley, C.M., J.C. Haggarty, C.J. Untermohle, M. Eldridge, R.E. Reanier, A. Crowell, B.A. Ream, D.R. Yeaner, J.M. Erlandson, P.E. Buck, W.B. Workman, and K.W. Workman. 1990. The 1989 Exxon Valdez Cultural Resource Program. Exxon Shipping Company and Exxon Company. Anchorage, AK.

Mocklin, J.A., K.E.W. Shelden, K.T. Goetz, L.V. Brattström, and C.L. Sims. 2011. Aerial surveys of bowhead whales near Barrow in late summer 2011. In Shelden, K.E.W. and J.A. Mocklin (eds.), Bowhead whale feeding ecology survey (BOWFEST), 2011 annual report. OCS Study BOEM 2012-077. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, Seattle, WA.

Moore, S.E. 2000. Variability of cetacean distribution and habitat selection in the Alaska Arctic, autumn 1982-91. Arctic 53(4): 448-460.

Moore, S.E. and H.P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. Ecological Applications 18(2) Supplement:S157–S165.

Moore, S.E. and R.R. Reeves. 1993. Distribution and movement. In Burns, J.J., J.J. Montague, and C.J. Cowles (eds.). The Bowhead Whale. Society for Marine Mammalogy, Lawrence, KA. pp. 313-386.

Moore, S.E., K.M. Stafford, M.E. Dahlheim, C.G. Fox, H.W. Braham, J.J. Polovina, and D.E. Bain. 1998. Seasonal variation in reception of fin whale calls at five geographic areas in the North Pacific. Marine Mammal Science 14(3):617-627.

Moore, S.E., D.P. DeMaster, and P.K. Dayton. 2000a. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. Arctic 53: 432–447.

Moore, S.R., J.M. Waite, L.L. Mazzuva, and R.C. Hobbs. 2000b. Provisional estimates of mysticete whale abundance on the central Bering Sea shelf. Journal of Cetacean Research and Management 2:227–234.

Moore, S.E., J.M. Waite, N.A. Friday, and T. Honkalehto. 2002. Distribution and comparative estimates of cetacean abundance on the central and south—eastern Bering Sea shelf with observations on bathymetric and pre associations. Progress in Oceanography 55:249–262.

Moore, S.E., K.M. Stafford, D.K. Mellinger, and C.G. Hildebrand. 2006. Listening for large whales in the offshore waters of Alaska. BioScience 56(1):49-55.

Morgan T.C., R.H. Day, and A. E Gall. 2012. Distribution and abundance of seabirds near the Sivulliq prospect in the northeastern U.S. Beaufort Sea. Report for Shell Exploration and Production Company, Anchorage, AK, by ABR, Inc.—Environmental Research & Services, Fairbanks, AK. 29 pp.

Mork, T. and A. Prestrud. 2004. Arctic rabies: a review. Acta Veterinaria Scandinavica 45:1-9.

Morrison, R.I.G., B.J. McCaffery, R.E. Gill, S.K. Skagen, S.L. Jones, G.W. Page, C.L. Gratto-Trevor, and B.A. Andres. 2006. Population estimates of North American shorebirds, 2006. Wader Study Group Bulletin 111: 67–85.

Moulton, L.L. and K.E. Tarbox. 1987. Analysis of Arctic cod movements in the Beaufort Sea nearshore region, 1978-79. Arctic, Vol. 40, No. 1:43-49.

Moulton, V.D., and J.W. Lawson. 2002. Marine mammal monitoring of Western Geco's open-water seismic program in the Alaskan Beaufort Sea, 2001. LGL Rep TA2564-4. Western Geco LLC, Anchorage, AK; BP Exploration (Alaska) Inc., Anchorage, AK National Marine Fisheries Service, Silver Spring, MD.

Moulton, V.D., W.J. Richardson, R.E. Elliott, T.L. McDonald, C. Nations, and M.T. Williams. 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(2): 217-242.

Murphy, S.M., and B.E. Lawhead. 2000. Caribou. Pages 59–84 in J.C. Truett and S.R. Johnson, (eds.). Natural history of an arctic oil field: development and the biota. Academic Press, San Diego, California.

MWAI (Montgomery Watson Americas, Inc.). 1994. 1994 Kuparuk Environmental Studies, Seawater Treatment Plant NPDES Monitoring Report. Prepared for ARCO Alaska, Inc. by Montgomery Watson Americas, Inc. (MWAI), Bellevue, WA.

Naidu, A.S., J.J. Kelley, J.J. Goering, and M.I. Venkatesan. 2001. Historical Changes in Trace Metals and Hydrocarbons in the Inner Shelf Sediments, Beaufort Sea: Prior and Subsequent to Petroleum-Related Industrial Developments. OCS Study, MMS 2001-061, MMS, Anchorage, Alaska.

Naidu, A.S., D. Misra, J.J. Kelley, A. Blanchard, and M.I. Venkatesan. 2011. Synthesis of Time-interval Changes in Trace Metals and Hydrocarbons in Nearshore Sediments of the Alaskan Beaufort Sea: A Statistical Analysis. Coastal Marine Institute, University of Alaska. Final Report, OCS Study BOEMRE 2011-031.

Naiman, J. 1996. ANILCA Section 810: An Undervalued Protection for Alaskan Villagers' Subsistence. Fordham Environmental Law Journal, Vol. VII, pp. 211-350.

National Research Council Committee. 2003. Cumulative environmental effects of oil and gas activities on Alaska's North Slope. Washington, D.C. National Academies Press.

Neff, J.M., G.S. Durell, J.S. Brown, J.H. Trefry, K.H. Dunton, M. Galginaitis. 2010. Continuation of the Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA): Synthesis, 1999-2007. Final Report. OCS Study BOEMRE OCS Study 2010-032.

NEI (Northern Economics, Inc.) and Institute of Social and Economic Research (ISER). 2009. Economic Analysis of Future Offshore Oil and Gas Development: Beaufort Sea, Chukchi Sea, and North Aleutian Basin. Prepared for Shell Exploration and Production. Anchorage, AK.

Nelson, R. 1979. Cultural Values of the Land in Native Livelihood and Dependence: A Study of Land Use Values Through Time. North Slope Borough Contract Staff. National Petroleum Reserve in Alaska 105(C) Land Use Study Field Study 1. USDOI, BLM, NPR-A Work Group 1. Anchorage, Alaska.

Nerurkar, N. 2012. U.S. Oil Imports and Exports. Congressional Research Service. Washington, D.C.

NMFS (National Marine Fisheries Service). 1995. Small takes of marine mammals incidental to specified activities; offshore seismic activities in southern California: Notice of issuance of an incidental harassment authorization. US Federal Register 60(200): 53753-53760.

NMFS (National Marine Fisheries Service). 2001. Endangered Species Act Section 7 Consultation Biological Opinion for BP Exploration's Proposed Liberty Development and Production Plan. United States Department of Commerce, National Oceanographic and Atmospheric Administration, National Marine Fisheries Service. Silver Spring Maryland. December 12.

NMFS (National Marine Fisheries Service). 2008. Endangered Species Act (ESA) Section 7(a)(2) Biological Option: Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska; and Authorization of Small Takes Under the Marine Mammal Protection Act. July 17, 2008.

NMFS (National Marine Fisheries Service). 2002. Status review under the Endangered Species Act: Southern Resident Killer Whales (Orcinus orca). NOAA (National Oceanographic and Atmospheric Administration) Tech. Memo. NMFSNWAFSC- 54, Seattle, Washington: NMFS. 131 pp.

NMFS (National Marine Fisheries Service). 2013. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion: Oil and Gas Leasing and Exploration Activities in the U.S. Beaufort and Chukchi Seas, Alaska. NMFS Consultation Number: F/AKR/2011/0647. May 2, 2013. National Marine Fisheries Service, Alaska Region. Available online at: http://alaskafisheries.noaa.gov/protectedresources/esa/section7/arcticbiop2013.pdf. Accessed June 24, 2014.

NMFS (National Marine Fisheries Service). 2014. Endangered Species Act: Section 7 Consultation Biological Opinion: Issuance of Regulations and a Letter of Authorization to Take Marine Mammals Incidental to Offshore Oil and Gas Operations at the Northstar Development in the U.S. Beaufort Sea, January 13, 2014 – January 14, 2019. February 12, 2014. National Marine Fisheries Service, Alaska Region.

NOAA (National Oceanic and Atmospheric Administration), 1978. Environmental Assessment of the Alaskan Outer Continental Shelf-Interim Synthesis: Beaufort/Chukchi.

NOAA (National Oceanic and Atmospheric Administration). 2011. Responding to Oil Spills – In Situ Burning – Questions about Environmental Impacts – What Are the Potential Ecological Effects of In-Situ Burning (ISB). NOAA Office of Response and Restoration website. Available online at http://response.restoration.noaa.gov. Accessed September 7, 2011.

NOAA (National Oceanic and Atmospheric Administration). 2013a. Effects of oil and gas activities in the Arctic Ocean, Supplemental Draft Environmental Impacts Statement. U.S. Department of Commerce, NOAA, NMFS, Office of Protected Resources, Silver Springs, MD.

NOAA (National Oceanic and Atmospheric Administration). 2013b. Introduction to Greenhouse Gases. Available online at http://www.ncdc.noaa.gov/cmb-faq/greenhouse-gases.php. Accessed November 17, 2013.

NOAA (National Oceanic and Atmospheric Administration) and U.S. Department of Commerce. 2013c. Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts. In: National Oceanic and Atmospheric Administration, U.S. Department of Commerce. (ed.). Available online at http://www.nmfs.noaa.gov/pr/acoustics/ draft_acoustic_guidance_2013.pdf. Accessed on April 22, 2014.

NOAA (National Oceanic and Atmospheric Administration). 2014a. Cetacean Assessment & Ecology Program Aerial Surveys of Arctic Marine Mammals (ASAMM). NOAA Fisheries, Alaska Fisheries Science Center. Available online at http://www.afsc.noaa.gov/NMML/cetacean/bwasp/index.php. Accessed January 23, 2014.

NOAA (National Oceanic and Atmospheric Administration). 2014b. Office of Response and Restoration. Residues from In Situ Burning of Oil on Water. Last updated Feb 20, 2014. Available online at http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/residues-in-situ-burning-oil-water.html. Accessed February 21, 2014.

National Climate Data Center (NCDC). 2006. Climate data for seven Beaufort Sea meteorological monitoring stations. http://www.ncdc.noaa.gov/oa/ncdc.html

NOAA NOS (National Oceanic and Atmospheric Administration, National Ocean Service). 2014. Datums for 9497645, Prudhoe Bay AK. Available online at http://tidesandcurrents.noaa.gov/ datums.html?id=9497645. Accessed April 21, 2014.

Nobmann, Elizabeth D. 1997. Nutritional Benefits of Subsistence Foods. Prepared by EDN Nutrition Consulting for the University of Alaska Anchorage, Institute of Social and Economic Research: Anchorage, Alaska.

Noel, L.E. and E.E. Cunningham. 2003. Caribou distribution in the Badami and Bullen Point to Staines River survey areas, Alaska, summer 2003. Report for BP Exploration (Alaska) Inc. by ENTRIX, Inc., Anchorage, Alaska.

Noel, L.E. and J.D. McKendrick. 2000. Land Cover Map for the Liberty Mine Site. Final Report, October 12, 2000. Prepared for BP Exploration (Alaska) Inc. by LGL Alaska Research Associates, Inc., Anchorage, Alaska. 17 pp. + Appendices.

Noel, L.E., S.R. Johnson, and M.K. Butcher. 2004. Snow Goose nesting and brood-rearing distributions in the Sagavanirktok River delta, Alaska, 1980–2002. Waterbirds 27: 388–395.

Noel, L.E., S.R. Johnson, and G.M. O'Doherty. 2005a. Long–tailed Duck, *Clangula hyemalis*, eider, *Somateria* spp., and scoter *Melanitta* spp., distributions in the central Alaska Beaufort Sea lagoons, 1999–2002. Canadian Field Naturalist 119: 181–185.

Noel, L.E., S.R. Johnson, G.M. O'Doherty, and M.K. Butcher. 2005b. Common Eider (*Somateria mollissima v-nigrum*) nest cover and depredation on central Alaskan Beaufort Sea barrier Islands. Arctic 58(2):129-136.

Noel, L.E., S.R. Johnson, and W.J. Gazey. 2006. Oilfield development and Glaucous Gull (*Larus hyperboreus*) distribution and abundance in central Alaska Beaufort Sea lagoons, 1970–2001. Arctic 59: 65–78.

Nortec. 1987. Endicott Development Project – 1986 NPDES Monitoring Program, Volume I, Sediment Quality Monitoring and Volume II, Benthic Macroinvertebrate Studies. Final Report.

Nortec. 1988. Endicott Development Project – 1987 NPDES Monitoring Program, Volume I, Sediment Quality Monitoring and Volume II, Benthic Macroinvertebrate Studies. Final Report.

Nortec. 1989. Endicott Development Project – 1988 NPDES Monitoring Program, Volume I, Sediment Quality Monitoring and Volume II, Benthic Macroinvertebrate Studies. Final Report.

North, M.R. 1994. Yellow-billed Loon (*Gavia adamsii*). The Birds of North America Online (A. Poole, ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/121. Accessed March 24, 2014.

Northern Technical Services. 1981. Environmental effects of gravel construction Endeavor and Resolution Islands, Beaufort Sea, AK. Prepared for Sohio Alaska Petroleum Company, Anchorage, AK.

Nowacek, D.P., L.H. Thorne, D.W. Johnson, and P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. Mammalian Review 37(2):81-115.

NRC (National Research Council). 2003. Ocean Noise and Marine Mammals. National Academy Press, Washington, D.C.

NRC. (National Research Council). 2007. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. National Academy

NSB (North Slope Borough). 1976. Nuiqsut/Teshekpuk Traditional Land Use Inventory. Unpublished manuscript. Commission on History and Culture, Barrow, AK.

NSB (North Slope Borough). 1978. The Nuiqsut and Teshekpuk Lake Area Traditional Land Use Inventory. North Slope Borough, Commission on Iñupiat History, Language and Culture. Barrow, AK.

NSB (North Slope Borough). 1980. Qiniqtuagaksrat Utuqqanaat Inuuniagninisiqun: The Traditional Land Use Inventory for the Mid-Beaufort Sea, Volume 1. North Slope Borough Commission on History and Culture: Barrow.

NSB (North Slope Borough). 2013. Traditional Land Use Inventory (TLUI). Database maintained by the North Slope Borough, Department of Planning and Community Services, Iñupiat History, Language and Culture Division, Barrow, AK.

NSIDC (National Snow & Ice Data Center). Undated. Satellite imagery from 1972 through 1996.

OASIS (OASIS Environmental, Inc.). 2008. Spectacled and Steller's eider ground-based nest surveys and avian inventory at six U.S. Air Force Radar Sites in northern Alaska. Report for U.S. Air Force, 611th Civil Engineer Squadron, Natural Resources, Elmendorf Air Force Base, AK, by OASIS Environmental, Inc., Anchorage, AK. 44 pp.

Obritschkewitsch, T. and R.J. Ritchie. 2013. Steller's Eider surveys near Barrow, Alaska, 2012. Report for U.S. Bureau of Land Management and U.S. Fish and Wildlife Service, Fairbanks, AK, by ABR, Inc.— Environmental Research & Services, Fairbanks, AK. 17 pp.

Okkonen, S.R., C.J. Ashjian, R.G. Campbell, J. Clarke, S.E. Moore, and K.D. Taylor. 2011. Satellite observations of circulation features associated with the Barrow area bowhead whale feeding hotspot. Remote Sensing Environ. 226:2168-2174.

OSI (Oceanographic Services, Inc.). 1976. Beaufort Sea Ice Movement Study 1975-76. AOGA Project 27. Santa Barbara, CA.

OSI (Oceanographic Services, Inc.). 1978a. Beaufort Sea Ice Movement Study 1976-77. AOGA Project 39. Santa Barbara, CA.

OSI (Oceanographic Services, Inc.). 1978b. Beaufort Sea Ice Movement Study 1977-78. AOGA Project 42. Santa Barbara, CA.

OSI (Oceanographic Services, Inc.). 1980. Beaufort Sea Ice Movement Study 1978-79. AOGA Project 52. Santa Barbara, CA.

Oceanweather (Oceanweather, Inc.). 1982. Beaufort Sea Wave Hindcast Study: Prudhoe Bay/Sag Delta and Harrison Bay. Vicksburg, MS.

Oceanweather (Oceanweather, Inc.). 2005. Final Report, Beaufort Sea Ocean Response Extremes (BORE), Phase I: Westerly Storms; Phase II: Easterly Storms. Cos Cob, CT: ConocoPhillips Alaska, Inc., Pioneer Natural Resources, Alaska, Inc., BP Exploration (Alaska) Inc., and Kerr-McGee Oil and Gas Corporation.

Okkonen, S.R., C.J. Ashjian, R.G. Campbell, J.T. Clarke, S.E. Moore, and K.D. Taylor. 2011. Satellite observations of circulation features associated with a bowhead whale feeding 'hotspot' near Barrow, Alaska. Remote Sensing of Environment 115:2168-2174.

OCS Governor's Coalition, Outer Continental Shelf Governor's Coalition. 2013. OCS 101. Available online at http://ocsgovernors.org/ocs101/. Accessed August 8, 2013.

Overland, J.E. 2009. Meteorology of the Beaufort Sea. Journal of Geophysical Research 114, c00A07, doi:10.1029/2008JC004861.

Pacific Ecorisk. 2014. NPDES Chronic Toxicity Testing of the Conoco Phillips Alaska, Inc. Kuparuk Seawater Treatment Plant. Performed for Kinnetic Laboratories, Inc.

Paine, R.T. 2002. Trophic control of production in a rocky intertidal community. Science 296(5568):736-739.

Pamperin, N.J., E.H. Follmann, and B. Petersen. 2008. Sea-ice use by arctic foxes in northern Alaska. Polar Biology 31(11):1421-1426.

Pamperin, N.J., E.H. Follmann, and B. Petersen. 2006. Interspecific killing of an arctic fox by a red fox at Prudhoe Bay, Alaska. Arctic 59(4):361-364.

Pedersen, S. 1979. Regional Subsistence Land Use, North Slope Borough, Alaska. Occasional Paper No. 21, Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska, Fairbanks and Conservation and Environmental Protection, North Slope Borough, Barrow.

Pedersen, S. 1986. Nuiqsut Subsistence Land Use Atlas: 1986 Update. Alaska Department of Fish and Game, Division of Subsistence File Report 1986-01.

Pedersen, S. 1990. Caribou Hunting: Land Use Dimensions, Harvest Level, and Selected Aspects of the Hunt during Regulatory Year 1987-88 in Kaktovik, Alaska. Technical Paper No. 172. Alaska Department of Fish and Game, Division of Subsistence: Fairbanks.

Pedersen, S. and M. Coffing. 1984. Caribou Hunting: Land Use Dimensions and Recent Harvest Patterns in Kaktovik, Northeast Alaska. Technical Paper No. 92. Alaska Department of Fish and Game. Fairbanks, AK.

Pedersen, S. and M. Coffing. 2001. Subsistence harvest levels and spatial dimensions of caribou, moose, brown bear and muskox hunting in Nuiqsut during regulatory year 2000. Draft Report: Division of Subsistence, Arctic region, Alaska Department of Fish and Game: Fairbanks, Alaska.

Pedersen, S., M. Coffing, and J. Thompson. 1985. Subsistence Land Use and Place Name Maps for Kaktovik, Alaska. Technical Paper No. 109. Alaska Department of Fish and Game. Fairbanks, AK.

Pedersen, S. and A. Linn. 2005. Kaktovik 2000-2002 Subsistence Fishery Harvest Assessment. U.S. Fish and Wildlife Service, Office of Subsistence management, Fisheries Resource Monitoring Program, Anchorage, Alaska.

Pedersen, S., R.J. Wolfe, C. Scott, and R.A. Caulfield. 2002. Subsistence Economies and Oil Development: Case Studies from Nuiqsut and Kaktovik, Alaska, and Subsistence Harvest Variability in Alaska Native Communities. Prepared by the Alaska Department of Fish and Game, Division of Subsistence for the USDOI, MMS, Alaska OCS Region.

Perham, C.J. 2000. Arctic fox den distribution and activity between the Sagavanirktok and Staines rivers, Alaska, including the Point Thomson Unit area. Anchorage, AK: BP Exploration (Alaska) Inc.

Perham, C.J. 2001. Arctic fox den distribution and activity between the Sagavanirktok River and the Staines River, Alaska, summer 2000. Anchorage, AK: BP Exploration (Alaska) Inc.

Petersen, M.R., J.B. Grand, and C.P. Dau. 2000. Spectacled Eider (*Somateria fischeri*). The Birds of North America Online (A. Poole, ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from http://bna.birds.cornell.edu/bna/species/547. Accessed on March 24, 2014.

Phillips, L.M., A.N. Powell, E.J. Taylor, and E.A. Rexstad. 2007. Use of the Beaufort Sea by King Eiders breeding on the North Slope of Alaska. Journal of Wildlife Management 71:1892–1898.

Powell, A.N. and S. Backensto. 2008. Productivity and locations of Common Ravens (*Corvus corax*) nesting on Alaska's North Slope. Report by Institute of Arctic Biology and Alaska Cooperative Fish & Wildlife Research Unit, University of Alaska, Fairbanks, AK, and Regional Resilience and Adaptation Program and Department of Biology and Wildlife, University of Alaska, Fairbanks, AK. 32 pp.

Powell, A.N. and S. Backensto. 2009. Common Ravens (*Corvus corax*) nesting on Alaska's North Slope oil fields. Report prepared for Minerals Management Service, Anchorage, AK, by Coastal Marine Institute, University of Alaska, Fairbanks, AK. Report No. MMS-2009-007. 37 pp.

Quakenbush, L.T., J.J. Citta, J.C. George, R.J. Small, and M.P. Heide-Jørgensen. 2010. Fall and winter movements of bowhead whales (*Balaena mysticetus*) in the Chukchi Sea and with a potential petroleum development area. Arctic 63:289–307.

Quakenbush, L. T., R. H. Day, B. A. Anderson, F. A. Pitelka, B. J. McCaffery. 2002. Historical and present breeding season distribution of Steller's Eiders in Alaska. Western Birds 33:99-120.

Quinlan S.E. and W.A. Lehnhausen. 1982. Arctic Fox, *Alopex lagopus*, predation on nesting Common Eiders, *Somateria mollissima*, at Icy Cape, Alaska. Canadian Field Naturalist 964:462-466.

Raatz, W. 1984. Observations of arctic haze during the Ptarmigan weather reconnaissance flights, 1948-1961. Tellus 36B(2): 126-136.

Radke, L.F., J.H. Lyons, D.A. Hegg, P.V. Hobbs, and I.H. Baily. 1984. Airborne observations of Arctic aerosol, I. Characteristics of Arctic Haze. Geophysical Research Letters 11: 393-396.

Rand, K.M. and E.A. Logerwell. 2011. The first demersal trawl survey of benthic fish and invertebrates in the Beaufort Sea since the late 1970's. Polar Biol. 34: 475-488.

Rawlinson, S. 1993. Surficial Geology and Morphology of the Alaskan Central Arctic Coastal Plain, Report of Investigations 93-1. State of Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys. March 1993.

RDC (Resource Development Council for Alaska, Inc.). 2013. Alaska's Oil & Gas Industry. Available online at http://www.akrdc.org/issues/oilgas/overview.html. Accessed August 8, 2013.

Reanier, R.E. 2000. Archaeological and Cultural Resources Reconnaissance in the Phillips Alaska Exploration Area, National Petroleum Reserve, Alaska, for the Year 2000. For Phillips Alaska, Inc. Reanier & Associates, Inc. Seattle, WA.

Reanier, R.E. 2002. Archaeological and Cultural Resources Reconnaissance in the Phillips Alaska Exploration Area, National Petroleum Reserve, Alaska, for the Year 2001. For Phillips Alaska, Inc. Reanier & Associates, Inc. Seattle, WA.

Reanier, R.E. 2003. Archaeological and Cultural Resources Reconnaissance for the Puviaq Prospect, National Petroleum Reserve, Alaska, for the Year 2002. For ConocoPhillips Alaska, Inc. Reanier & Associates, Inc. Seattle, WA.

Reanier, R.E. 2004. Archaeological and Cultural Resources Reconnaissance for the Jacob's Ladder Prospect, North Slope, Alaska, for the Year 2003. For Anadarko Petroleum Corp. Reanier & Associates, Inc. Seattle, WA.

Reanier, R.E. 2005. Cultural Resources Reconnaissance for the Cronus Prospect, North Slope, Alaska, for the Year 2005. For ConocoPhillips Alaska, Inc. Reanier & Associates, Inc. Seattle, WA.

Reanier, R.E. 2008. Cultural Resources in the Liberty Development Project Area, North Slope, Alaska. For BPXA. Reanier & Associates, Inc. Seattle, WA.

Reed, C.E. 1985. The Role of Wild Resource Use in Communities of the Central Kenai Peninsula and Kachemak Bay, Alaska. Technical paper No. 106. Alaska Department of Fish and Game, Division of Subsistence: Juneau.

Regehr, E.V., S.C. Amstrup, and I. Stirling. 2006. Polar bear population status in the southern Beaufort Sea. U.S. Geological Survey Open-file report 2006–1337.

Reimnitz E., S.M. Graves, and P.W. Barnes. 1988. Beaufort Sea Coastal Erosion, Sediment Flux, Shoreline Evolution, and the Erosional Shelf Profile. US Geological Survey Map I-1182G.

Reimnitz, E. and R. Ross. 1979. Lag deposits of boulders in Stefansson Sound, Beaufort Sea, Alaska. U.S. Geological Survey 79:1205. 26 pp.

Rember, R.D. and J.H. Trefry. 2004. Increased concentrations of dissolved trace metals and organic carbon during snowmelt in rivers of the Alaskan Arctic. Geochimica et Cosmochimica Acta 68(3):477-489.

Reynolds, P.E., K.J. Wilson, and D.R. Klein. 2002. Muskoxen. Pages 54-64 in D.C. Douglas, P.E. Reynolds, and E.B. Rhode, eds. Arctic Refuge Coastal Plain Terrestrial Wildlife Research Summaries, U.S. Geological Survey, Biological Resources Division, Biological Science Report USGS/BRD/BSR-2002-0001.

Rhodes, D.C., D.F. Boesch, Z-c. Tang, F-s. Xu, L-q. Huang, and K.J. Nilsen. 1985. Macrobenthos and sedimentary faceis on the Changjiang delta platform and adjacent continental shelf, East China Sea. Continental Shelf Science 4:189-203.

Richardson, P.R., A.R. Martin, and J.R. Orr. 2001. Summer and autumn movements of belugas of the eastern Beaufort Sea Stock. Arctic 54:223–236.

Richardson, W.J. and M.T. Williams. 2004. Monitoring of industrial sounds, seals, and bowhead whales near BP's Northstar oil development, Alaskan Beaufort Sea, 1999-2003. Annual and Comprehensive Report, Dec 2004. A report from LGL Ltd., Greeneridge Sciences Inc., and WEST Inc. for BP Exploration (Alaska) Inc. LGL Report TA 4001, 297 pp. BP Exploration (Alaska) Inc., Anchorage, AK.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, and D.H. Thomson. 1995. Marine Mammals and Noise. Academic Press, New York.

Richardson, W.J., G.W. Miller, C.R. Greene. 1999. Displacement of migrating bowhead whales by sounds from seismic surveys in shallow waters of the Beaufort Sea. Journal of the Acoustical Society of America 106:228 (abstract only).

Ritchie, R.J., A.M. Wildman, and D.A. Yokel. 2003. Aerial surveys of cliff-nesting raptors in the National Petroleum Reserve—Alaska, 1999, with comparisons to 1977. U.S. Bureau of Land Management, Fairbanks, AK. Technical Note No. 413. 66 pp.

Ritchie, R.J., R.M. Burgess, J. Shook, and T. Obritschkewitsch. 2008. Surveys for nesting and brood-rearing Brant and Lesser Snow Geese, Barrow to Fish Creek delta, and Lesser Snow Goose banding near the Ikpikpuk River delta, Alaska, 2007. Report for Department of Wildlife Management, North Slope Borough, Barrow, AK, by ABR, Inc., Environmental Research & Services, Fairbanks, AK. 53 pp.

Ritchie, R.J., R.M. Burgess, and A.A. Stickney. 2009. Results of Snow Goose banding on the Sagavanirktok River delta, Alaska, 2009. Report for BP Exploration (Alaska), Inc., by ABR, Inc.—Environmental Research & Services, Fairbanks, AK. 10 pp.

Robilliard, G.A., R.W. Smith and J.M. Colonell. 1988. Final Report. Prudhoe Bay Waterflood Project. Benthic Infauna and Water Quality Components of the NPDES Monitoring Program - May 1986. Prepared for ARCO Alaska, Inc. and the Prudhoe Bay Unit, Anchorage, AK.

Robilliard, G.A., A. Jahn, R.W. Smith and B. Bernstein. 1989. Final Report. Prudhoe Bay Waterflood Project. Benthic Infauna and Water Quality Components of the NPDES Monitoring Program - May 1988. Prepared for ARCO Alaska Inc. and the Prudhoe Bay Unit, Anchorage, AK.

Rodrigues, R., M.K. Blees, and M.L. Bourdon. 2009. Howe Island Snow Goose and Brant nest monitoring, Sagavanirktok River delta area, Alaska, 2009. Report for BP Exploration (Alaska), Inc., by LGL Alaska Research Associates, Inc., Anchorage, AK. 14 pp.

Rogers, J.S. 2014. Submerged Cultural Resources Assessment, Liberty Development Project, Beaufort Shelf, Alaska. February 2014. Prepared by Northern Land Use Research Alaska, LLC for SLR International Corporation and BP Exploration (Alaska) Inc. Anchorage, Alaska. 20 pp.

Rojek, N.A. 2008. Breeding biology of Steller's Eiders nesting near Barrow, Alaska, 2007. Report by U.S. Fish and Wildlife Service, Fairbanks, AK. Technical Report. 45 pp.

Romano, T.A., M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran. 2004. Anthropogenic sound and marine mammal health: Measures of the nervous and immune systems before and after intense sound exposure. Canadian Journal of Fisheries and Aquatic Sciences 61(7): 1124-1134.

Roth, J.D. 2003. Variability in Marine Resources Affects Arctic Fox Population Dynamics. Journal of Animal Ecology 72:668-676.

Rugh, D.J., D. DeMaster, A. Rooney, J. Brewick, K. Shelden, and S. Moore. 2003. A review of bowhead whale (*Balaena mysticetus*) stock identity. Journal of Cetacean Research and Management 5:267–279.

Rugh, D.J., and M.A. Fraker. 1981. Gray whale (*Eschrichtius robustus*) sightings in Eastern Beaufort Sea. Arctic 34(2):186-187.

Rugh, D.J., R.C. Hobbs, J.A. Lerczak, and J.M. Breiwick. 2005. Estimates of abundance of the eastern north Pacific stock of gray whales 1997–2002. Journal of Cetacean Research and Management 71:1–12.

Saalfeld, S.T., R.B. Lanctot, S.C. Brown, D.T. Saalfeld, J.A. Johnson, B.A. Andres, and J.R. Bart. 2013. Predicting breeding shorebird distributions on the Arctic Coastal Plain of Alaska. Ecosphere 4:16. Available online at http://dx.doi.org/10.1890/ES12-002921. Accessed December 2013.

Samelius, G. and R.T. Alisauskus. 2000. Foraging patterns of arctic foxes at a large arctic goose colony. Arctic 53:279-288.

Sanzone, D., B. Streever, B. Burgess, and J. Lukin. 2009. Long-term ecological monitoring in BP's North Slope oil fields: 2008. Report prepared by BP Exploration (Alaska), Inc., Anchorage, Alaska. 82 pp.

Scanlon, B. 2012. Fishery Management Report for Sport Fisheries in the Northwest/North Slope Management Area, 2011. Alaska Department of Fish and Game, Division of Sport Fish, Research and Technical Services. Anchorage, AK.

Schell, D.M. 1975. Seasonal Variation in the Nutrient Chemistry and Conservative Constituents in Coastal Alaskan Beaufort Sea Waters. Research Reporting Series, Ecological Research Environmental Studies of an Arctic Estuarine System DPA-660/3-75-026. U.S. Environmental Protection Agency, National Environmental Research Center, Corvallis, Oregon. As cited in BPXA (2007).

Schmidt, D.R., W.B. Griffiths, D.K. Beaubien, and C.J. Herlugson. 1991. Movement of young-of-the-year Arctic ciscoes across the Beaufort Sea coast, 1985-1988. American Fisheries Society Symposium 11: 132-144.

Schliebe, S., T. Evans, K. Johnson, M. Roy, S. Miller, C. Hamilton, R. Meehan, and S. Jahrsdoerfer. 2006. Range-wide status review of the polar bear (*Ursus maritimus*). U.S. Fish and Wildlife Service, Anchorage, AK.

Schliebe, S., K.D. Rode, J.S. Gleason, J. Wilder, K. Proffitt, T.J. Evans, and S. Miller. 2008. Effects of sea ice extent and food availability on spatial and temporal distribution of polar bears during the fall open-water period in the Southern Beaufort Sea. Polar Biology 31:999–1010.

Schmutz, J.A. 2009. Model-based predictions of the effects of harvest mortality on population size and trend of Yellow-billed Loons. U.S. Geological Survey, Anchorage, AK. Open-File Report No. 2009-1040. 18 pp.

Schmutz, J.A. and D.J. Rizzolo. 2012. Monitoring marine birds of concern in the eastern Chukchi nearshore areas (loons). OCS Study BOEM 2012-078. Report for U.S. Bureau of Ocean Energy Management, Anchorage, AK, by U. S. Geological Survey, Anchorage, AK. 38 pp.

Seaman, G.A., G.F. Tande, D.L. Clausen, and L. L. Trasky. 1981. Mid-Beaufort coastal habitat evaluation study: Colville River to Kuparuk River. Report by Alaska Department of Fish and Game, Anchorage AK, for North Slope Borough, Barrow, AK.

Shapiro, L., R. Metzner, and K. Toovak. 1979. Historical References to Ice Conditions Along the Beaufort Sea Coast of Alaska. Geophysical Institute Report UAG R-268. Fairbanks, AK: University of Alaska.

Shaw, G.E. 1995. The arctic haze phenomenon. Bulletin of American Meteorological Society 76: 2403-2413.

Shell (Shell Offshore Inc.). 2011. Environmental Impact Analysis, Revised Outer Continental Shelf Lease Exploration Plan, Camden Bay, Beaufort Sea, Alaska. Anchorage, AK.

Shepro, C.E. and D.C. Maas. 1999. North Slope Borough 1998/99 Economic Profile and Census Report: Volume VIII. Prepared for the North Slope Borough Department of Planning and Community Services: Barrow.

Shideler, R., and J. Hechtel. 2000. Grizzly Bear. Pages 105-132 in J.C. Truett and S.R. Johnson, eds. The Natural History of an Arctic Oil Field Development and the Biota. Academic Press, San Diego, California.

Shin, P.K.S., F.N. Yau, S.H. Chow, K.K. Tai, and S.H. Cheung. 2002. Responses of the green-lipped mussel *Perna viridis* (L.) to suspended solids. Marine Pollution Bulletin 45:157-162.

Skoog, R.O. 1968. Ecology of the caribou (Rangifer tarandus granti) in Alaska. PhD Thesis. University of California-Berkeley, Berkeley, California. 699pp.

SLR (SLR International Corporation). 2014. Air Quality Impact Analysis for the Liberty Development Project. Version 1.0. November 2014. Prepared by SLR International Corporation prepared for BP Exploration (Alaska) Inc. Anchorage, Alaska. 44 pp.

Smith, T.G. 1976. Predation of ringed seal pups by the arctic fox. Canadian Journal of Zoology 54:1610-1616.

Smith, T.S., S.T. Partridge, S.C. Amstrup, and S. Schliebe. 2007. Post-den emergence behavior of polar bears (*Ursus maritimus*) in Northern Alaska. Arctic 60:187–194.

Smith, M., N. Walker, C. Free, M. Kirchhoff, N. Warnock, A. Weinstein, T. Distler, and I. Stenhouse. 2012. Marine Important Bird Areas in Alaska: Identifying Globally Significant Sites Using Colony and At-Sea Survey Data. Audubon Alaska, Anchorage. Alaska. Available online

at http://ak.audubon.org/sites/default/files/documents/marine_ibas_report_final_sep_2012.pdf. Accessed January 31, 2014.

Sobelman, S.S. 1985. The economics of wild resource use in Shishmaref, Alaska. ADF&G Division of Subsistence, Technical Paper No. 112. Alaska Department of Fish and Game: Fairbanks.

Sohio (Sohio Alaska Petroleum Company). 1983. Environmental Summer Studies (1982) for the Endicott Development. Prepared by: LGL Alaska Research Associates and Northern Technical Services. B.J. Gallaway and R.P. Britch, eds.

Southall, B.L., A.E. Bowles, W.T. Ellison, J.J. Finneran, R.L. Gentry, C.R. Greene, Jr., D. Kastak, D.R. Ketten, and J.H. Miller. 2007. Marine mammal noise exposure criteria: Initial scientific recommendations. Aquatic Mammals 33:411-521.

Sovada, M.A., R.M.l. Anthony, and B.D.J. Batt. 2001. Predation on waterfowl in arctic tundra and prairie breeding areas: a review. Wildlife Society Bulletin 29(1):6-15.

Spight, T.M. and K.E. Tarbox. 1979. Life history summary for some Arctic fishes. In: Woodward-Clyde Consultants, Prudhoe Bay Waterflood Project, Biological effects of impingement and entrainment from operation of the proposed intake, Summer 1978. For: Prudhoe Bay Unit

SRB&A (Stephen R. Braund and Associates). 2003. Public Testimony/Traditional Knowledge by Resource Technical Report [for Subsistence], Point Thomson Gas Cycling Project EIS. Prepared for CH2M Hill: Anchorage.

SRB&A (Stephen R. Braund and Associates). 2009. Impacts and Benefits of Oil and Gas Development to Barrow, Nuiqsut, Wainwright, and Atqasuk Harvesters. Prepared for the North Slope Borough Department of Wildlife Management: Barrow.

SRB&A (Stephen R. Braund and Associates). 2010a. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Prepared for U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Environmental Studies Program. Anchorage, Alaska.

SRB&A (Stephen R. Braund and Associates). 2010b. Literature Review of North Slope Marine Traditional Knowledge. Prepared for Tetra Tech and U.S. Environmental Protection Agency. Anchorage, Alaska.

SRB&A (Stephen R. Braund and Associates). 2010c. Oil Development Impacts on Subsistence: Monitoring and Assessing Mitigation in the Vicinity of Nuiqsut, Alaska. Powerpoint presented to the Canada – United States Northern Oil and Gas Research Forum, Calgary, Alberta, Canada.

SRB&A (Stephen R. Braund and Associates). 2011. Report of Traditional Knowledge Workshops – Point Lay, Barrow, Nuiqsut, and Kaktovik. Prepared for Tetra Tech and U.S. Environmental Protection Agency. Anchorage, Alaska.

SRB&A (Stephen R. Braund and Associates). 2012. Subsistence and Traditional Land Use Patterns Technical Report, Appendix Q. Prepared for HDR Alaska Inc. as part of the Point Thomson Project Final EIS and submitted to the U.S. Army Engineer District Alaska Regulatory Division CEPOA-RD: Anchorage.

St. Martin, J. 1987. Arctic Drifting Buoy Data 1979-85. US Coast Guard Report No. CG D 10-87, Washington, DC.

SPCO (State Pipeline Coordinator's Office). 2012. 2012 Annual Report. Anchorage, AK.

Steger, K.K. and J.P.A. Gardner. 2007. Laboratory experiments on the effects of variable suspended concentrations on the ecophysiology of the porcelain crab *Petrolisthes elongates* (Milne Edwards, 1837). Journal of Experimental Marine Biology and Ecology 344:181-192.

Stehn, R.A., C.P. Dau, B. Conant, and W.I. Butler, Jr. 1993. Decline of Spectacled Eiders nesting in western Alaska. Arctic 46: 264–277.

Stehn, R.A., W.W. Larned, and R.M. Platte. 2013. Analysis of aerial survey indices monitoring waterbird populations of the Arctic Coastal Plain, Alaska, 1986–2012. Report by U.S. Fish and Wildlife Service, Anchorage and Soldotna, AK. 56 pp.

Stehn, R. and R. Platte. 2000. Exposure of birds to assumed oil spills at the Liberty Project. 19 September 2000. Report prepared by U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK.

Stickney, A.A. 1991. Seasonal patterns of prey availability and the foraging behavior of arctic foxes (*Alopex lagopus*) in a waterfowl nesting area. Canadian Journal of Zoology 69:2853-2859.

Stickney, A.A., R.J. Ritchie, R.M. Burgess, and L.B. Attanas. 2011. Results of Snow Goose banding on the Sagavanirktok River delta, Alaska, 2010. Report for BP Exploration (Alaska), Inc., by ABR, Inc.—Environmental Research & Services, Fairbanks, AK. 9 pp.

Stirling, I., M. Kingsley, and W. Calvert. 1982. The distribution and abundance of seals in the eastern Beaufort Sea, 1984–79. Environment Canada, Canadian Wildlife Service, Edmonton, AB, Canada.

Stickney, A.A., T. Obritschkewitsch, and R.M. Burgess. 2014. Shifts in fox den occupancy in the Greater Prudhoe Bay Area, Alaska. Arctic 67(2):196-202.

Stirling, I., W. R. Archibald, and D. DeMaster. 1977. Distribution and abundance of seals in the eastern Beaufort Sea. Journal of the Fisheries Research Board of Canada 34(7): 976–988

Stratton. L. 1989. Resource Use in Cordova, A Coastal Community of Southcentral Alaska. Technical Paper No. 153. Alaska Department of Fish and Game, Division of Subsistence: Juneau.

Stratton. L. 1990. Resource harvest and use in Tatitlek, Alaska. Technical Paper No. 181. Alaska Department of Fish and Game, Division of Subsistence: Juneau.

Stratton. L. 1992. Cordova: A 1988 Update on Resource Harvests and Uses. Technical Paper No. 204. Alaska Department of Fish and Game, Division of Subsistence: Juneau.

Streever, B. and S. Cargill Bishop (eds.). 2013. Long-Term Ecological Monitoring in BP's North Slope Oil Fields Through 2012. BP Exploration (Alaska) Inc., Anchorage, Alaska.

Streever, B., D. Sanzone, R. Burgess, and J. Lukin. 2007. Long-Term Ecological Monitoring in BP's North Slope Oil Fields: 2006 Annual Report. Anchorage, AK: BP Exploration (Alaska) Inc.

Suydam, R.S. and J.C. George. 1992. Recent sightings of harbor porpoises, *Phocoena phocoena*, near Point Barrow, Alaska. The Canadian Field Naturalist 106:489–492.

Suydam, R.S., L.F. Lowry, K.J. Frost, G.M. O'Corry-Crowe and D. Pikok Jr. 2001. Satellite tracking of eastern Chukchi Sea beluga whales into the Arctic Ocean. Arctic 54(3):237–243.

Suydam, R.S., L.F. Lowry, and K.J. Frost. 2005. Distribution and movements of beluga whales from the eastern Chukchi Sea stock during summer and early autumn. Final report, OCS Study MMS 2005–035.

Tannerfeldt, M. and A. Angerbjorn. 1998. Fluctuating resources and the evolution of litter size in the arctic fox. Oikos 83:545-559.

TAPS Owners. 2001. Draft Environmental Report for Trans Alaska Pipeline System Right-of-Way Renewal. Trans Alaska Pipeline System Owners.

Tarbox, K.E. and T.M. Spight. 1979. Beaufort Sea fishery investigations. In: Woodward-Clyde Consultants, Prudhoe Bay Waterflood Project, Biological effects of impingement and entrainment from operation of the proposed intake, Summer 1978. For: Prudhoe Bay Unit.

Taylor, A.R., R.B. Lanctot, A.N. Powell, F. Huettmann, D.A. Nigro, and S.J. Kendall. 2010. Distribution and community characteristics of staging shorebirds on the northern coast of Alaska. Arctic 63: 451–467.

Taylor, A.R., R.B. Lanctot, A.N. Powell, S.J. Kendall, and D.A. Nigro. 2011. Residence time and movements of postbreeding shorebirds on the northern coast of Alaska. Condor 113: 779–794.

Tekmarine, Inc., Polar Alpine Inc., and OCTI. 1985. 1984 Beaufort Sea Multiyear Ice Floe Tracking Study. AOGA Project 280. Sierra Madre, CA.

Thorndike, A. and J. Cheung. 1977a. AIDJEX Measurements of Sea Ice Motion, 11 April 1975 to 14 May 1976. AIDJEX Bulletin No. 35. Seattle, WA.

Thorndike, A. and J. Cheung. 1977b. Measurements of Sea Ice Motion Determined from OCS Data Buoys, October 1975 to December 1976. Seattle, WA: Polar Science Center, University of Washington.

Thorsteinson, L.K., L.E. Jarvela, and D.A. Hale. 1991. Arctic fish habitat use investigations: nearshore studies in the Alaskan Beaufort Sea, Summer 1990. Annual Report, NOAA, National Ocean Service, Office of Ocean Resources Conservation and Assessment, Anchorage, AK.

Toimil, L.J. and K.H. Dunton. 1983. Supplemental study: environmental effect of gravel island construction, OCS-Y0191 (BF-37) Beechey Point, Block 480, Stefansson Sound, AK. Harding Lawson Associates.

Toimil, L.J. and K.H. Dunton. 1984. 1983 Supplemental Study: environmental effect of gravel island construction, OCS-Y0191 (BF-37) Beechey Point, Block 480, Stefansson Sound, AK. Harding Lawson Associates.

Toimil, L.J. and K.H. Dunton. 1985. 1984 Supplemental study: environmental effect of gravel island construction, OCS-Y0191 (BF-37) Beechey Point, Block 480, Stefansson Sound, AK. Harding Lawson Associates.

Toimi, L.J., and J.M. England. 1980. Investigation of rock habitats and sub-seabed conditions, Beaufort Sea, Alaska. Exxon Company, USA, Final Report. Harding Lawson Associates.

Toimil, L.J. and J.M. England. 1982. Environmental effects of gravel island construction: OCS-Y0191(BF-37), Beechey Point Block 480, Stefansson Sound, Alaska. Harding Lawson Associates.

Treacy, S.D. 2000. Aerial surveys of endangered whales in the Beaufort Sea, fall 1998–1999. OCS Study MMS 2000–066. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Anchorage.

Treacy, S.D. 2002. Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2001. OCS Study MMS 2002-061. U.S. Department of the Interior, Minerals Management Service, Alaska Outer Continental Shelf Region.

Treacy, S.D., J.S. Gleason, and C.J. Cowles. 2006. Offshore distances of bowhead whales (*Balaena mysticetus*) observed during fall in the Beaufort Sea. Arctic 59:83–90.

Trefry, J.H., R.D. Rember, R.P. Trocine, and J.S. Brown. 2003. Trace Metals in Sediments Near Offshore Oil Exploration and Production Sites in the Alaskan Arctic. Environmental Geology 45:149-160.

Trefry, J.H., R.D. Rember, R.P. Trocine. 2004. ANIMIDA Task 5, Sources, Concentrations and Dispersion Pathways for Suspended Sediment in the Coastal Beaufort Sea. Final Report, OCS Study MMS 2004-032, MMS, Alaska OCS Region, Anchorage, Alaska.

Trefry, J.H., R.P. Trocine, M.B. Alkire, C.M. Semmler, M. Savoie, and R.D. Rember. 2009. cANIMIDA Tasks 3 and 4: Sources, Concentrations, Composition, Partitioning, and Dispersion Pathways for Suspended Sediments and Potential Metal Contaminants in the Coastal Beaufort Sea. Final Report, OCS Study MMS 2009-014, MMS, Alaska OCS Region, Anchorage, Alaska.

Troy, D. 2010. Movements of Glaucous Gulls in Arctic Alaska, 2009–2010. Report prepared for Department of Wildlife Management, North Slope Borough, Barrow, AK, by Troy Ecological Research Associates, Anchorage, AK. 25 pp.

Tyack, P. L., J. Gordon, D. Thompson. 2004. Controlled exposure experiments to determine the effects of noise on marine mammals. Marine Technology Society Journal 37 (4): 41-53.

Tyack P.L., Zimmer W.M.X., Moretti D., Southall B.L., Claridge D.E., Durban J.W., Clark C.W., D'Amico A., DiMarzio N., Jarvis S., et al. 2011 Beaked Whales Respond to Simulated and Actual Navy Sonar. PLoS One 6(3). (doi:e17009 10.1371/journal.pone.0017009).

USCB (U.S. Census Bureau). 2013a. American Community Survey. Available online at http://www.census.gov/acs/www/. Accessed August 8, 2013.

USCB (U.S. Census Bureau). 2013b. American Fact Finder. Available online at http://factfinder.census.gov/home/saff/main.html?_lang=en. Accessed August 7, 2013.

Urick, R.J. 1983. Principles of Underwater Sound. 3rd edition. McGraw Hill, New York. 423 pp.

USACE (U.S. Army Corps of Engineers). 1984a. Endicott Development Project Public Hearings: Nuiqsut. February 29, 1984. Prepared by Accu-Type Depositions, Inc. for the U.S. Army Corps of Engineers: Anchorage.

USACE (U.S. Army Corps of Engineers). 1984b. Endicott Development Project Public Hearings: Kaktovik. March 2, 1984. Prepared by Accu-Type Depositions, Inc. for the U.S. Army Corps of Engineers: Anchorage.

USACE (U.S. Army Corps of Engineers). 1996a. Beaufort Sea Oil and Gas Development Northstar EIS Project Public Scoping Meeting: Kaktovik. March 26, 1996. Prepared by Alaska Stenotype Reporters for U.S. Army Corps of Engineers: Anchorage.

USACE (U.S. Army Corps of Engineers). 1996b. Beaufort Sea Oil and Gas Development Northstar EIS Project Public Scoping Meeting: Nuiqsut. May 7, 1996. Prepared by Alaska Stenotype Reporters for U.S. Army Corps of Engineers: Anchorage.

USACE (U.S. Army Corps of Engineers). 1996c. Beaufort Sea Oil and Gas Development Northstar EIS Nuiqsut Whaling Captains' Meeting: Nuiqsut. August 14, 1996. Prepared by SRB&A and Dames and Moore, Inc. for U.S. Army Corps of Engineers: Anchorage.

USACE (U.S. Army Corps of Engineers). 1999. Beaufort Sea Oil and Gas Development/Northstar Project Final Environmental Impact Statement. Anchorage, AK: U.S. Army Corps of Engineers, Alaska District.

USACE (U.S. Army Corps of Engineers). 2012a. Point Thomson Project EIS Final Environmental Impact Statement. July 2012. Anchorage, AK: U.S. Army Corps of Engineers, Alaska District.

USACE (U.S. Army Corps of Engineers). 2012b. Alaska Stand Alone Gas Pipeline Final Environmental Impact Statement. October 2012. Anchorage, AK: U.S. Army Corps of Engineers, Alaska District.

USACE and ERT (U.S. Army Corps of Engineers, Alaska District, and Environmental Research and Technology, Inc.). 1984. Endicott Development Project. Final Environmental Statement (3 volumes). Anchorage, AK.

USCG (United State Coast Guard). 2013. Nome Maritime Symposium. USCG Seventeenth District, United States Department of Homeland Security.

USEIA (U.S. Energy Information Administration). 2014. AEO2014 Early Release Overview. Washington, D.C.

USFWS (U.S. Fish and Wildlife Service). 1985. National Wetlands Inventory: Notes to the user for North Slope 1:63,360 Scale maps. Available online at http://www.fws.gov/wetlands/. Accessed November 21, 2013.

USFWS (U.S. Fish and Wildlife Service). 1996. Spectacled eider recovery plan. Anchorage, AK. 157 pp.

USFWS (U.S. Fish and Wildlife Service). 2001. Final determination of critical habitat for the spectacled eider. Federal Register 66: 9146-9185.

USFWS (U.S. Fish and Wildlife Service). 2002. Steller's Eider Recovery Plan. Fairbanks, Alaska.

USFWS (U.S. Fish and Wildlife Service). 2007. Final Biological Opinion for Minerals Management Service and their agents BP Exploration (Alaska) Inc. Liberty Development Project. October. 41 pp.

USFWS (U.S. Fish and Wildlife Service). 2009. Final Amended Biological Opinion for BP Exploration (Alaska) Inc.'s Northstar and Liberty Development Projects. Consultation with the Minerals Management Service – Alaska OCS Region, Anchorage, AK. September 1, 2009. 55 pp.

USFWS (U.S. Fish and Wildlife Service). 2012. Biological Opinion for ExxonMobil's Point Thomson Project. September 14, 2012. Consultation with the U.S. Army Corps of Engineers. Fairbanks Fish and Wildlife Field Office, Fairbanks, AK. 80 pp.

USFWS (U.S. Fish and Wildlife Service). 2013a. USFWS Listed and Candidate Species in Alaska. Available online at http://www.fws.gov/alaska/fisheries/endangered/species.htm. Accessed November 20, 2013.

USFWS (U.S. Fish and Wildlife Service). 2013b. unpublished bird data – CB Unpublished Data. Personal Communication, K. Kuletz, U.S. Fish and Wildlife Service, Anchorage, Alaska.

USFWS (U.S. Fish and Wildlife Service). 2013c. National Wetlands Inventory. Wetland Data Download. Available online at http://www.fws.gov/wetlands/Data/Data-Download.html. Accessed December 2013.

USGS (U.S. Geological Survey). 2012. Studying Ocean Acidification in the Arctic Ocean. USGS Fact Sheet 2012-3058. April.

Van Rijn, L.C. 2014. Simple General Formulae for Sand Transport in Rivers, Estuaries and Coastal Waters. Available online at http://www.leovanrijn-sediment.com/papers/Formulaesandtransport.pdf

Vaudrey, K. 1980. Beaufort Sea First-Year Ice Features Survey – 1979, Volume I: Field Investigation. AOGA Project No. 55, Houston, TX: Gulf Research and Development Co.

Vaudrey, K. 1981. 1980 Freezeup Study of the Barrier Island Chain and Harrison Bay. AOGA Project 129. Missouri City, TX.

Vaudrey, K. 1982a. 1981 Breakup Study of the Barrier Island Chain and Harrison Bay. AOGA Project 148. Missouri City, TX.

Vaudrey, K. 1982b. 1981 Freezeup Study of the Barrier Island Chain and Harrison Bay. AOGA Project 160. San Luis Obispo, CA.

Vaudrey, K. 1983a. 1982 Breakup Study of the Barrier Island Chain and Harrison-Smith Bays. AOGA Project 191. San Luis Obispo, CA.

Vaudrey, K. 1983b. 1982 Freezeup Study of the Barrier Island Chain and Harrison Bay. AOGA Project 200. San Luis Obispo, CA.

Vaudrey, K. 1984a. 1983 Breakup Study of the Alaskan Beaufort and Upper Chukchi Seas. AOGA Project 224. San Luis Obispo, CA.

Vaudrey, K. 1984b. 1983 Freezeup Study of the Alaskan Beaufort and Upper Chukchi Seas. AOGA Project 246. San Luis Obispo, CA.

Vaudrey, K. 1985a. 1984 Breakup Study of the Alaskan Beaufort and Upper Chukchi Seas. AOGA Project 274. San Luis Obispo, CA.

Vaudrey, K. 1985b. 1984 Freezeup Study of the Alaskan Beaufort and Upper Chukchi Seas. AOGA Project 282. San Luis Obispo, CA.

Vaudrey, K. 1986a. 1985 Breakup Study of the Alaskan Beaufort and Upper Chukchi Seas. AOGA Project 319. San Luis Obispo, CA.

Vaudrey, K. 1986b. 1985 Freezeup Study of the Alaskan Beaufort and Upper Chukchi Seas. AOGA Project 327. San Luis Obispo, CA.

Vaudrey, K. 1987. 1985-86 Ice Motion Measurements in Camden Bay. AOGA Project 328. San Luis Obispo, CA.

Vaudrey, K. 1988a. 1987 Summer and Freeze-Up Ice Conditions in the Beaufort and Chukchi Seas Design Developed from Satellite Imagery. AOGA Project No. 360. San Luis Obispo, CA.

Vaudrey, K. 1988b. Ice and Meteorological Criteria for the Karluk Prospect King Spray Ice Island 1988-89: Chevron USA Inc.

Vaudrey, K. 1989a. 1988 Summer and Freeze-Up Ice Conditions in the Beaufort and Chukchi Seas Design Developed from Satellite Imagery. AOGA Project No. 370. San Luis Obispo, CA.

Vaudrey, K. 1989b. Break-Up Ice Movement of the Karluk Spray Ice Island: Chevron USA Inc.

Vaudrey, K. 1990. 1989 Summer and Freeze-Up Ice Conditions in the Beaufort and Chukchi Seas Design Developed from Satellite Imagery. AOGA Project No. 372. San Luis Obispo, CA.

Vaudrey, K. 1991. 1990 Summer and Freeze-Up Ice Conditions in the Beaufort and Chukchi Seas Design Developed from Satellite Imagery. AOGA Project No. 381. San Luis Obispo, CA.

Vaudrey, K. 1992. 1991 Summer and Freeze-Up Ice Conditions in the Beaufort and Chukchi Seas Design Developed from Satellite Imagery. AOGA Project No. 386. San Luis Obispo, CA.

Vaudrey, K. 1996. 1995-96 Monitoring Program for the West Dock Causeway 650-ft Breach: ARCO Alaska, Inc.

Vaudrey, K. 1997. Design Basis Ice Criteria for the Liberty Development. Anchorage, AK: BPXA.

Vaudrey, K. and D. Dickins. 1996. Oil Spill Tracking at the Northstar Development during Break-Up and Early Summer Using Satellite Tracking Buoys. Anchorage, AK: BPXA.

Vaudrey and Coastal Frontiers (Vaudrey, K. and Coastal Frontiers Corporation). 2013. Design Basis Ice Criteria for the Liberty Development. Anchorage, AK: BPXA.

Ver Hoef, J.M., M.F. Cameron, P.L. Boveng, J.M. London, and E.E. Moreland. 2013. A spatial hierarchical model for abundance of three ice—associated seal species in the eastern Bering Sea. Statistical Methodology. Available online at http://www.sciencedirect.com/science/article/pii/S1572312713000282. Accessed April 8, 2013.

Wade, P.R. and R. Angliss. 1997. Guidelines for assessing marine mammal stock: report of the GAMMS workshop April 3–5, 1996, Seattle, WA. U.S. Department of Commerce, NOAA Technical Memo NMFS-OPR-12.

Walker, D.A., K.R. Everett, P.J. Webber, and J. Brown. 1980. Geobotanical Atlas of the Prudhoe Bay Region, Alaska. CRREL Report 80-14. June 1980. U.S. Army corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. 73 pp.

Walker, D.A., P.J. Webber, K.R. Everett, and J. Brown. 1978. Effects of Crude and Diesel Oil Spills on Plant Communities at Prudhoe Bay, Alaska, and the Derivation of Oil Spill Sensitivity Maps. Arctic 31(3):242-259.

Ward, D. H., R. A. Stehn, and D. B. Derksen. 2000. Response of geese to aircraft disturbances. Pp. 52–54 in Effects of Noise on Wildlife Conference Proceedings, Happy Valley–Goose Bay, NL, Canada.

Ward, D. H., R. A. Stehn, W. P. Erickson, D. V. Derksen. 1999. Response of fall-staging Brant and Canada Geese to aircraft overflights in southwestern Alaska. Journal of Wildlife Management 63: 373–381.

Walker, H.J. 1983. The Colville River Delta-A Field Guide. In: Proceedings, International Conference on Permafrost. Fairbanks, Alaska.

Watkins, W.A., M.A. Daher, G.M. Reppucci, J.E. George, D.L. Martin, N.A. DiMarzio, and D.P. Gannon. 2000. Seasonality and distribution of whale calls in the North Pacific. Oceanography 13(1):62-67.

Watson Company. 1999. The Preliminary Liberty Cultural Resources Report. For BPXA. Anchorage, AK.

WCC (Woodward-Clyde Consultants). 1981. Environmental Report for Exploration in the Beaufort Sea Federal/State Outer Continental Shelf Lease Sale, Tern Prospect. For Shell Oil Company. Anchorage, AK.

Weingartner, T.J. and S.R. Okkonen. 2001. Beaufort Sea Nearshore Under-Ice Currents: Science, Analysis and Logistics. Final Report. December 2001. OCS Study MMS 2001-068. Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, Alaska. 28 pp.

Weingartner, T.J., S.R. Okkonen, and S.L. Danielson. 2005. Circulation and Water Property Variations in the Nearshore Alaskan Beaufort Sea. Final Report. June 2005. OCS Study, MMS 2005-028. Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, Alaska. 111 pp.

Weingartner, T.J., S.L. Danielson, J.L. Kasper, and S.R. Okkonen. 2009. Circulation and Water Property Variations in the Nearshore Alaskan Beaufort Sea (1999-2007). Publications of the U.S. Geological Survey. Paper 88. Available online at http://digitalcommons.unl.edu/usgspubs/88. Accessed February 2014.

Wentworth, C. 1979. Kaktovik Synopsis in Native Livelihood & Dependence: A Study of Land Use Values Through Time. National Petroleum Reserve in Alaska Work Group 1 in Cooperation with the North Slope Borough, Field Study 1. U.S. Department of the Interior: Anchorage.

Wilce, R.T. and K.H. Dunton. 2014. The Boulder Patch (North Alaska, Beaufort Sea) and its benthic algal flora. *Arctic* 67(1): 43-59.

Wilcox, W.J., and C.F. Cahill. 2003. Regional Haze Trends in Alaska: Implications for Protected Class I Visibility Areas. EM-PITTSBURGH-AIR AND WASTE MANAGEMENT ASSOCIATION 34-39.

Williams, M.T. and J.A. Coltrane (eds.). 2002. Marine mammal and acoustical monitoring of the Alaska gas producers pipeline team's open water pipeline route survey and shallow hazards program in the Alaskan Beaufort Sea, 2001. LGL Report No. P643. Report from LGL Alaska Research Associates, Inc., for BP Exploration (Alaska), Inc.; ExxonMobil Production; Phillips Alaska, Inc., and the National Marine Fisheries Service.

Wilson, W. 2006. Fishery management options for the Alaskan EEZ in the Chukchi and Beaufort Seas of the Arctic Ocean-a discussion paper. North Pacific Fish. Mgmt. Council.

Winters, J.F. and W.A. Morris. 2004. Fisheries Investigations in Streams Crossed by the Proposed Point Thomson Gas Cycling Project. Technical Report No. 04-03. May 2004. Alaska Department of Natural Resources, Office of Habitat Management and Permitting.

Wiseman, W.J., Jr., M. Coleman, A. Gregory, S.A. Hsu, A.D. Short, J.N. Suhayda, C.D. Walters, Jr., and L.D. Wright. 1973. Alaskan Arctic Coastal Processes and Morphology. Technical Report No. 149. Coastal Studies Institute. Louisiana State University. Baton Rouge, LA: 171 pp.

Wiswar, D.W. and D.J. Frugé. 2006. Fisheries Investigations in Western Camden Bay, Arctic National Wildlife Refuge, Alaska, 1987. Alaska Fisheries Data Series Number 2006-10, U.S. Fish and Wildlife Service: Fairbanks.

Wolfe, R.J. 1983. Understanding Resource Uses in Alaskan Socioeconomic Systems *in* Resource Use and Socioeconomic Systems: Case Studies of Fishing and Hunting in Alaskan Communities. Alaska Department of Fish and game, Division of Subsistence: Juneau.

Wolfe, R.J. and C.J. Utermohle. 2000. Wild Food Consumption Rate Estimates for Rural Alaska. Technical Paper No. 261, Alaska Department of Fish and Game, Division of Subsistence: Juneau, Alaska.

Wolfe, R.J., J.J. Gross, S.J. Langdon, J.M. Wright, G.K. Sherrod, L.J. Ellanna, V. Sumida, and P.J. Usher. 1984. Subsistence-based Economies in Coastal Communities of Southwest Alaska. Prepared for the Alaska Department of Fish and Game, Division of Subsistence, Juneau and Minerals Management Service, Alaska Region, USDOI. Social and Economic Studies Program Technical Report Number 95. Anchorage.

Wolfe, S.A., B. Griffith, and C.A. Gray Wolfe. 2000. Response of Reindeer and Caribou to Human Activities. Polar Research 19(1):63-73.

Woodward, D.F., E. Snyder-Conn, R.G. Riley, and T.R. Garland. 1988. Drilling Fluids and the Arctic Tundra of Alaska: Assessing Contamination of Wetlands Habitat and the Toxicity to Aquatic Invertebrates and Fish. Archives of Environmental Contamination and Toxicity 17:683-697.

Wooley, C.B. and J.C. Haggarty. 1995. Archaeological Site Protection: An Integral Component of the Exxon Valdez Shoreline Cleanup. In: Exxon Valdez Oil Spill: Fate and Effects in Alaskan Waters, P. Wells, J. Butler, and J. Hughes, eds., pp. 933-949. American Society for Testing and Materials, Philadelphia, PA.

Worl, R. 1979. Values of Subsistence to North Slope Iñupiat Culture in Native Livelihood and Dependence: A Study of Land Use Values Through Time. North Slope Borough Contract Staff. National Petroleum Reserve in Alaska 105(C) Land Use Study Field Study 1. USDOI, BLM, NPR-A Work Group 1. Anchorage, Alaska.

World Oil Online. 2013. ExxonMobil to spend $253 million on Point Thomson project. Available online at http://www.worldoil.com/ExxonMobil_to_spend_253_million_on_Point_Thomson_project.html. Accessed August 8, 2013.

Worm, B., H.K. Lotze, C. Bostroem, R. Engkvist, V. Labanauskas, and U. Sommer. 1999. Marine diversity shift linked to interactions among grazers, nutrients, and propagule banks. Marine Ecology Progress Series 185:309-314.

Yager, G.C. 2011. The impact of the Endicott Causeway on the sediment transport in the Sagavanirktok River Delta, North Slope Alaska, Master's Thesis, University of Alaska Anchorage, Anchorage, AK, 173 pages.

Yokel, D., D. Huebner, R. Meyers, D. Nigro, and J. Ver Hoef. 2007. Offsetting versus overlapping ice road routes from year to year: impacts to tundra vegetation. BLM-Alaska Open File Report 112, June 2007. U.S. Department of the Interior, Bureau of Land Management.

Page intentionally left blank

ATTACHMENT 1
DISPERSION MODELING AND AIR QUALITY ANALYSES

ATTACHMENT 2
SUBSISTENCE AND TRADITIONAL LAND USE PATTERNS