Exhibit 15

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An Evaluation of the Science Needs to Inform Decisions on Outer Continental Shelf Energy Development in the Chukchi and Beaufort Seas, Alaska

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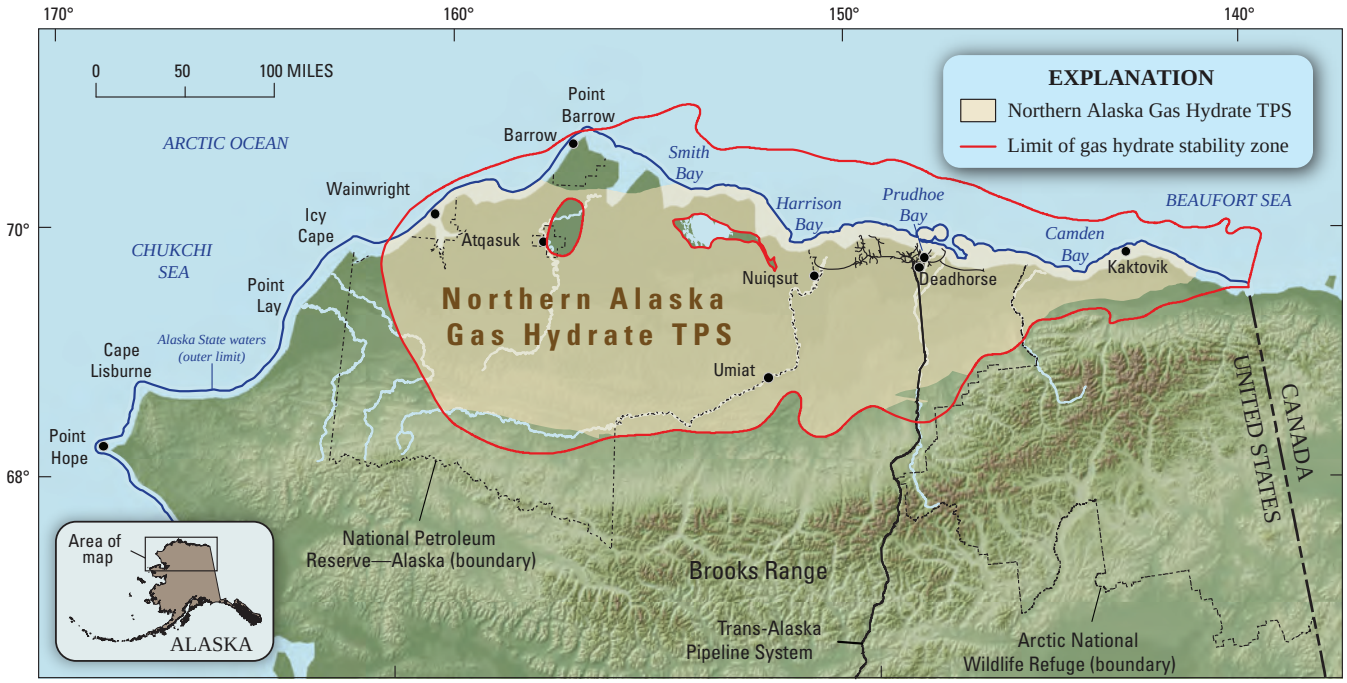

Figure 2–6. Map showing extent of the Northern Alaska Gas Hydrate Total Petroleum System (TPS) (shaded in tan), and the limit of gas hydrate stability zone in northern Alaska (red outline). Collett and others (2008) used this TPS as a basis for the first assessment of undiscovered, technically recoverable gas-hydrate resources beneath the Alaska North Slope and State-owned waters. Modified from Collett and others (2008).

and quantification of the resource. Specific National Research Council (2010) recommendations pertaining to the quantification of the resource include:

> "Pilot seismic surveys using existing geophysical methods optimized to map and quantify in-place methane hydrate accumulations;"
>
> "Improved understanding of *in-situ* properties of sediments containing methane hydrate through comprehensive testing (geophysical, geochemical, microbiological, geomechanical) of undisturbed natural drill cores and synthetic samples;" and
>
> "Consideration of the development of new geophysical imaging, processing, and quantification techniques, particularly with respect to quantifying the in-place resource."

In recognizing some of these knowledge gaps and research needs, the U.S. Arctic Research Commission (2010) recommended gas hydrate research (onshore and offshore) as one of the areas of emphasis for the Department of Energy's Arctic Energy Office. The U.S. Arctic Research Commission (2010) also noted that it may be appropriate to consider the inclusion of Arctic mapping and gas hydrates research activities within other agencies' resource assessment and earth science program plans.

Gas Hydrate Studies—Climate Change Linkages and Geohazards

In addition to the study of gas hydrates from an energy resource perspective, the potential linkages among subsea gas hydrates, climate change, and sea-level changes, particularly on the Beaufort continental slope, have long been recognized (Kayen and Lee, 1991). One of the key research questions regarding these linkages is discerning whether gas hydrate degassing plays a causative role in global warming, or is merely a response to the effects of rapid global warming (Ruppel and Pohlman, 2008). The long-term warming may lead to dissociation of the gas hydrates, during which gas is released. This release of gas can change the physical properties of the surrounding sediments and affect infrastructure through loss of borehole integrity and (or) regional subsidence (Lee and others, 2010). However, most of the scenarios that may suggest gas hydrates as a geohazard to traditional hydrocarbon infrastructure do not manifest themselves at the time the well is being drilled, but rather result as a consequence of the long-term warming of the sediment associated with hydrocarbon production (National Research Council, 2010).

The National Research Council (2010) review recommended that further studies are required to address the processes involved in (1) the transmission of methane from

Chapter 3

Ecological and Subsistence Context

By Anthony R. DeGange and Lyman Thorsteinson

Introduction

This chapter provides a general overview of the physical and biological environments of the Beaufort and Chukchi Seas. We also include information on the human communities and subsistence resources of this area. This chapter, along with Chapter 2, Geological Context, which discusses the current knowledge of oil and gas resources, sets the stage for other chapters in this report that delve into greater detail on important aspects of these marine areas and resources and their relationship to oil and gas leasing, exploration, and development. In this chapter, we present findings and recommendations that speak to the state of the broader science foundation of the Arctic. This information informs specific oil and gas development-related discussions in later chapters. Two broad syntheses have recently captured much of this information, some of which is repeated here (Hopcroft and others, 2008a; Minerals Management Service, 2008). These summaries are authoritative and should be consulted to develop a broader framework of the previous research in the Beaufort and Chukchi Seas.

The Beaufort and Chukchi Seas are marginal seas of the Arctic Ocean (fig. 1–1). They lie north and northwest, respectively, of Alaska. Both seas are linked atmospherically via the Aleutian Low, whose variable position, strength and interactions with Arctic air masses affect meteorological conditions. They are linked oceanographically with the Pacific Ocean primarily via the Bering Strait, through which northward flow transports waters and organisms from the Bering Sea Shelf. The Beaufort Sea extends from Point Barrow in Alaska east to Banks and Victoria Islands of the Canadian Arctic Archipelago and the Amundsen Gulf. The Chukchi Sea extends from Point Barrow, Alaska and the Beaufort Sea in the east to Wrangell Island and the East Siberian Sea in the west. The Bering Strait forms the southern boundary of the Chukchi Sea and connects it with the Bering Sea and Pacific Ocean.

numerous shallow lagoons with average depths less than 5 m and ecological traits different from those in the open water. Compared to the Chukchi Sea, productivity and benthic biomass in the Alaskan Beaufort Sea are dramatically lower. Consequently, benthic-pelagic coupling is not as pronounced as in the Chukchi Sea and food chains are longer.

Much less is known about the slopes of the Chukchi and especially the Beaufort Sea, and the adjacent basins (Bluhm and others, 2008). The existing investigations of the slopes and abyssal infaunal benthos in the western Arctic revealed low abundances and biomass values relative to the shelves, especially with increasing water depth and distance from the shelves. At taxonomic levels of phylum and orders, the soft-bottom deep Arctic macrofauna appear to be similar to the shelf communities: polychaetes, bivalves, and crustaceans are dominant, but on a family, genus, and species level, inventories differ from the shelves.

3.04. Findings and Recommendations: Regional hot spots for regular monitoring should include the southern Chukchi Sea, Barrow Canyon, and the Barter Island area. Secondly, source areas of organic and inorganic carbon should receive special attention, such as the inflow of nutrient-rich Anadyr water through the Bering Strait and river and permafrost run-off along the coastlines. The importance lies in regular sampling of the same areas to establish long-term time series.

Routine and robust monitoring of the benthos in areas of offshore development would be useful to establish trend information and to monitor the impacts of development and pollution.

Marine Mammals

The marine mammal fauna of the Chukchi and Beaufort Seas off the coast of Alaska are among the most diverse in the World and are of high scientific and public interest. Fifteen species and (or) stocks of marine mammal are common to the study area (table 3–1). Many of the species are used for subsistence purposes by Alaska Natives and many have an important symbolic role in cultural identity. Some have a high profile because they are covered by international conservation agreements (polar bear) or because they are classified as threatened or endangered under the Endangered Species Act (ESA). All marine mammals in the United States receive special protection under the Marine Mammal Protection Act (MMPA). The MMPA places a moratorium on the take, including harassment, of all marine mammals with special exemptions for subsistence use by Alaska Natives, for permitted activities such as research and public display, and for restricted permitted take incidental to commercial fishing and industrial activities. Additional protection is afforded to any species that is classified as depleted under the Act. Any species that is classified as threatened or endangered under ESA is automatically classified as depleted under MMPA. The marine mammals found in the Beaufort and Chukchi Seas study area include baleen and toothed whales, ice seals, walruses, and polar bears. For many of these species, their distribution, movements, and life history events are closely tied to the presence or absence of sea ice. Most species are harvested by coastal subsistence hunters, and they can make up a substantial proportion of the annual diet in coastal communities.

Status of Important Marine Mammal Stocks that Inhabit the Beaufort and Chukchi Seas

Information on the status of marine mammals is derived primarily from the most recent stock assessments provided by the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) for whales, pinnipeds, Pacific walrus, and polar bears (Allen and Angliss, 2010). Some life history information on these marine mammal species also is included in the stock assessments, but is widely available elsewhere.

Bowhead Whale (*Balaena mysticetus*)

The western Arctic stock of the bowhead whale is almost exclusively an Arctic species. It summers in the Canadian Beaufort Sea, migrates through the U.S. Beaufort Sea into the Chukchi Sea and winters in the northern Bering Sea. They generally are associated with shelf and slope waters of the Arctic, where they feed primarily on copepods and euphausiids. With the advent of satellite telemetry, detailed information on bowhead whale movements are now available (Quakenbush and others, 2010) (fig. 3–9). Bowhead whales are classified as endangered under the ESA and depleted under the MMPA. The most recent (2001) estimate of the population of western Arctic bowhead whales is 10,545 and the population is increasing. Bowhead whales are an important subsistence species and are hunted in the spring and autumn as they pass coastal Alaska villages in the northern Bering, Chukchi, and Beaufort Seas. Noise, oil pollution, and climate warming are important concerns. Key information needs include: continued assessments of population size; integrative research on oceanography, prey availability, foraging and behavioral ecology; characterization of wintering habitat; and development of models incorporating data on whales, sea ice, and oceanography to predict the effects of climate change and anthropogenic impacts.

Table 3–1. Most common marine mammal stocks found in the Chukchi and Beaufort Seas of Alaska.

[Information primarily from Allen and Angliss (2010). Endangered Species Act (ESA) status: D, de-listed; E, endangered; P, proposed for listing; T, threatened]

Name	Stock	Estimated population	ESA status
Spotted seal (*Phoca largha*)	Alaska	Not available	
Bearded seal (*Erignathus barbatus*)	Alaska	Not available	P
Ringed seal (*Phoca hispida*)	Alaska	Not available	P
Ribbon seal (*Histriophoca fasciata*)	Alaska	Not available	
Beluga whale (*Delphinapterus leucas*)	Beaufort Sea	39,258	
	Eastern Chukchi Sea	3,710	
Harbor porpoise (*Phocoena phocoena*)	Bering Sea	48,215	
Gray whale (*Eschrictius robustus*)	Eastern North Pacific	18,813	D
Humpback whale (*Megaptera novaeangliae*)	Western North Pacific	938	E
Fin whale (*Balaenoptera physalus*)	Northeast Pacific	5,700	E
Minke whale (*Balaenoptera acutorostrata*)	Alaska	Not available	
Bowhead whale (*Balaena mysticetus*)	Western Arctic	10,545	E
Polar bear (*Ursus maritimus*)	Southern Beaufort Sea	1,526	T
	Chukchi/Bering Seas	2,000	T
Pacific walrus (*Odobenus rosmarus*)	Alaska	129,000	P

Gray Whale (*Eschrictius robustus*)

The eastern North Pacific stock of the gray whale winters and calves in lagoons on the Pacific side of Baja California, Mexico, and summers primarily in the shallow northern Bering and Chukchi Seas. It was formerly listed under the ESA, but responded well to protection from overexploitation and was delisted in 1994. Recent population estimates range from 18,178 to 29,758. The population is believed to be at or approaching carrying capacity. It is unclear how climate change will affect this species. Because the gray whale is primarily a benthic feeder, relaxation of the tight pelagic-benthic coupling that currently fuels high rates of benthic productivity in the Chukchi Sea would likely not favor this species.

Beluga Whale (*Delphinapterus leucas*)

Two stocks of beluga whale are found in the study area: the Beaufort Sea stock and the eastern Chukchi Sea stock. Satellite tagging suggests that the range of these two stocks may widely overlap. Whales tagged in Kasegaluk Lagoon in the Chukchi Sea moved north, with males moving into deep waters of the Beaufort Sea with more than 90-percent ice cover, and adult and immature females moving to the shelf break of the Chukchi Sea. The size of the eastern Chukchi Sea stock is not known but it is not believed to be declining. The Beaufort Sea stock numbers about 39,000 animals. It is assumed that most whales from these two stocks winter in the Bering Sea where they are closely associated with pack ice.

Ribbon Seal (*Histriophoca fasciata*)

The Alaska stock of the ribbon seal inhabits the Bering, Chukchi, and western Beaufort Seas and is associated with open water, pack ice, and rarely shorefast ice. They are most abundant in the northern edge of the ice front in the central and western Bering Sea in the winter and recent data suggest that they migrate into the Chukchi Sea in the summer. A reliable population estimate is not available. The NMFS received a petition to list the ribbon seal under the ESA in 2007. In December 2008, NMFS determined that listing the ribbon seal was not warranted (National Marine Fisheries Service, 2008). The NMFS concluded that although a gradual decline in the ribbon seal population is likely with a decrease in frequency of years with suitable sea-ice habitat, ribbon seals are not likely to become an endangered species within the foreseeable future (Boveng and others, 2008).

Spotted Seal (*Phoca largha*)

Spotted seals are distributed along the continental shelf of the Bering, Chukchi, and Beaufort Seas. Satellite tagging studies showed that seals tagged in the northeastern Chukchi Sea moved south in October and passed through the Bering Strait in November. Seals overwintered in the Bering Sea along the ice edge and made east-west movements along the edge. A reliable estimate of spotted seal population abundance is currently not available, although the NMFS's current estimate for the eastern and central Bering Sea is about 101,500 (National Marine Fisheries Service, 2009). The NMFS received a petition on May 28, 2008, to list spotted seals under the ESA due to loss of sea-ice habitat caused by climate change in the Arctic, but concluded there are insufficient data to make reliable predictions of the effects of Arctic climate change on the Alaska spotted seal stock. In their Final Rule, the NMFS concluded that spotted seals in the Pacific exist as three Distinct Population Segments (DPS) and determined that only the southern DPS was threatened under the ESA (National Marine Fisheries Service, 2009). This DPS is located in the Sea of Japan and Yellow Sea, well outside of our geographic area of study. The NMFS published a Final Rule to that effect in October 2010 (National Marine Fisheries Service, 2010c).

Pacific Walrus (*Odobenus rosmarus*)

Pacific walrus range throughout the continental shelf waters of the Bering and Chukchi Seas, occasionally moving into the East Siberian Sea and the Beaufort Sea. They use sea ice over shallow, continental shelf waters as a moving platform for resting from which they dive to the seafloor for benthic invertebrates, such as clams. During the summer months, females and young migrate into the Chukchi Sea with the sea ice; however, thousands of animals, primarily adult males, aggregate near coastal haulouts in the Gulf of Anadyr, Bering Strait region, and in Bristol Bay. While in the Chukchi Sea, walruses are distributed broadly over the continental shelf, especially in the southern Chukchi Sea and along the coastlines of Chukotka and Northwest Alaska as indicated by satellite tags (fig. 3–12). Recent research has improved our understanding of how walruses use sea ice (Udevitz and others, 2009; Jay and others, 2010) and is beginning to shed light on how walruses will respond to diminishing sea ice in the Chukchi Sea (Jay and Fischbach, 2008; Fischbach and others, 2009; Jay and others, 2011). Modeling suggests a trend of worsening conditions for Pacific walrus through the end of this century (Jay and others, 2011). The estimate of the population from a 2006 survey of about 129,000 walruses is biased low because some areas known to be important to walrus were not surveyed due to poor weather conditions (Speckman and others, 2010). In February 2008, the USFWS received a petition to list the Pacific walrus under the ESA. On February 8, 2011, the USFWS announced that listing the Pacific walrus under the ESA was warranted, but precluded due to other higher priority listing actions. Like other ice-associated pinnipeds, walrus are difficult to study. Information gaps include: population size; stock structure; foraging ecology in relation to prey distributions and oceanography; relationship of changes in sea ice to distribution, movements, reproduction, and survival; models to predict the effects of climate change and anthropogenic impacts; and improved estimates of harvest. Impacts to walrus of changes in Arctic and subarctic ice dynamics are not well understood. Harvest and oil and gas development also are potential conservation concerns.

Polar Bear (*Ursus maritimus*)

Polar bears are perhaps the best known of the Arctic marine mammals in Alaska. Two stocks of polar bears are currently recognized in Alaska, the Chukchi Sea stock that is shared with Russia and the southern Beaufort Sea stock that is shared with Canada. The two stocks overlap widely in the vicinity of Point Barrow. Most polar bears remain with the sea ice throughout the year in the Beaufort and Chukchi Seas, but as sea ice retreats farther offshore in the summer and autumn increasing numbers of bears are coming to shore (Schliebe and others, 2008). In both seasonal and non-seasonal sea-ice environments, recent studies suggest that longer ice-free seasons are affecting polar bear size, recruitment and survival, and in some cases population size (Amstrup and others, 2008; Hunter and others, 2010; Regehr and others, 2010; Rode and others, 2010). The southern Beaufort Sea stock is currently estimated at 1,526 based on capture-recapture data. It has been difficult to derive an estimate for the Chukchi Sea stock, but it is estimated at about 2,000 bears based on an extrapolation of aerial den surveys. Both stocks of polar bears are classified as depleted under the MMPA and threatened under the ESA. Both stocks of polar bears are currently under study in Alaska, but comparatively less is known about polar bears in the Chukchi Sea.

- Restricted-ranges species (species vulnerable because they are not widely distributed);
- Species that are vulnerable because their populations are concentrated in one general habitat type or biome; or
- Species, or groups of similar species (such as waterfowl or shorebirds), that are vulnerable because they occur at high densities due to their congregatory behavior.

Colonial and Non-Colonial Seabirds

Nesting habitat for seabirds is limited in the area, so they are aggregated in a few very large colonies. Cliff-nesting seabirds reach their northern extent in the Chukchi Sea at Cape Lisburne and Cape Thompson. These colonies provide most of the cliff-nesting habitat for thick-billed murres (*Uria lomvia*) and black-legged kittiwakes (*Rissa tridactyla*) in the eastern Chukchi and are the largest colonies in the region with more than 200,000 birds present at each location. Horned puffins (*Fratercula corniculata*) breed at Cape Lisburne, as well as at Chamisso Island in Kotzebue Sound in the southern Chukchi Sea, and more recently at Cooper Island, a small barrier island in the western Beaufort Sea. A well-studied colony of black guillemots (*Cepphus grille*) is located at Cooper Island. Small colonies of glaucous gulls (*Larus hyperboreus*) and Arctic terns (*Sterna paradisaea*) are distributed in coastal areas throughout the study area (Sowls and others, 1978; Weiser and Powell, 2010). During the ice-free season, seabirds move into the Chukchi Sea from areas farther south and are distributed widely. These include murres (*Uria* spp.), black-legged kittiwakes (*Rissa tridactyla*), crested (*Aethia cristatella*), least (*Aethia pusilla*), and parakeet (*Cyclorrhynchus psittacula*) auklets, short-tailed shearwaters (*Puffinus tenuirostris*), northern fulmars (*Fulmarus glacialis*), jaegers (*Stercorarius* spp.), and others.

Kittlitz's Murrelets (*Brachyramphus brevirostris*), a small, uncommon, non-colonial seabird that nests primarily in glaciated landscapes in southeast and south-central Alaska, west through the Aleutian Islands, also nest in small numbers on the Seward and Lisburne Peninsulas in northwest Alaska. At-sea records for this species exist in Kotzebue Sound, near Point Hope and in Ledyard Bay, including the Chukchi Sea oil and gas lease area and the Beaufort Sea (R. Day, Alaska Biological Research, Inc., oral commun., 2011). Kittlitz's Murrelets are a species of conservation concern because of recent population declines in more southerly areas of their breeding range. They are considered a candidate species under the Endangered Species Act by the USFWS. Very little is known about their population status, distribution, and abundance in northwest Alaska.

Loons

Three species of loons nest in coastal areas of the Chukchi and Beaufort Seas and use coastal marine habitats for foraging: the red-throated loon (*Gavia stellata*), Pacific loon (*G. pacifica*), and yellow-billed loon (*G. adamsii*). Red-throated loons tend to nest in small tundra ponds close to the coast and feed primarily in saltwater during the breeding season, making trips back and forth to their nesting ponds. Both Pacific loons and yellow-billed loons nest on larger tundra lakes that contain fish. All loons use coastal marine habitats during parts of their annual cycle. Red-throated loons and yellow-billed loons have an interesting migration strategy. Birds from the North Slope migrate and winter in coastal habitats along the western North Pacific wintering as far south as the Korean Peninsula. In contrast, birds nesting on the Seward Peninsula winter in marine waters of western Alaska. Recent telemetry data indicate widespread use of coastal and marine habitats in the Chukchi Sea during breeding and migration (fig. 3–14).

The USFWS was petitioned to list the Alaska breeding population of yellow-billed loons, and after review determined that listing the species was warranted but precluded because of higher priority listing actions. It is a candidate species under the ESA. Relatively little is known about these species in Arctic Alaska, although all three species of loons are currently under study on the North Slope of Alaska. Ongoing concerns include disturbance from development (loons are particularly vulnerable to disturbance), oil pollution, and harvest.

Sea Ducks

Fifteen species of waterfowl make up the sea ducks, which nest in coastal areas or in freshwater habitats and winter primarily in coastal marine habitats. Five species dominate the sea duck avifauna of the Chukchi and Beaufort Seas: the long-tailed duck (*Clangula hyemalis*), and the eiders (common eider *Somateria mollissima*, king eider—*S. spectabilis*, spectacled eider—*S. fischeri*, and Steller's eider—*Polysticta stelleri*). Common eiders, king eiders, and long-tailed ducks are the most abundant of the species. Eiders and long-tailed ducks are the first of the waterfowl to appear in the spring, exploiting leads in the ice as they open in the Chukchi and Beaufort Seas between shorefast and pack ice. Common eiders nest primarily in small colonies on barrier islands and other coastal habitats. Other sea ducks are more dispersed nesters across the North Slope. Sea ducks migrate in large numbers along the coasts of the Chukchi and Beaufort Seas to and from nesting grounds in Alaska and the Canadian Arctic, and are important subsistence species. Coastal lagoons of the Beaufort Sea are particularly important habitats for long-tailed ducks after breeding and before freeze-up.

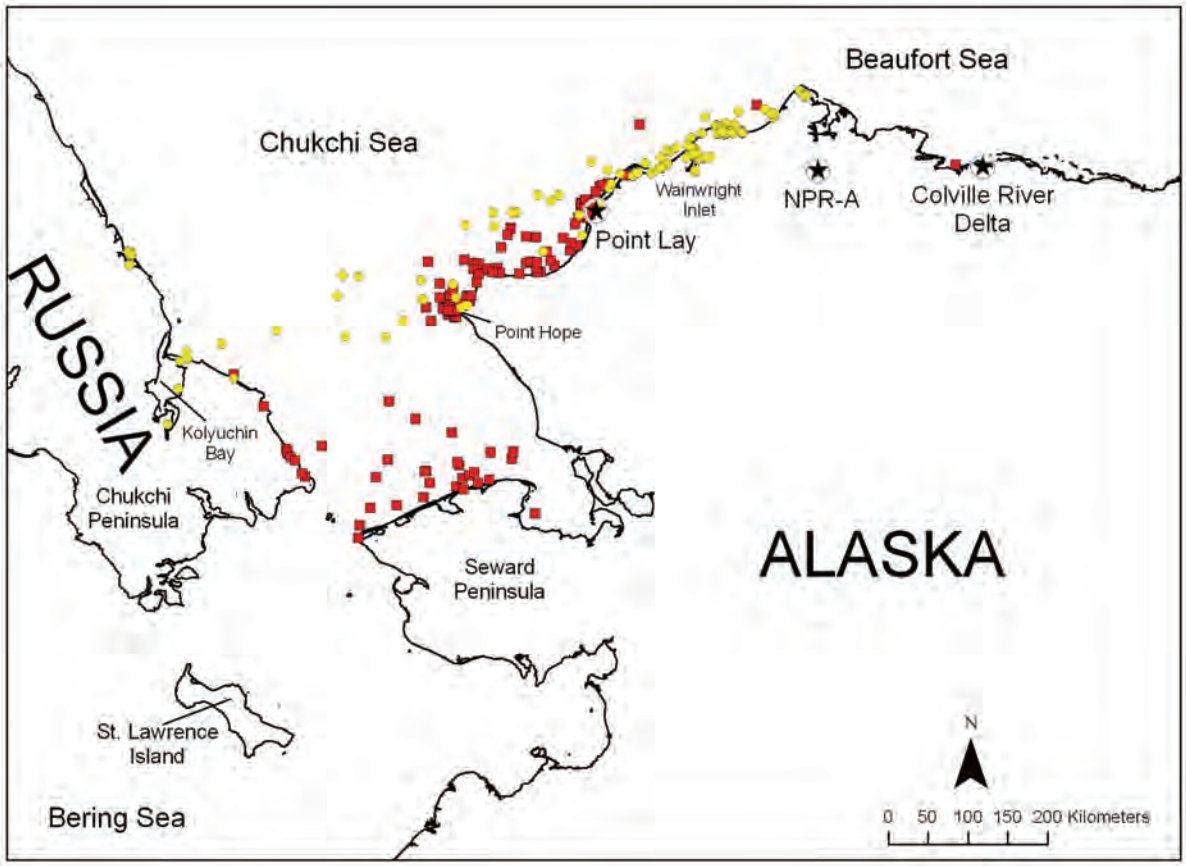

Figure 3–14. Locations of red-throated (red squares) and yellow-billed (yellow circles) loons based on satellite transmitters in 2010. Sites of original marking are indicated by stars (U.S. Geological Survey, unpub. data, 2010). (NPR-A, National Petroleum Reserve Alaska.)

Two species of eiders are of particular conservation concern for the Department of the Interior: spectacled eider and Steller's eider. Both are listed as threatened by the USFWS. Spectacled eiders breed across the North Slope of Alaska, especially west of the Prudhoe Bay area. They use coastal marine habitats during non-breeding in both the Beaufort and Chukchi Seas (fig. 3–15). Ledyard Bay in the Chukchi Sea is an important staging area and formally designated as Critical Habitat for this species. The entire World's population winters in highly dense concentrations within the sea ice of the northern Bering Sea (fig. 3–15) between St. Lawrence and St. Matthew Islands. An ongoing telemetry study will reveal new information about timing of migration, migratory pathways, and residence times in coastal areas of the Beaufort and Chukchi Seas that could be impacted by development activities.

Steller's eiders were formerly an abundant breeding bird on the Yukon Delta and the North Slope. During summer, they are now found primarily between Prudhoe Bay and Point Lay and number in the low thousands. Following breeding, they undergo a long migration to molting and wintering habitats on the Alaska Peninsula and the Aleutian Islands where they mix with the more abundant population of Steller's eiders that breeds in Russia.