A SYNTHESIS OF IMPORTANT AREAS IN THE U.S. CHUKCHI AND BEAUFORT SEAS
THE BEST AVAILABLE DATA TO INFORM MANAGEMENT DECISIONS

1. INTRODUCTION

Understanding how the Arctic marine food web functions is necessary for making well-informed management decisions in the Arctic Ocean. The objective of our study was to identify areas critical to the functioning of the marine ecosystem in the U.S. Chukchi and Beaufort Sea federal planning areas, based on a synthesis of the current body of knowledge of the Arctic scientific community. One of the best tools to examine inter-relationships among the biotic, physical, and human elements within a system is through mapping. We conducted an extensive literature and data review of best available data. We used spatial analyses and mapping to examine patterns of use and overlap of high-value habitats. Our synthesis resulted in identification of important areas that include wildlife migration routes, foraging hotspots, subsistence use areas, seafloor habitats, ice habitat, and places with high primary productivity.

We identified and described seven areas critical to ecosystem functioning: the Chukchi Corridor, Barrow Canyon Complex, Hanna Shoal Region, Herald Shoal, Harrison Bay, Central U.S. Beaufort, and Eastern U.S. Beaufort. The U.S. Beaufort Sea shelf and slope are also important migration corridors for marine species that encompass waters in the Beaufort Sea within 75 miles of shore.

On January 27th President Obama—using his authorities under the OCS Lands Act—designated portions of the Chukchi and Beaufort seas off limits from consideration for future oil and gas leasing in order to protect areas of critical importance to subsistence use by Alaska Natives, as well as for their unique and sensitive environmental resources. This synthesis details the scientific support for the President's recent action and provides the spatial information for management and conservation of additional areas of the U.S. Arctic marine ecosystem.

Data gaps limit our knowledge of some aspects of the U.S. Chukchi and Beaufort Sea federal planning areas. For example, there have been less systematic surveys of marine mammals conducted north of 72° N latitude as well as during the spring, summers and winter, limiting our understanding of species use and occupancy of the region. Furthermore, there are currently fish and lower-trophic community studies on-going in both the Beaufort and Chukchi seas that are scheduled to be completed by 2016[1]. Once these studies are completed, they will provide not only additional information on areas important to fish, but additional insights concerning areas important to higher trophic level species such as pinnipeds. There are also on-going studies by Bureau of Ocean Energy Management (BOEM), North Slope Borough (NSB), National Oceanic and Atmospheric Administration (NOAA), and Alaska Department of Fish and Game (ADFG) on the distribution and movement of pinnipeds that should provide some insight about habitat use by ice seals.

We describe the data collection and mapping methods for this synthesis, followed by a summary of resources in each important area, including values specific to the areas not recently withdrawn, and references cited. Appendix A contains maps that identify the important areas and geographically depict the ecosystem values that we used to define areas in the Chukchi Sea. Appendix B provides detailed information on the scientific research used to map the Chukchi Sea ecosystem values. Appendix C contains maps that identify the important areas and geographically depict the ecosystem values that we used to define areas in the Beaufort Sea. Appendix D provides detailed information on the scientific research used to map the Beaufort Sea ecosystem values.

2. DATA COLLECTION AND MAPPING METHODS

Our maps draw on an extensive literature and data review of the current knowledge of the scientific community. Sources include tagging data, aerial and boat surveys, maps and area descriptions in published studies, scientifically documented (publicly available) local and traditional knowledge, and personal communications with experts. In seeking updated information and performing new analysis, we sought to identify areas that are important for maintaining habitat heterogeneity or the viability of a species, or contribute disproportionately to an ecosystem's health, including its productivity, biodiversity, function, structure, or resilience. Omission from our maps did not necessarily indicate that an area was considered unimportant; additional field data collection from the area could reveal ecological patterns that were not apparent in our analysis (e.g. areas north of 72° N latitude).

Our work is based on the extensive data collected in the Arctic Marine Synthesis: Atlas of the Chukchi and Beaufort Seas (Smith 2010) and the atlas of Important Ecological Areas of the Beaufort and Chukchi Seas (Oceana 2013a). For this project, we reviewed these data, adding more scientific papers and agency reports to our library of over 800 Arctic marine references. Based on these references, we collected additional spatial information and further refined spatial boundaries based on the best available data and studies. Our maps are based primarily on western science but also include a significant number of studies documenting local and traditional knowledge. Inclusion of publicly available traditional knowledge and advice from local communities, governments, tribes and co-management organizations was a priority.

In presenting subsistence use areas in the following series of maps, we do not attempt to assign any

[1] http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Alaska-Region/Alaska-Studies/index.aspx

weight or priority within the use areas that have been documented. Our maps show the use areas compiled from publicly available data sources to illustrate the large extent of these areas and to acknowledge and honor their importance to the Iñupiat of the North Slope. How these areas should be treated in management and regulation should be determined in consultation with the communities and hunters.

We strived to make our work as objective and transparent as possible. The methods, sources, and attributes for each data layer are tracked in our extensive geodatabase which are available to BOEM upon request. Our process for acquiring and analyzing data is summarized below:

- Direct from source (no modifications)
- Direct, with modifications (some modifications from the original source data, e.g. to improve the display of the data)
- Analyzed from raw data (new information based on repeatable spatial analysis)
- Interpreted from spatial data (new information based on spatial interpretation)
- Interpreted from text description (spatial boundaries drawn by interpreting the intent of a textual reference)
- Outside expert (expert opinion from outside our organizations)
- Best professional judgment (expert opinion from within our organizations).

On our maps, we separated known concentration areas from the extent of the known range of species to indicate relative importance. Map features are described in the legend and footnoted reflecting the abbreviated citation for the reference that documented the information. We linked directly to primary literature where possible, then to white or gray literature. In some cases the spatial boundary of a concentration area was not presented in the literature, but textual descriptions documented an area as important. In such cases there was information known to be accurate (e.g., bowhead whales migrate north along the Chukchi coast) but is not spatially precise (e.g., no exact boundary lines determined). As necessary, and as adequate information was available to interpret spatial boundaries, our science team drew boundary lines representing those studies. Those cases are documented on our maps as “based on” a list of multiple sources, rather than being taken directly from a map presented in such sources. We also worked in close consultation with the lead agency scientists for the ASAMM database, which is a BOEM funded data collection effort. We analyzed this and other publicly available survey data to produce mammal and bird species distribution and concentration maps, from which we derived many of our recommendations (Audubon Alaska 2014, Oceana and Audubon Alaska 2015).

We want to express our appreciation to the many Arctic scientists who advised, reviewed, or provided data for our analysis and to the scientists and funding agencies and organizations who conducted and supported the original studies that generated the data.

3. IMPORTANT AREA DESCRIPTIONS

3.1 Chukchi Corridor

The Chukchi Corridor, approximately 50 miles in width, follows the Chukchi Sea coast from Point Hope to Wainwright and offshore of Barrow. Within this corridor, there is significant wildlife activity, including one of the largest marine mammal migrations in the world. From winter through early summer, the area is covered in sea ice with recurring open leads and polynyas (Eicken et al. 2005) that allow wildlife to migrate north from the Bering Sea to areas of the Chukchi or Beaufort seas during spring and early summer. The entire Chukchi Sea coastline serves as an essential corridor for marine mammals including bowhead whales, Pacific walrus and ice seals as well as for indigenous subsistence hunters (Oceana 2013a). Birds follow the Chukchi Corridor to northern waters and inland to the North Slope. The corridor contains globally important hotspots for several bird species including yellow-billed and red-throated loons (Schmutz and Rizzolo 2012); spectacled, Steller's and king eiders (Martin et al. 2009, Oppel et al. 2009, Sexson et al. 2012); black brant (Johnson 1993); common and thick-billed murres (Hatch et al. 2000); glaucous gulls; pomerine jaegers; and black-legged kittiwakes (Smith et al. 2014b). Aside from its importance during migration, the Chukchi Corridor is an important place for resident animals. Pacific walrus use this zone, particularly after the sea ice retreat in late summer. Walrus make trips to and from Hanna Shoal, hauling out on the coast off Icy Cape, and then forage on benthic organisms until they migrate south along the Chukchi coast (Jay et al. 2012). On January 27th, 2015 the President – using his authorities under the OCS Lands Act -withdrew from future oil and gas leasing the 25 mile buffer along the Chukchi Sea coast, an area deferred from leasing since 1997.

The Chukchi Corridor important area encompasses the following values:

- **Subsistence hunting areas for the communities of Point Hope, Point Lay, Wainwright, and Barrow.** Studies conducted on behalf of BOEM and other organizations show that residents of Alaska Native villages rely extensively on areas in the Chukchi Corridor for hunting during the year (Pedersen 1979a;b, Braund and Burnham 1984, Stephen R. Braund and Associates and Institute of Social and Economic Research 1993, Kassam and Wainwright Traditional Council 2001, Stephen R. Braund and Associates 2010, Nelson c1982).
- **A major migration passageway for marine mammal species in the U.S. Arctic Ocean.** Open leads and recurring polynyas between the landfast ice and offshore pack ice are critical passageways for Arctic wildlife that migrate north in spring and south in fall (Stirling 1997). Most marine mammals that live in the Chukchi and Beaufort seas in summer spend the winter south of the Bering Strait (with the exception of polar bears and some seals). In spring, they disperse northward through the Strait into the Chukchi Sea and beyond (Smith 2010). A majority of individuals of all species of marine mammals move north in spring as the ice begins to thin and break apart, navigating the Chukchi lead system during this time period. The Chukchi Corridor is especially important for endangered migrating bowhead whales. Almost the entire population of bowhead whales travels along the Chukchi Sea coast out to approximately 60 miles from shore during spring months, from April through June (Quakenbush et al. 2013).
- **A major migration passageway for birds nesting on the North Slope in summer.** Many bird species that migrate to the North Slope for summer breeding travel past Point Hope, through the Chukchi Corridor, then around Point Barrow (or travel the route in reverse in the fall). This spring and fall migration and staging corridor is likely used by the entire breeding population of king eiders in Western North America (Oppel et al. 2009), which are an Audubon WatchList species due to depressed population numbers (Kirchhoff and Padula 2010). Kasegaluk Lagoon and Ledyard Bay host post-breeding staging and migration concentrations of threatened Steller's eider (Martin et al. 2009). It is a migration area for as much as half of the Pacific brant population, which visits Kasegaluk Lagoon during fall migration (Johnson et al. 1993). Yellow-billed and red-throated loons migrate to and from wintering grounds in Russia through this

corridor between May and October (Schmutz and Rizzolo 2012). A variety of shorebirds stop over along the Chukchi coast and barrier islands in concentrated groups (Taylor et al. 2010), including tens of thousands of dunlin and red phalarope in spring, summer, and autumn (Alaska Shorebird Group 2008). Home to 19 shorebird species during fall migration and an important area for molting waterfowl, Kasegaluk Lagoon is a potential Western Hemisphere Shorebird Reserve Network (WHSRN) site (Alaska Shorebird Group 2008).

- **ESA Critical habitat for threatened spectacled eiders.** In 2001, the U.S. Fish and Wildlife Service designated Ledyard Bay as critical habitat for spectacled eiders (Federal Register 2001). This is the principal molting and staging area for more than 10,000 females nesting on the North Slope (Petersen et al. 1999).
- **A network of globally significant Important Bird Areas (IBAs)** (Smith et al. 2014a, Smith et al. 2014b). Chukchi nearshore waters host several IBAs. Lisburne Peninsula Marine IBA is a feeding hotspot for black-legged kittiwakes nesting on the peninsula's cliffs, as well as common and thick-billed murres that forage both in the IBA and also much farther out, over 100 miles offshore (Hatch et al. 2000). Icy Cape Marine IBA was established for significant numbers of foraging glaucous gulls and pomerine jaegers. Delineated using the most recent satellite telemetry data, Ledyard Bay IBA was designated for concentrations of spectacled eiders (Sexson et al. 2012), black-legged kittiwakes, and common murres. Kasegaluk Lagoon IBA has a significant breeding population of Pacific brant and the highest diversity and abundance of birds of any lagoon system in Arctic Alaska (Johnson et al. 1993). Point Lay Marine IBA is home to more than 10,000 long-tailed ducks in summer. The Chukchi Sea Nearshore IBA hosts as much as 15% of the global population of glaucous gulls and 2% of the population of Sabine's gulls.
- **Nesting colonies that support one quarter million breeding birds** (World Seabird Union 2011). From Point Hope to Point Barrow there are 31 known nesting colonies along the coast from Point Hope to Point Barrow. The cliffs of the Lisburne Peninsula host approximately 245,000 seabirds, primarily thick-billed and common murres, black-legged kittiwakes, and horned puffins. Kasegaluk Lagoon is home to 1700 nesting birds—mostly common eiders, glaucous gulls, and Arctic terns. These birds forage in the offshore waters of the Chukchi Sea. Murres and kittiwakes forage over 100 miles offshore (Hatch et al. 2000, Smith et al. 2014a).
- **A summer (May through October) core area for WatchList bird species of concern** (Audubon Alaska 2014). Based on Audubon analysis of the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014), the Chukchi Corridor is a 50% core use area for brant.
- **Important habitat for foraging, transiting, and hauled-out walrus** (Robards et al. 2007, Huntington et al. 2012, Jay et al. 2012, Kuletz et al. in press). Walrus move through the Chukchi Corridor when transiting between offshore and coastal haulout areas—an intensifying pattern due to loss of sea ice, which places greater importance on movement corridors and new concentration areas. These animals are increasing their use of nearshore foraging areas when ice cover is sparse (Jay et al. 2012). In recent years, walrus haulouts at Icy Cape and Point Lay have increased substantially, from what used to be a few individuals (Robards et al. 2007) to as many as 30,000 in 2011 (NOAA Fisheries 2014). This trend that will likely continue as late summer sea ice recedes earlier and further north due to climate warming (Clarke et al. 2012, Jay et al. 2012, Clarke et al. 2013, NOAA Fisheries 2014). When hauled out, walruses are sensitive to human disturbance, including aircraft or boat traffic (Garlich-Miller et al. 2011).
- **A significant concentration of molting and calving beluga whales** (Frost et al. 1993, Huntington and The Communties of Buckland 1999, Suydam and Alaska Department of Fish and Game 2004, NOAA Office of Response and Restoration 2005, Hauser et al. 2014, Kuletz et al. in press).

Kasegaluk Lagoon and the Kuk River estuary “are important seasonal summer habitats of beluga whales” (Bureau of Land Management 2003) as thousands of whales use the shallow lagoon as a molting area from mid-June to late July (Frost et al. 1993, NOAA Office of Response and Restoration 2005). Belugas are sensitive to human disturbance; airborne and waterborne noise may influence their distribution (Frost and Lowry 1990) and drive them from important habitats.

- **Core areas for beluga whales in summer and fall** (Hauser et al. 2014). Beluga whales from the Eastern Chukchi Stock have been observed to concentrate in the Chukchi Corridor near Point Lay in July and near Point Hope in November; the Beaufort Sea Stock concentrates near Wainwright in September.
- **High use sea ice habitat and known feeding and low-density denning areas for polar bears.** This is a prominent polar bear feeding area where the bears hunt seals along the coast, landfast ice, edges of open leads, and at seal breathing holes in the pack ice during all seasons of the year (Kalxdorff 1997, US DOI Fish and Wildlife Service 2013). It is a coastal and sea ice denning area for expecting female polar bears in winter (NOAA 1988, USFWS 1995, Kalxdorff 1997, USFWS 2010), however the number of maternal dens on the Chukchi coast has decreased due to reduced connectivity with sea-ice during late fall (Fischbach et al. 2007, USFWS 2010). Audubon Alaska, based on Durner et al. (2009) found the corridor to be a high use area in autumn and winter (October through May). US Fish and Wildlife Service (2013) documented this as an area of consistently high probability of use due to polynyas, high density of ringed seals, and being along a seasonal migration corridor.
- **Ice seal concentration areas.** Spotted seals haul out at multiple locations along the Chukchi coast (Frost et al. 1993, Lowry et al. 1998, Alaska Department of Fish and Game Habitat and Restoration Division 2001, NOAA Office of Response and Restoration 2005). Of 14 known spotted seal haulouts in Western Alaska and Eastern Russia, 4 located at Kasegaluk Lagoon (Lowry et al. 1998). Counts of over 1000 spotted seals have been recorded at Kasegaluk Lagoon haulouts repeatedly from mid-July through early September (Frost et al. 1993). Spotted seals are considered the most wary of seals, exhibiting high sensitivity to aircraft within 1.25 miles, and to human disturbances at their haulouts (Quakenbush 1988, Johnson et al. 1992, Frost et al. 1993). Bearded and ringed seals concentrate in the Chukchi Corridor in spring (NOAA 1988, Bengtson et al. 2005).
- **Three Most Environmentally Sensitive Areas (MESAs) identified by Alaska Department of Fish and Game.** The MESA program for oil spill contingency planning along the coast of Alaska (Alaska Department of Fish and Game Habitat and Restoration Division 2001) identified Kasegaluk Lagoon as important based on nearshore migration and rearing habitat for anadromous fish; waterfowl spring and fall staging, molting, and nesting; seabird colonies; spotted seal haulouts; ringed seal breeding and pupping; and regular occurrence of beluga whales nearshore. Cape Lisburne was identified based on seabird colonies, walrus haulouts, ringed seal breeding and pupping, and then-confirmed coastal polar bear denning. Cape Thompson was identified for seabird colonies and ringed seal breeding and pupping. Cape Lisburne and Cape Thompson are part of the Alaska Maritime Wildlife Refuge.
- **Gray whale feeding hotspots.** From wintering areas in the waters of northern Mexico, gray whales make the longest known migration of any mammal on earth to feed in the Chukchi and Bering seas in summer. These whales concentrate in an area of known high seafloor biomass (Grebmeier et al. 2006) from about 50 miles offshore of Wainwright tapering toward Barrow, sometimes as far out as the Hanna Shoal Region (Moore et al. 2000, Clarke and Ferguson 2010, Clarke et al. 2013, Kuletz et al. in press).

- **Essential Fish Habitat.** Saffron and Arctic cod are critical to the Arctic marine food web (NPFMC 2009). The National Marine Fisheries Service designated areas along the entire Chukchi coast out to 15-30 miles offshore as Essential Fish Habitat (EFH) for saffron cod. They are concentrated "in pelagic and epipelagic waters along the coastline, within nearshore bays, and under ice along the inner (0 to 50 m) shelf throughout Arctic waters and wherever there are substrates consisting of sand and gravel" (NMFS 2005). The whole of the U.S. continental shelf to 500 m depth was designated EFH for Arctic cod. Capelin, an important food source for seabirds, other fishes, and marine mammals (Rose 2005), spawn in sand and gravel in tidal areas (NPFMC 2009) along the Chukchi coast (NOAA 1988), coincident with areas designated for saffron and Arctic cod.
- **Ecosystem-level hotspots.** An integrated analysis of concentration areas for wildlife, hunting areas for local people, benthic and pelagic productivity, and sea ice habitat highlighted the Chukchi Corridor as having very high importance values based on multiple criteria (Ayers et al. 2010, Oceana 2013b).
- **Ecosystem resilience and climate change refugia.** The Chukchi Corridor is likely to provide ecosystem resilience (Gunderson 2000, Christie and Sommerkorn 2012) to climate change due to the unique combination of environmental drivers (e.g. seasonal sea-ice dynamics and regional currents) that is responsible for the exceptional local diversity of species. Although the extent and timing of occurrence varies between years, regional circulation patterns and seasonal sea-ice dynamics that drive lead and polynya emergence in the Chukchi Corridor provide consistent sea ice habitat and migratory corridors (Martin et al. 2004, Weingartner et al. 2005, Weingartner et al. 2013). This consistency during a time of rapid environmental change indicates that the polynya and lead system that distinguishes the Chukchi Corridor as a key feature is likely to persist in the future, thereby remaining a priority for conservation over the long term.

Chukchi Corridor South: Point Hope to Cape Lisburne
Specific to the area not already withdrawn from leasing 25 miles to 50 miles offshore, the following values are significant:

- **A spring migration corridor regularly used by bowhead and beluga whales** (Quakenbush et al. 2013, Clarke et al. 2015).
- A system of **recurring leads and polynyas used by migratory wildlife in spring** (Stringer and Groves 1991, Mahoney et al. 2012).
- **A high-use sea ice habitat area for polar bears** based on resource selection models (Wilson et al. 2014).
- Identified as a **seabird hotspot relative to other areas of the Chukchi** and Beaufort seas based on the Getis-Ord Gi hotspot analysis by Kuletz et al. (in press).
- **A major concentration area for thick-billed and common murres** that nest on the Lisburne Peninsula and forage out to 100 or more miles offshore. The area qualifies as a continentally significant Important Bird Area (Hatch et al. 2000, Smith et al. 2014b).
- **A biologically important gray whale feeding area** overlaps the far southern part of this section (Clarke et al. 2015).
- Identified as an **Important Ecological Area** based on analysis by Oceana (2013a).

Chukchi Corridor Central: Ledyard Bay to Southern Kasegaluk Lagoon
Specific to the area not already withdrawn from leasing 25 miles to 50 miles offshore, the following values are significant:

- **A spring migration corridor regularly used by bowhead and beluga whales** (Quakenbush et al. 2013, Clarke et al. 2015).
- A system of **recurring leads and polynyas used by migratory wildlife in spring** (Stringer and Groves 1991, Mahoney et al. 2012).
- **High levels of benthic biomass** that provide food for marine mammals (Dunton et al. 2005), including walrus and bearded seals.
- **Highly concentrated walrus foraging area** in early summer and late fall (Jay et al. 2012).
- **A high-use sea ice habitat area for polar bears** based on resource selection models (Wilson et al. 2014).
- **A core use area for threatened spectacled eiders** (Sexson et al. 2012) **that are migrating, staging, and foraging.** This is a US Fish and Wildlife Service **designated critical habitat area.**
- **A high concentration staging area for king eiders during spring and fall migration** (Oppel et al. 2009). The entire breeding population of King Eiders in western North America—about **half of a million birds**—is believed to use this area.
- Identified as a **seabird hotspot relative to other areas of the Chukchi** and Beaufort seas based on the Getis-Ord Gi hotspot analysis by Kuletz et al. (in press).
- Highly **concentrated bearded seal habitat** in spring (Bengtson et al. 2005).
- Identified as an **Important Ecological Area** based on analysis by Oceana (2013a).

Chukchi Corridor North: Icy Cape to Point Belcher
Specific to the area not already withdrawn from leasing 25 miles to 50 miles offshore, the following values are significant:

- A system of **recurring leads and polynyas used by migratory wildlife in spring** (Stringer and Groves 1991, Mahoney et al. 2012).
- **High levels of benthic biomass** that provide food for marine mammals (Dunton et al. 2005, Grebmeier et al. 2006, Grebmeier 2012), including walrus, bearded seals, and gray whales.
- **A spring migration corridor regularly used by bowhead and beluga whales** (Quakenbush et al. 2013, Clarke et al. 2015).
- Beluga whales from the **eastern Chukchi Sea stock of beluga whales use this region during summer** when moving from the Kasegaluk Lagoon to Barrow Canyon (Suydam et al. 2005, Hauser et al. 2014).
- **A biologically important area for gray whale feeding and reproduction** (sightings of calves) **in summer and fall** (Clarke et al. 2014, Clarke et al. 2015).
- **A foraging area and major transit area for walrus traveling between haulouts onshore and near Hanna Shoal** (Jay et al. 2012).
- Identified as a **seabird and mammal hotspot relative to other areas of the Chukchi** and Beaufort seas based on the Getis-Ord Gi hotspot analysis by Kuletz et al. (in press).
- An area with **continentally and globally significant proportions of bird species** including black-legged kittiwake, glaucous gull, and pomerine jaeger (Smith et al. 2014b).
- Identified as an **Important Ecological Area** based on analysis by Oceana (2013a).

3.2 Hanna and Herald Shoals

During a time of rapid change, Hanna and Herald shoals appear to be important over the long-term. These shallow areas divert warm water masses flowing northward from the Bering Sea, entraining colder water long into the summer season (Weingartner et al. 2005). As a result, sea ice persists in these areas longer into the summer season as well (Martin and Drucker 1997, Spall 2007), although the duration and extent of ice retention varies between years. Even though the shoals are no longer covered by continuous pack ice all year, they still have the most reliable ice present on the Chukchi shelf, in the form of broken ice floes. (Weingartner et al. 2013). Hanna Shoal and Herald Shoal persistent ice floes are increasingly important because they may become a last stronghold for some ice-obligate species such as Pacific walrus, polar bear, bearded seal, and ringed seal (Moore and Huntington 2008). Recent satellite-tracking data demonstrates the periodic importance of the Hanna Shoal area during bowhead whale migration in the fall (Quakenbush et al. 2010), and of both shoals for walrus foraging and resting, especially during the summer (U.S. Geological Survey 2009-2013, Jay et al. 2012).

The Hanna and Herald Shoal important areas encompass the following values:

- **Mid to late-summer lingering sea ice.** Sea ice haulout areas are necessary for walrus, polar bear, and seal species to rest between foraging/hunting trips. Maintaining the integrity of the area for walrus is of particular concern. Walrus are likely to continue relying on lingering ice and increase their use of shore-based haulouts over time (MacCracken 2012). In a worst-case scenario, walrus have a potential extinction risk due to compounding environmental stressors (MacCracken 2012), making these shoals a last stronghold on the shelf as ice continues to recede earlier each year.
- **Seafloor (benthic) biomass and primary productivity hotspots.** The Hanna Shoal Region has high levels of primary productivity (water column algae); Herald Shoal was not similarly sampled (Grebmeier et al. 2006). Both shoals have relatively high values for benthic food resources compared to other portions of the program area (Grebmeier et al. 2006).
- **High-concentration walrus summer haulout and foraging area** (Clarke et al. 2013, Kuletz et al. in press)**.** Herald Shoal is visited by foraging and/or migrating walrus in early to mid-summer (U.S. Geological Survey 2009-2013), and is often one of the last stopover areas holding ice along the transit between Alaska waters and the Chukotka coast. Shallow water, late-summer ice for hauling out, and relatively high benthic biomass (Dunton et al. 2005, Grebmeier et al. 2006) make the Hanna Shoal Region a highly important conservation area for walrus. Recent satellite telemetry shows that walrus forage and haul out in high concentrations at Hanna Shoal from June through September (Jay et al. 2012).
- **Feeding area for gray whales, bearded seals, and marine birds.** Due to the relatively high seafloor biomass at Hanna Shoal, the area is a foraging area for benthic feeders such as bearded seal and gray whale (Aerts et al. 2013). Gray whale use has shifted toward areas more near shore in recent years (Clarke et al. 2013). However, as feeding areas in other regions change, this area could provide additional food resources for gray whales in the future (Moore et al. 2003). Several species of marine birds come here to forage, including black-legged kittiwake, black guillemot, crested auklet, glaucous gull, ivory gull, northern fulmar, pomerine jaeger, and Ross's gull (Drew and Piatt 2013).
- **Northern migration corridor for marine mammals and birds.** A major migration corridor for several species crosses the Hanna Shoal Region. Whales traveling past Barrow Canyon cross the

region in autumn to access habitats in Russian waters (e.g. Hauser et al. 2014, Kuletz et al. in press). Bowhead whales utilize this corridor in fall when traveling in the direction of Wrangel Island before heading south to feeding areas north of the Chukotka Peninsula (Quakenbush et al. 2010, Quakenbush et al. 2012). Beluga whales from the Eastern Chukchi Stock have also been observed to concentrate in the Herald Shoal Region in October before migrating southward into the Bering Sea (Hauser et al. 2014). Marine birds also migrate through this corridor, including Steller's eiders (Martin et al. 2009), king eiders (Oppel et al. 2009), ivory gulls (Mallory et al. 2008, Drew and Piatt 2013), and Ross's gulls (Blomqvist and Elander 1981, Drew and Piatt 2013).

- **Ecosystem-level hotspots.** An integrated analysis of concentration areas for wildlife, hunting areas for local people, benthic and pelagic productivity, and sea ice habitat highlighted this area as having high importance values based on multiple criteria (Ayers et al. 2010, Oceana 2013b). Kuletz et al. (in press) identified Hanna Shoal as a biologically important pelagic area for marine mammals and seabirds using a hotspot analysis of aerial survey data.
- **Ecosystem resilience and climate change refugia.** Both Hanna and Herald shoals are likely to provide ecosystem resilience (Gunderson 2000, Christie and Sommerkorn 2012) to climate change due to the particular biophysical features of these sites (e.g. regional circulation patterns and seasonal sea-ice dynamics) responsible for the high benthic biomass at Hanna Shoal and to a lesser degree at Herald Shoal; persistence of sea-ice during the summer; and local wildlife diversity. The shallow topographic features of the shoals on the Chukchi shelf divert the flow of warmer Bering Sea water during springtime and form Taylor columns, an anti-cyclonic circulation pattern that entrains cold water and influences the persistence of sea-ice over the shoals (Martin and Drucker 1997, Weingartner et al. 2005, Woodgate et al. 2005, Weingartner et al. 2013). The unique combination of drivers that distinguish Herald and Hanna shoals as key features are likely to persist in future decades, thereby making these areas a priority for conservation over the long-term.

Specific to the area outside of the Hanna Shoal 40-meter isobath contours that were withdrawn from leasing, the following values are significant:

- **A majority of the Hanna Shoal Walrus Use Area identified by USFWS** which is important foraging habitat for walruses in summer (Jay et al. 2012). The area north of the withdrawal is important, particularly as sea ice recedes; this is an area with lingering sea ice that has particularly heavy use in August because it provides easy access to the shallow floor before a steep decline into the Canada Basin. Both walrus and bearded seal distributions in the northeastern Chukchi Sea are heavily dependent upon habitat (and thusly forage) location (Aerts et al. 2013).
- **A connectivity corridor that provides a link between Hanna Shoal and the coastline** (Jay et al. 2012, Clarke et al. 2014). The area to the south of the withdrawal moving toward the coastline is critical to walrus in the fall as it provides important foraging habitat closer to land-based haulout sites in August and September. This is particularly important late summer as sea ice disappears and walrus and bearded seals start hauling out on land to rest between foraging trips to the southern Hanna Shoal area as indicated by aerial surveys (e.g. Fig. 34 in Clarke et al. 2014) and recorded vocalizations (Day et al. 2013, Hannay et al. 2013)
- **Identified as a walrus hotspot relative to other areas of the Chukchi Sea** based on the Getis-Ord Gi hotspot analysis by Kuletz et al. (in press).
- **Bowhead whale migration and foraging hotspots in the fall.** Sightings from the Aerial Survey of Arctic Marine Mammals indicates bowhead whales utilize the region to the south of Hanna

Shoal during the fall migration at levels similar to hotspots in the Beaufort Sea fall migration corridor (Oceana and Audubon Alaska 2015). The sightings of whales south of Hanna Shoal were primarily from 2012 and 2013 seasons where survey effort occurred from 2008–2013 (Clarke et al. 2013, Clarke et al. 2014). Almost no surveys have been flown above 72° North in the past couple of decades to be able to assess the use north of Hanna Shoal with these data. Satellite tagging data, which are not limited to the region south of Hanna Shoal, have documented bowhead whales using the greater Hanna Shoal region in the fall (Citta et al. 2012, Quakenbush et al. 2013). However, the degree of use of the Hanna Shoal region in fall and the location of that use has been variable from year to year (Quakenbush et al. 2013, Citta et al. 2015).

- **Very high levels of benthic biomass** to the north and south of Hanna Shoal that provide food for marine mammals (Dunton et al. 2005, Grebmeier et al. 2006, Grebmeier 2012), including walrus and bearded seals. The benthos south of Hanna Shoal is especially rich with high abundance of bivalves and polychaetes—important prey of walrus and bearded seals (e.g. Fig. 5 in Schonberg et al. 2014). The same study found a high abundance of amphipods in the area between Hanna Shoal and Barrow Canyon where gray whales were observed feeding.
- **Relatively high levels of primary production** across the greater Hanna Shoal region (Dunton et al. 2005, Grebmeier et al. 2006).
- **Identified as an Important Ecological Area** based on analysis by Oceana (2013a).

3.3 Barrow Canyon Complex

Barrow Canyon and the associated complex of ecological values straddle the boundary between the Beaufort and Chukchi seas. Complex water mass mixing, upwelling, and sea ice dynamics make the waters around Point Barrow and Barrow Canyon very productive compared to other nearby areas and the nutrient-poor Canada Basin (Mathis et al. 2007). This submarine canyon runs along the Chukchi Sea coast, approximately 5 to 15 miles offshore from Point Franklin to Point Barrow, and then cuts through the shelf break into the Canada Basin. It is 150 miles long, about 15 miles wide, and reaches depths that are about 1200 feet below the surrounding cliffs and peaks. Barrow Canyon is a concentrated migration passageway for marine mammals and birds following open leads in the sea ice. The area has very high levels of primary productivity (Grebmeier et al. 2006), along with a high biomass of zooplankton. *Pseudocalanus* copepods and euphausiids concentrate off Point Barrow to the shelf break (Ashjian et al. 2010), serving as an important food source (Moore and Laidre 2006), especially in the fall (Moore et al. 2010). Nearshore areas are globally important staging and foraging areas for several species of birds, including yellow-billed loons (Schmutz and Rizzolo 2012); spectacled and king eiders (Oppel et al. 2009, Sexson et al. 2012); Arctic terns; black-legged kittiwakes; glaucous and Sabine's gulls; long-tailed ducks; and red phalaropes (Smith et al. 2014b). On January 27th, 2015 the President – using his authorities under the OCS Lands Act -withdrew from future oil and gas leasing the Beaufort Sea Barrow whaling area deferred from leasing since 2003 as well an additional subsistence area north of Barrow in the Chukchi Sea deferred from leasing in the 2012-2017 Final Program.

Ecologically, the Barrow Canyon Complex is a single, connected important marine area that includes waters in both the Chukchi and Beaufort program areas, as described below. This important area encompasses the following values:

- **Subsistence hunting areas for the communities of Barrow and Wainwright.** Studies conducted on behalf of BOEM and other organizations show that these villages rely extensively on areas influenced by the high levels of productivity at Barrow Canyon for hunting during the year (Pedersen 1979b, Braund and Burnham 1984, Stephen R. Braund and Associates and Institute of Social and Economic Research 1993, Kassam and Wainwright Traditional Council 2001, Stephen R. Braund and Associates 2010, Nelson c1982).
- **A major migration passageway for marine mammal species in the U.S. Arctic Ocean.** Marine mammals such as whales and ice seals that live in the Beaufort Sea in summer migrate across Barrow Canyon in the spring and fall. For example, bowhead whales migrate northeast up the Chukchi coast past Point Barrow in April and May before heading farther offshore on their way to the Canadian Beaufort Sea for summer foraging. In the fall, they follow the Alaskan Beaufort Sea coast back west across Barrow Canyon in late August through early November (Alaska Department of Fish and Game 2010). Much like bowhead whales, beluga whales migrate through this area twice per year during spring and fall migration (Clarke et al. 1993, Moore et al. 1993, Moore et al. 2000).
- **A major migration passageway for birds nesting on the North Slope in summer.** Many bird species that migrate to the North Slope for summer breeding migrate through the Chukchi Corridor, then around Point Barrow, or in reverse in the fall. This spring and fall migration and staging corridor is likely used by the entire breeding population of king eiders in Western North America (Oppel et al. 2009), which are an Audubon WatchList species due to depressed population numbers (Kirchhoff and Padula 2010). Based on satellite telemetry, the Barrow area is a Steller's eider concentration area (Martin et al. 2009, Smith 2010). King eiders concentrate in Peard Bay and in nearshore Beaufort waters during spring and fall staging and migration (Oppel et al. 2009). Spectacled eiders move through the area from June through October in significant concentrations (Sexson et al. 2012). Yellow-billed and red-throated loons migrate to and from wintering grounds in Russia through this corridor between May and October (Schmutz and Rizzolo 2012). A variety of shorebirds stop over along the northeast Chukchi coast in concentrated groups (Taylor et al. 2010). At Peard Bay, upwards of 56,000 shorebirds, mostly red phalaropes, move through during the post-breeding season. At Elson Lagoon, as many as 418,000 post-breeding shorebirds stop during fall migration (Alaska Shorebird Group 2008).
- **A summer (May through October) core area for WatchList bird species of concern** (Audubon Alaska 2014). Based on Audubon analysis of the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014), Barrow Canyon is a 50% core use area for red-throated loons, brant, king eider, and spectacled eider.
- **Globally significant IBAs** (Smith et al. 2014a, Smith et al. 2014b). Nearly a quarter of North America's long-tailed ducks and king eiders use the Barrow Canyon & Smith Bay IBA. The Chukchi Sea Nearshore IBA hosts as much as 15% of the North American population of glaucous gulls. These two IBAs, along with the Beaufort Sea Shelf Edge 152°W 71°N IBA, also have globally significant numbers of Arctic terns, black-legged kittiwakes, glaucous gulls, pomerine jaeger, red phalaropes, red-throated loons, and Sabine's gulls.
- **A major concentration area for bowhead whales feeding in the spring and fall.** Previously documented as an important fall feeding area (Ashjian et al. 2010, Moore et al. 2010), a recent study of the Barrow Canyon area found that 61% of bowhead whales migrating across Barrow Canyon in spring were actively feeding, as were 99% of the whales studied in the fall (Huntington and Quakenbush 2009, Mocklin et al. 2012); Kuletz et al. (in press) identified Barrow Canyon as a biologically important pelagic area using a hotspot analysis of aerial survey

data, and it has also been identified as a core area based on analysis of satellite tagging data (Quakenbush et al. 2013). Based on analysis of the ASAMM database, Oceana and Audubon Alaska (2015) found this to be a core use area for bowheads in the fall.

- **A core concentration area for beluga whales in summer and fall.** Hauser et al. (2014) identified Barrow Canyon as a core area for the Eastern Chukchi Sea population of belugas based on the 50% utilization distribution from satellite telemetry data between 1998 and 2007. It is important for the Eastern Chukchi Stock from July through October and for the Beaufort Sea Stock in September. Based on analysis of the ASAMM database, Oceana and Audubon Alaska (2015) found this to be a core use area for belugas in the fall.
- **Gray whale feeding hotspots.** As noted above, gray whales feed in the Chukchi and Bering seas in summer and fall, including in Barrow Canyon (Kuletz et al. in press). The whales concentrate in an area of known high seafloor biomass (Grebmeier et al. 2006) from about 50 miles offshore of Wainwright tapering toward Barrow, sometimes as far out as the Hanna Shoal Region (Moore et al. 2000, Clarke and Ferguson 2010, Clarke et al. 2013).
- **Critical sea ice habitat and known feeding and denning concentration areas for polar bears.** This is a polar bear feeding area where the bears hunt seals along the coast, landfast ice, edges of open leads, and in holes in the pack ice during all seasons of the year (Kalxdorff 1997). The whaling bone pile at Point Barrow is another important aggregation and feeding area. Barrow Canyon is an important coastal and sea ice denning area for expecting female polar bears in winter (NOAA 1988, USFWS 1995, Kalxdorff 1997, USFWS 2010), however the number of maternal dens west of Point Barrow has decreased due to reduced connectivity with sea-ice during late fall (Fischbach et al. 2007, USFWS 2010). Audubon Alaska, based on Durner et al. (2009) found the canyon to be a high use area in winter (December through May) and medium-high use in spring and autumn (June through July and October through November).
- **Important habitat for walrus** (Robards et al. 2007, Clarke et al. 2012, Huntington et al. 2012, Jay et al. 2012, Clarke et al. 2013). Walrus forage in Peard Bay in June and move through the bay when transiting between offshore and coastal haulout areas in summer (Jay et al. 2012). Coastal haulouts and nearby benthic foraging resources are increasingly important as offshore sea ice melts. In recent years, high numbers of walrus have been documented on aerial surveys of Peard Bay and Barrow Canyon (Clarke et al. 2012, Clarke et al. 2013). When hauled out, walruses are sensitive to human disturbance, including aircraft or boat traffic (Garlich-Miller et al. 2011).
- **Ice seal concentration areas.** Spotted seals haul out along the coast and islands near Point Franklin, Dease Inlet, and Smith Bay between July and November (NOAA Office of Response and Restoration 2005, Huntington et al. 2012). Bearded and ringed seals concentrate in the Barrow Canyon area in spring and winter (NOAA 1988, Bengtson et al. 2005).
- **Seafloor (benthic) biomass and primary productivity hotspots.** Benthic biomass is an excellent long-term indicator of physical processes that spur pelagic productivity (Dunton et al. 2005). Barrow Canyon and Peard Bay have high primary productivity as indicated by high concentrations of water column algae compared to other portions of the program area (Grebmeier et al. 2006). This area also has high values for benthic food resources compared to other portions of the program area (Grebmeier et al. 2006, Grebmeier 2012).
- **Essential Fish Habitat. S**affron and Arctic cod are critical to the Arctic marine food web (NPFMC 2009). The National Marine Fisheries Service designated areas along the entire Chukchi coast out to 15-30 miles offshore as Essential Fish Habitat (EFH) for saffron cod, and the U.S. continental shelf to 500 meters depth as EFH for Arctic cod. Capelin spawn in sand and gravel in tidal areas (NPFMC 2009) along the Chukchi coast (NOAA 1988), coincident with areas designated for saffron and Arctic cod.

- **A MESA (Most Environmentally Sensitive Area) identified by Alaska Department of Fish and Game.** The MESA program for oil spill contingency planning along the coast of Alaska identified Peard Bay as important based on waterfowl spring and fall staging, molting, and nesting; gray whale nearshore feeding; spotted seal haulouts; ringed seal breeding and pupping; bearded seals generally associated with active ice; and confirmed coastal polar bear denning (Alaska Department of Fish and Game Habitat and Restoration Division 2001).
- **Ecosystem-level hotspots.** An integrated analysis of concentration areas for wildlife, hunting areas for local people, benthic and pelagic productivity, and sea ice habitat highlighted this area as having very high importance values based on multiple criteria (Ayers et al. 2010, Oceana 2013b).
- **Ecosystem resilience and climate change refugia.** A Rapid Assessment of Circum-arctic Ecosystem Resilience conducted in 2010 (Christie and Sommerkorn 2012) identified Barrow Canyon as a key feature in the Arctic marine ecosystem. The assessment results indicate that the canyon is likely to provide ecosystem resilience (Gunderson 2000) to climate change due to the unique combination of environmental drivers (e.g. complex water mass mixing, upwelling, and sea ice dynamics) responsible for the high benthic biomass, primary productivity (Grebmeier et al. 2006), and local diversity. The topographic features in Barrow Canyon are fixed features that coincide with local circulation patterns and sea-ice dynamics to enhance local productivity and diversity, which may explain long-term high benthic biomass values documented by Grebmeier (2012). The unique combination of drivers that distinguish Barrow Canyon as a key feature are likely to persist in future decades, thereby making it a priority for conservation over the long term.

Specific to the area outside of the Barrow Canyon complex withdrawals, the following values are significant:

- **A core summer and fall use area for the Eastern Chukchi Stock of beluga whales** at the mouth of Barrow Canyon , which is evident from satellite tagging data (Hauser et al. 2014) and aerial surveys (Oceana and Audubon Alaska 2015). Dive data from satellite tags indicates these beluga whales are likely feeding on Arctic cod (Citta et al. 2013).
- **A spring and fall migration area for bowhead whales** (Clarke et al. 2015). The area near the mouth of Barrow Canyon has been documented as an important feeding area for bowhead whales during the spring migration (Clarke et al. 2015).
- **A fall migration area and likely feeding area for beluga whales** (Citta et al. 2013, Clarke et al. 2015) using the shelf break to the east of the mouth of Barrow Canyon at relatively high densities (Hauser et al. 2014, Oceana and Audubon Alaska 2015).
- **A beluga whale hotspot relative to other areas of the Chukchi and Beaufort seas** at the mouth of Barrow Canyon and the shelf break to the east of Barrow Canyon, based on the Getis-Ord Gi hotspot analysis by Kuletz et al. (in press). The area is also a spring migration corridor regularly used by beluga whales (Quakenbush et al. 2013, Clarke et al. 2015)
- **An important feeding area for bowhead whales in the summer and fall** in the region east of Point Barrow (Ashjian et al. 2010, Citta et al. 2014, Clarke et al. 2015) and a core part of the bowhead whale fall migration corridor (Quakenbush et al. 2013, Clarke et al. 2015, Oceana and Audubon Alaska 2015).
- **Relatively high predicted values of benthic biomass and integrated water column algae** in the Barrow Canyon Complex portion of the Beaufort Sea, which indicates the region is relatively productive compared to other portions of the U.S. Beaufort Sea (Dunton et al. 2005).

3.4 Harrison Bay

Harrison Bay is located offshore from Cape Halkett east of Teshekpuk Lake, past the Colville River delta, to Oliktok Point, where the central Beaufort barrier islands begin. Harrison Bay is adjacent to the Colville River, which is Alaska's largest Arctic river and one of the major rivers of the circumpolar Arctic. Shallow depth and nutrient supply from the Colville results in relatively high productivity compared to other nearshore areas of the Beaufort Sea (Alexander et al. 1975). Likely because of this higher productivity and shallow, sheltered waters, Harrison Bay supports substantial numbers of birds of concern, including scoters, eiders, and loons (Fischer et al. 2001, Lysne et al. 2004, Audubon Alaska 2014, Smith et al. 2014b).

The Harrison Bay important area encompasses the following values:

- **A major hotspot for marine birds** (Audubon Alaska 2014). Based on all marine bird species abundance data combined, Harrison Bay is a 50% core use area based on Audubon's analysis of data in the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014). Kuletz et al. (in press) estimated 50-100 birds/sq. km in summer in the bay.
- **A summer (May through October) core area for WatchList bird species of concern** (Audubon Alaska 2014). Based on Audubon analysis of the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014), Harrison Bay is a 50% core use area for yellow-billed loons, red-throated loons, brant, king eider, and spectacled eider.
- **A globally significant IBA** (Smith et al. 2014a, Smith et al. 2014b). The Beaufort Sea Nearshore IBA is recognized for having 1% or more of the North American population of long-tailed ducks, king eiders, red-throated loons, Arctic terns, surf scoters, brant, and glaucous gulls. Nearly 30% of North American long-tailed ducks are estimated to use this IBA.
- **A major migration staging area** for red-throated and yellow-billed loons in summer and fall; and spectacled and king eiders in spring and fall (Phillips et al. 2007, Schmutz and Rizzolo 2012, Sexson et al. 2012).
- **A hotspot for benthic-feeding seabirds in summer** based on the analysis by Kuletz et al. (in press) comparing binned abundances to the average abundances across their Chukchi and Beafort seas study area.
- **Feeding and high-density denning areas for polar bears.** This is a prominent polar bear feeding area where the bears hunt seals along the coast, landfast ice, edges of open leads, and at seal breathing holes in the pack ice during all seasons of the year (Kalxdorff 1997). It is a high density coastal and sea ice denning area for pregnant female polar bears in winter (NOAA 1988, USFWS 1995, Kalxdorff 1997, USFWS 2010), and is one of the core denning areas identified in recent studies (Fischbach et al. 2007, USFWS 2010).
- **A MESA identified by Alaska Department of Fish and Game.** The MESA program for oil spill contingency planning along the coast of Alaska identified the Colville River Delta as important based on waterfowl nesting and molting, polar bear dens, anadromous waters, and spotted seal haulout (Alaska Department of Fish and Game Habitat and Restoration Division 2001).

3.5 Central U.S. Beaufort

The Central U.S. Beaufort is part of the fall migratory corridor for bowhead whales from the Beaufort to Bering seas (Moore 2000, Moore et al. 2000). During fall migration, bowhead whales follow continental slope habitat closer to the sea coast than the slope migratory pathway they follow during the spring migration. Within the migration corridor across the Beaufort shelf there are several areas where more bowhead whales are consistently observed (from year to year), likely because they provide feeding habitat for the long journey to the southern Bering Sea. The area northeast and east of Cross Island has consistently been observed to have more bowhead whales observed during surveys than surrounding areas in the bowhead migration corridor. Cross Island is used by subsistence hunters as a staging location from which to harvest bowhead whales in the fall (Galginaitis 2014). The Central U.S. Beaufort is also characterized by nearshore barrier islands with productive lagoon areas. The lagoons and surrounding marine areas have significantly high abundances of marine birds, including long-tailed ducks, king and common eiders, yellow-billed and red-throated loons, glaucous gulls, and brant (Drew and Piatt 2013, Audubon Alaska 2014, Smith et al. 2014b, Walker and Smith 2014). Farther offshore, near the shelf break, is an area where pinnipeds (primarily ringed and bearded seals) are found in higher densities. It is unclear why bowhead whales and pinnipeds are found in higher abundances in portions of the Central U.S. Beaufort. While the region tends to have lower primary productivity than do other shelf areas in the Arctic, it has higher levels of seafloor biomass than surrounding areas (Dunton et al. 2005). Nonetheless, these higher abundances of marine mammals and birds indicate the importance of the area regardless of the reason.

The Central U.S. Beaufort important area encompasses the following values:

- **Subsistence hunting area for the community of Nuiqsut**. Subsistence hunters from Nuiqsut have camps on Cross Island from which they hunt. The Central U.S. Beaufort important area overlaps subsistence use areas for bowhead whales, seals and waterfowl (Stephen R. Braund and Associates 2010, Galginaitis 2014).
- **A concentration area for bowhead whales during their fall migration**. The Oceana and Audubon Alaska (2015) analysis of the ASAMM dataset found that the region east and northeast of Cross Island was a high relative density area. Other recent analyses of ASAMM data also indicate this is a region with a higher relative density of bowhead whales during the fall migration (Clarke et al. 2014, Kuletz et al. in press).
- **A core area for Beaufort Sea stock female beluga whales in September**. Analysis of satellite tagged whales from the Beaufort Sea stock indicates this area is part of the core area for female beluga whales during their migration from the Canadian Beaufort Sea to the western Chukchi Sea (Hauser et al. 2014).
- **Ringed seal subnivean denning habitat**. The nearshore portion of this area is covered in landfast sea ice during the winter and spring, which is high value subnivean lair habitat for ringed seals (Kelly et al. 2010).
- **Feeding and high-density denning areas for polar bears.** This is a prominent polar bear feeding area where the bears hunt seals along the coast, landfast ice, edges of open leads, and at seal breathing holes in the pack ice (Kalxdorff 1997). It is a high density coastal and sea ice denning area for expecting female polar bears in winter (NOAA 1988, USFWS 1995, Kalxdorff 1997,

USFWS 2010) and is one of the core denning areas identified in recent studies (Fischbach et al. 2007, USFWS 2010).

- **A major hotspot for marine birds** (Audubon Alaska 2014). Based on all marine bird species abundance data combined, the Central U.S. Beaufort is a 50% core use area hotspot based on Audubon's analysis of data in the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014). Kuletz et al. (in press) estimated up to 50 birds/ sq. km in this region in summer and 50-100 birds/sq. km in fall.
- **A summer (May through October) core area for WatchList bird species of concern** (Audubon Alaska 2014). Based on Audubon analysis of the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014), Central U.S. Beaufort is a 50% core use area for yellow-billed loons, red-throated loons, brant, and common eider.
- **A globally significant IBA** (Smith et al. 2014a, Smith et al. 2014b). The Beaufort Sea Nearshore IBA is recognized for having 1% or more of the North American population of long-tailed ducks, king eiders, red-throated loons, Arctic terns, surf scoters, brant, and glaucous gulls. Nearly 30% of North American long-tailed ducks are estimated to use this IBA.
- **A major concentration area** for king eiders in spring and spectacled eiders in spring through fall (Phillips et al. 2007, Schmutz and Rizzolo 2012, Sexson et al. 2012).
- **A hotspot for benthic-feeding seabirds in fall,** particularly black guillemots and Kittlitz's murrelets, based on the Kuletz et al. (in press) analysis comparing binned abundances to the average abundances across the Chukchi and Beafort seas study area.
- **Two MESAs identified by Alaska Department of Fish and Game.** The MESA program for oil spill contingency planning along the coast of Alaska identified Howe/Duck Islands & Sagavanirktok River Delta as important based on waterfowl nesting, seabird colonies, and anadromous waters; they identified Stefansson Sound Boulder Patch as important for kelp/benthic invertebrates, waterfowl nesting, molting, and brood rearing, seabird colonies, and polar bear dens (Alaska Department of Fish and Game Habitat and Restoration Division 2001).
- **Ecosystem-level hotspot**. An integrated analysis of concentration areas for wildlife, hunting areas for local people, benthic and pelagic productivity, and sea ice habitat highlighted the inner shelf portion of this area as having high importance values based on multiple criteria (Ayers et al. 2010, Oceana 2013b).

3.6 Eastern U.S. Beaufort

The Eastern U.S. Beaufort lies between Camden Bay and Demarcation Bay at the eastern boundary of the Beaufort Sea Planning Area. The important area is in close proximity to the village of Kaktovik and complements the subsistence values of this native community. The areas are part of an important migratory corridor for bowhead whales during the fall migration from the Beaufort to the Bering seas (Moore 2000, Moore et al. 2000). There are several important feeding and resting hotspots for marine mammals and seabirds in this area. The important areas lie to the west of the Mackenzie Delta and are consistent with an area of relatively high productivity in the Beaufort Sea Planning Area, second only to the head of Barrow Canyon (Dunton et al. 2005). Nearly all of the major species examined for this analysis appear to be concentrated in, forage in, or migrate through this area. During the fall migration bowhead whales traverse continental slope habitat closer to the sea coast where the migratory pathway brings them directly through this area (Quakenbush et al. 2010). Similarly, the seasonal movements and distribution of beluga whales (Hauser et al. 2014), bearded seals (Boveng and Cameron 2013), ringed seals (Harwood et al. 2012) and seabirds (Smith et al. 2014a, Smith et al. 2014b) indicate that the Eastern U.S. Beaufort is an ecologically rich area. On January 27th, 2015 the President – using his authorities under the OCS Lands Act -withdrew from future oil and gas leasing the Kaktovik whaling area deferred from leasing since 2003.

The Eastern U.S. Beaufort important area encompasses the following values:

- **Subsistence hunting area of the community of Kaktovik**. Studies conducted on behalf of BOEM and other organizations show that residents of the Native village of Kaktovik rely on areas in the Eastern U.S. Beaufort for hunting (Stephen R. Braund and Associates 2010).
- **A concentration area for bowhead whales feeding and resting in the fall**. The Oceana and Audubon Alaska (2015) analysis of the ASAMM dataset found that the region to the east of Kaktovik is a core use area. This area is known as a place where milling and feeding whales are found during the westward fall migration (Clarke et al. 2014). Other analyses of the ASAMM data also confirm that this region has higher relative densities of bowhead whales in the fall (Clarke et al. 2013, Clarke et al. 2014, Kuletz et al. in press) as well as during the summer (Kuletz et al. in press).
- **Beluga whale concentration area**. Based on the Oceana and Audubon Alaska (2015)analysis of the ASAMM data, the region offshore of Kaktovik is a core use area for beluga whales during the fall. This region of the continental shelf slope is broader than the rest of the slope in the western Beaufort Sea. Other analyses of the ASAMM data have also found that parts of the Eastern U.S. Beaufort important area are hotspots for beluga whales in the summer (Kuletz et al. in press). Analysis of satellite tagged beluga whales from the Beaufort Sea stock (BSS) and the eastern Chukchi Sea stock (ECS) confirm that this area is part of the core area for male beluga whales, specifically for the BSS in September and the ECS in October (Hauser et al. 2014).
- **A summer (May through October) core area for WatchList bird species of concern** (Audubon Alaska 2014). Based on Audubon analysis of the North Pacific Pelagic Seabird Database (Drew and Piatt 2013) and the Alaska Waterbird Dataset (Walker and Smith 2014), Eastern U.S. Beaufort is a 50% core use area for brant and red-throated loon.
- **A globally significant IBA** (Smith et al. 2014b). The Beaufort Sea Nearshore IBA is recognized for having 1% or more of the North American population of long-tailed ducks, king eiders, red-throated loons, Arctic terns, surf scoters, brant, and glaucous gulls. Nearly 30% of North American long-tailed ducks are estimated to use this IBA.
- **A major concentration area** for king eiders in spring (Phillips et al. 2007).
- **A hotspot for benthic-feeding seabirds in fall,** particularly black guillemots and Kittlitz's murrelets, based on Kuletz et al. (in press) analysis comparing binned abundances to the average abundances across the Chukchi and Beafort Sea study area.
- **Ice seal foraging habitat.** Bearded and ringed seals forage in summer and fall in continental shelf areas located north of Demarcation Bay. Although based on small number of individual seals, satellite tracking of both bearded (Boveng and Cameron 2013) and ringed seals (Harwood and Yurkowski 2014), indicate that specific areas in the nearshore Eastern U.S. Beaufort Sea may serve as an important foraging area for these species during the open water period (summer and fall). Juvenile ringed seals in particular travel through the Eastern U.S. Beaufort during their westward fall migration to areas in the Chukchi and Bering seas (Harwood et al. 2012).
- **Ringed seal subnivean denning habitat**. The nearshore portions of this area is covered in landfast sea ice during the winter and spring, which is high value subnivean lair habitat for ringed seals (Kelly et al. 2010).

- **Feeding and high-density denning areas for polar bears.** This is a prominent polar bear feeding area where the bears hunt seals along the coast, landfast ice, edges of open leads, and at seal breathing holes in the pack ice (Kalxdorff 1997). In fall, high densities of polar bears use barrier islands and other coastal areas in this region (Schliebe et al. 2008). It is a high density coastal and sea ice denning area for expecting female polar bears in winter (NOAA 1988, USFWS 1995, Kalxdorff 1997, USFWS 2010) and is one of the core denning areas identified in recent studies (Fischbach et al. 2007, USFWS 2010).
- **Primary productivity hotspot.** The Eastern U.S. Beaufort important area is a region of elevated primary productivity in comparison to the rest of the Beaufort Sea, with the exception of the hotspot of primary productivity in the Barrow Canyon area (Dunton et al. 2005).
- **Ecosystem-level hotspot.** An integrated analysis of concentration areas for wildlife, hunting areas for local people, benthic and pelagic productivity, and sea ice habitat highlighted the inner shelf portion of this area as having high importance values based on multiple criteria (Ayers et al. 2010, Oceana 2013b).

4. REFERENCES CITED

Aerts, L. A. M., A. E. McFarland, B. H. Watts, K. S. Lomac-MacNair, P. E. Seiser, S. S. Wisdom, A. V. Kirk, and C. A. Schudel. 2013. Marine mammal distribution and abundance in an offshore sub-region of the northeastern Chukchi Sea during the open-water season. *Continental Shelf Research* 67:116-126.

Alaska Department of Fish and Game, 2010. Bowhead Movements May 2006-July 2010. Alaska Department of Fish and Game, Juneau, AK. Accessed online October 2013 at http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.bowheadmovements.

Alaska Department of Fish and Game Habitat and Restoration Division. 2001. Oil Spill Contingency Planning: Most Environmentally Sensitive Areas (MESA) Along the Coast of Alaska, Volume I. ADFG, Anchorage, AK.

Alaska Shorebird Group. 2008. Alaska Shorebird Conservation Plan, Version II. Alaska Shorebird Group, Anchorage, AK.

Alexander, V., D. Burrell, J. Chang, R. Cooney, C. Coulon, J. J. Crane, J. A. Dygas, G. E. Hall, P. J. Kinney, D. Kogl, T. C. Mowatt, A. S. Naidu, T. E. Osterkamp, D. M. Schell, R. D. Siefert, and R. W. Tucker. 1975. Environmental Studies of an Arctic Estuarine System - Final Report. US EPA National Environmental Research Center, Corvallis, OR.

Ashjian, C. J., S. R. Braund, R. G. Campbell, J. George, J. Kruse, W. Maslowski, S. E. Moore, C. R. Nicolson, S. R. Okkonen, and B. F. Sherr. 2010. Climate variability, oceanography, Bowhead Whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. *Arctic* 63:179-194.

Audubon Alaska, 2014. Marine Bird Species Core Area Analysis. Anchorage, AK.

Ayers, J., A. Blacow, B. Enticknap, C. Krenz, S. Murray, S. Roberts, G. Shester, J. Short, and J. Warrenchuk. 2010. Important Ecological Areas in the Ocean: a Comprehensive Ecosystem Protection Approach to the Spatial Management of Marine Resources - an Oceana Discussion Paper. http://oceana.org/sites/default/files/reports/oceana_iea_discussion_paper.pdf.

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.

Blomqvist, S., and M. Elander. 1981. Sabine's Gull (*Xema sabini*), Ross's Gull (*Rhodostethia rosea*) and Ivory Gull (*Pagophila eburnea*) Gulls in the Arctic: A Review. *Arctic*:122-132.

Boveng, P. L., and M. F. Cameron. 2013. Pinniped Movements and Foraging: Seasonal Movements, Habitat Selection, Foraging and Haul-out Behavior of Adult Bearded Seals in the Chukchi Sea. Anchorage, Alaska, USA.

Braund, S. R., and D. Burnham. 1984. Subsistence Economics and Marine Resource Use Patterns. *in Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development*. Prepared by LGL Ecological Research Associates, Inc. Prepared for U.S. Department of Interior, Minerals Management Service and Department of Commerce, NOAA., Anchorage, AK.

Bureau of Land Management. 2003. Northwest NPR-A Final Integrated Activity Plan and Environmental Impact Statement. BLM Alaska State Office, Anchorage, AK.

Christie, P., and M. Sommerkorn. 2012. RACER: Rapid Assessment of Circum-arctic Ecosystem Resilience. World Wildlife Fund, Global Arctic Programme, Ottawa, Canada.

Citta, J. J., L. T. Quakenbush, J. C. George, R. J. Small, M. P. Heide-Jørgensen, H. Brower, B. Adams, and L. Brower. 2012. Winter movements of bowhead whales (*Balaena mysticetus*) in the Bering Sea. *Arctic* 65:13–34.

Citta, J. J., L. T. Quakenbush, S. Okkonen, J. George, R. J. Small, M. P. Heide-Jorgensen, L. A. Harwood, and H. Brower. 2015. Inter-annual variability in the fall movements of bowhead whales in the Chukchi Sea, *in Alaska Marine Science Symposium*. Anchorage, AK.

Citta, J. J., L. T. Quakenbush, S. R. Okkonen, M. L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J. C. George, H. Brower, R. J. Small, and C. J. Ashjian. 2014. Ecological characteristics of core-use areas used by Bering–Chukchi–Beaufort (BCB) bowhead whales, 2006–2012. *Progress in Oceanography*.

Citta, J. J., R. S. Suydam, L. T. Quakenbush, K. J. Frost, and G. M. O'Corry-Crowe. 2013. Dive Behavior of Eastern Chukchi Beluga Whales (*Delphinapterus leucas*), 1998—2008. *Arctic*:389-406.

Clarke, J. T., A. A. Brower, C. L. Christman, and M. C. Ferguson. 2014. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2013. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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. Annual Report, OCS Study BOEM 2012-009. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J. T., and M. C. Ferguson. Aerial Surveys of Large Whales in the Northeastern Chukchi Sea, 2008-2009, with Review of 1982-1991 Data. Paper SC/62/BRG13 presented at the International Whaling Commission Scientific Committee Meetings, Morocco, 2010.

Clarke, J. T., M. C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Arctic Region. *Aquatic Mammals*:94-103.

Clarke, J. T., S. E. Moore, and M. M. Johnson. 1993. Observations on beluga fall migration in the Alaskan Beaufort Sea, 1982-87, and northeastern Chukchi Sea, 1982-91. *Report of the International Whaling Commission* 0:387-396.

Day, R. H., T. J. Weingartner, R. R. Hopcroft, L. A. M. Aerts, A. L. Blanchard, A. E. Gall, B. J. Gallaway, D. E. Hannay, B. A. Holladay, J. T. Mathis, B. L. Norcross, J. M. Questel, and S. S. Wisdom. 2013. The offshore northeastern Chukchi Sea, Alaska: A complex high-latitude ecosystem. *Continental Shelf Research* 67:147-165.

Drew, G. F., and J. Piatt, 2013. North Pacific Pelagic Seabird Database (NPPSD) v2. US Geological Survey Alaska Science Center & US Fish and Wildlife Service, Anchorage, AK.

Dunton, K. H., J. L. Goodall, S. V. Schonberg, J. M. Grebmeier, and D. R. Maidment. 2005. Multi-decadal synthesis of benthic-pelagic coupling in the western arctic: role of cross-shelf advective processes. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3462-3477.

Durner, G. M., D. C. Douglas, R. M. Nielson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. C. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. *Ecological Monographs* 79:107-120.

Eicken, H., L. H. Shapiro, A. G. Gaylord, A. Mahoney, and P. W. Cotter. 2005. Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas.

Federal Register. 2001. Endangered and threatened wildlife and plants; final determination of critical habitat for the spectacled eider; final rule. Volume 66:25.

Fischbach, A., 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., T. J. Tiplady, and W. W. Larned. 2001. Monitoring Beaufort Sea Waterfowl and Marine Birds: Aerial Survey Component, Final Progress Report. Report for Minerals Management Service. US Fish and Wildlife Service, Anchorage, AK.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. *In*: Advances in Research on the Beluga Whale. *Canadian Bulletin of Fisheries and Aquatic Sciences* 224:39-57.

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.

Galginaitis, M. 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). U.S. Department of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, Alaska.

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*). *USFWS, Anchorage AK. 163pp*.

Grebmeier, J. M. 2012. Shifting Patterns of Life in the Pacific Arctic and Sub-Arctic Seas. *Annual Review of Marine Science* 4:63-78.

Grebmeier, J. M., L. W. Cooper, H. M. Feder, and B. I. Sirenko. 2006. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

Gunderson, L. 2000. Ecological Resilience-In Theory and Application. *Annual Review of Ecological Systems* 31:425.

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.

Harwood, L., and D. Yurkowski, 2014. Ringed Seal Telemetry Tracking Data (unpublished work). Fisheries and Oceans Canada, Yellowknife, NWT.

Harwood, L. A., T. G. Smith, and J. C. Auld, 2012. Fall migration of Ringed Seals (*Phoca hispida*) through the Beaufort and Chukchi seas, 2001-02 65.

Hatch, S. A., P. M. Meyers, D. M. Mulcahy, and D. C. Douglas. 2000. Seasonal movements and pelagic habitat use of murres and puffins determined by satellite telemetry. *Condor* 102:145-154.

Hauser, D. D., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). *Polar Biology*:1-13.

Huntington, H. P., M. Nelson, and L. T. Quakenbush. 2012. Traditional knowledge regarding walrus near Point Lay and Wainwright, Alaska.

Huntington, H. P., and L. T. Quakenbush. 2009. Traditional knowledge of bowhead whale migratory patterns near Kaktovik and Barrow, Alaska. Report to the Alaska Eskimo Whaling Commission and the Barrow and Kaktovik Whaling Captains. in Quakenbush, L.T., J.J. Citta, R.J. Small. 2010. Satellite Tracking of Western Arctic Bowhead Whales, Final Report. OCS Study BOEMRE 2010-033. Department of the Interior; Bureau of Ocean Energy Management, Regulation and Enforcement.

Huntington, H. P., and E. The Communties of Buckland, Koyuk, Point Lay, and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the Eastern Chukchi and Northern Bering Seas, Alaska. *Arctic* 52:49-61.

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.

Johnson, S. R. 1993. An important early-autumn staging area for Pacific flyway brant - Kasegaluk Lagoon, Chukchi Sea, Alaska. *Journal of Field Ornithology* 64:539-548.

Johnson, S. R., K. J. Frost, and L. F. Lowry. 1992. Use of Kasegaluk Lagoon, Chukchi Sea, Alaska, by Marine Birds and Mammals. LGL Alaska Research Associates and AK Department of Fish and Game,

Johnson, S. R., D. A. Wiggins, and P. F. Wainwright. 1993. Late-summer abundance and distribution of marine birds in Kasegaluk Lagoon, Chukchi Sea, Alaska. *Arctic* 46:212-227.

Kalxdorff, S. 1997. Collection of local knowledge regarding polar bear habitat use in Alaska. Technical Report MMM 97-2. USFWS, Marine Mammal Management, Anchorage, Alaska.

Kassam, K.-A. S., and Wainwright Traditional Council. 2001. *Passing on the knowledge : mapping human ecology in Wainwright, Alaska*. Arctic Institute of North America, Calgary.

Kelly, B. P., J. Bengtson, P. Boveng, M. Cameron, S. Dahle, J. Jansen, E. Logerwell, J. Overland, C. Sabine, and G. Waring. 2010. Status Review of the Ringed Seal (*Phoca hispida)*.

Kirchhoff, M., and V. Padula. 2010. Alaska WatchList: Highlighting Declining and Vulnerable Bird Species in Alaska. Audubon Alaska, Anchorage, AK.

Kuletz, K. J., M. C. Ferguson, B. Hurley, A. E. Gall, E. A. Labunski, and T. C. Morgan. in press. Seasonal spatial patterns in seabird and marine mammal distribution in the Pacific Arctic: identifying biologically important pelagic areas. *Progress in Oceanography* 00:000-000.

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.

Lysne, L. A., E. J. Mallek, and C. P. Dau. 2004. Nearshore Surveys of Alaska's Arctic Coast, 1999-2003. US Fish and Wildlife Service, Migratory Bird Management Waterfowl Branch, Fairbanks, Alaska.

MacCracken, J. G. 2012. Pacific Walrus and climate change: observations and predictions. *Ecology and evolution* 2:2072-2090.

Mahoney, A., H. Eicken, L. H. Shapiro, R. Gens, T. Heinrichs, F. Meyer, and A. Graves-Gaylord. 2012. Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas. OCS Study BOEM 2012-067. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, AK.

Mallory, M., I. J. Stenhouse, G. Gilchrist, G. Robertson, J. C. Haney, and S. D. MacDonald. 2008. Ivory Gull (*Pagophila eburnea*). Cornell Lab of Ornithology, Ithaca, NY.

Martin, P. D., D. C. Douglas, and T. Obritschkewitsch, 2009. Distribution and movements of Steller's eiders in the non-breeding period. Unpublished manuscript. U.S. Fish and Wildlife Service and U.S. Geological Survey,

Martin, S., and R. Drucker. 1997. The effect of possible Taylor columns on the summer ice retreat in the Chukchi Sea. *Journal of Geophysical Research* 102:10473-10482.

Martin, S., R. Drucker, R. Kwok, and B. Holt. 2004. Estimation of the thin ice thickness and heat flux for the Chukchi Sea Alaskan coast polynya from Special Sensor Microwave/Imager data, 1990-2001. *Journal of Geophysical Research* 109:1-15.

Mathis, J. T., D. A. Hansell, D. Kadko, N. R. Bates, and L. W. Cooper. 2007. Determining net dissolved organic carbon production in the hydrographically complex western Arctic Ocean. *Limnology and Oceanography* 52:1789-1799.

Mocklin, J. A., D. J. Rugh, S. E. Moore, and R. P. Angliss. 2012. Using aerial photography to investigate evidence of feeding by bowhead whales. *Marine Mammal Science* 28:602-619.

Moore, S. E. 2000. Variability of Cetacean distribution and habitat selection in the Alaskan Arctic, autumn 1982-91. *Arctic* 53:448-460.

Moore, S. E., J. T. Clarke, and M. M. Johnson. 1993. Beluga Distribution and Movements Offshore Northern Alaska in Spring and Summer, 1980-84. Report of the International Whaling Commission.

Moore, S. E., D. P. DeMaster, and P. K. Dayton. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. *Arctic* 53:432-447.

Moore, S. E., J. C. George, G. Sheffield, J. Bacon, and C. J. Ashjian. 2010. Bowhead whale distribution and feeding near Barrow, Alaska, in late summer 2005–06. *Arctic*:195-205.

Moore, S. E., J. M. Grebmeier, and J. R. Davies. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. *Canadian Journal of Zoology-Revue Canadienne De Zoologie* 81:734-742.

Moore, S. E., and H. P. Huntington. 2008. Arctic marine mammals and climate change: impacts and resilience. *Ecological Applications 18*:S157-S165.

Moore, S. E., and K. L. Laidre. 2006. Trends in sea ice cover within habitats used by bowhead whales in the western Arctic. *Ecological Applications* 16:932-944.

Nelson, R. K., c1982. Harvest of the Sea: Coastal Subsistence in Modern Wainwright. North Slope Borough's Coastal Management Program, Barrow, AK.

NMFS. 2005. Final Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska. NOAA National Marine Fisheries Service, Alaska Region, Anchorage, AK.

NOAA. 1988. Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas. Rockville, MD.

NOAA Fisheries, 2014. NOAA's Aerial Surveys of Arctic Marine Mammals Photograph Walrus Haulout Site - Scientists Call Behavior a New Phenomenon. National Marine Fisheries Service, Alaska Regional Office, Anchorage, AK. Accessed online December 1 2014 at http://alaskafisheries.noaa.gov/newsreleases/2013/walrushaulout093013.htm.

NOAA Office of Response and Restoration, 2005. North Slope, Alaska, Environmental Sensitivity Index. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Seattle, WA.

NPFMC. 2009. Fishery Management Plan for Fish Resources of the Arctic Management Area. North Pacific Fishery Management Council, Anchorage, AK.

Oceana, 2013a. Important Ecological Areas of the Beaufort and Chukchi Seas. Oceana, Juneau, AK.

_____. 2013b. Oceana Comments on Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement, 78 FR 21347. Oceana, Juneau, AK.

Oceana, and Audubon Alaska, 2015. Marine Mammal Species Core Area Analysis. Juneau and Anchorage, AK.

Oppel, S., D. L. Dickson, and A. N. Powell. 2009. International importance of the eastern Chukchi Sea as a staging area for migrating king eiders. *Polar Biology* 32:775-783.

Pedersen, S. 1979a. Point Hope synopsis. *in Native Livelihood and Dependence: A Study of Land Use Values through Time*. U.S. Department of the Interior, Anchorage, AK.

_____. 1979b. Regional Subsistence Land Use, North Slope Borough, Alaska. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska.,

Petersen, M. R., W. W. Larned, and D. C. Douglas. 1999. At-sea distribution of Spectacled Eiders: A 120-year-old mystery resolved. *Auk* 116:1009-1020.

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.

Quakenbush, L., J. Citta, J. C. George, M. P. Heide-Jorgensen, R. Small, H. Brower, L. Harwood, B. Adams, L. Brower, G. Tagarook, C. Pokiak, and J. Pokiak. 2012. Seasonal Movements of the Bering-Chukchi-Beaufort Stock of Bowhead Whales: 2006-2011 Satellite Telemetry Results.

Quakenbush, L. T. 1988. *Phoca largha*. *in* J. Lentfer, editor. *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations*. Marine Mammal Commission, Washington, DC.

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 within a potential petroleum development area. *Arctic* 63:289-307.

Quakenbush, L. T., R. J. Small, and J. J. Citta. 2013. Satellite Tracking of Bowhead Whales: Movements and Analysis from 2006 to 2012. OCS Study BOEM 2013-01110, Anchorage, AK.

Robards, M., A. Kochnev, and S. Deming. 2007. Sharing Knowledge About Pacific Walrus (published map).

Rose, G. A. 2005. Capelin (*Mallotus villosus*) distribution and climate: a sea "canary" for marine ecosystem change. *ICES Journal of Marine Science* 62:1524-1530.

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* 31:11.

Schmutz, J. A., and D. J. Rizzolo. 2012. Monitoring Marine Birds of Concern in the Eastern Chukchi Nearshore Area (Loons). USGS and BOEM, Anchorage, AK.

Schonberg, S. V., J. T. Clarke, and K. H. Dunton. 2014. Distribution, abundance, biomass and diversity of benthic infauna in the Northeast Chukchi Sea, Alaska: Relation to environmental variables and marine mammals. *Deep Sea Research Part II: Topical Studies in Oceanography* 102:144-163.

Sexson, M. G., M. R. Petersen, and A. N. Powell. 2012. Spatiotemporal distribution of Spectacled Eiders throughout the annual cycle, *in 15th Alaska Bird Conference*. Anchorage, AK.

Smith, M., N. J. Walker, I. J. Stenhouse, C. M. Free, M. Kirchhoff, O. Romanenko, S. Senner, N. Warnock, and V. Mendenhall. 2014a. A new map of Important Bird Areas in Alaska, *in Alaska Bird Conference*. Juneau, AK.

Smith, M. A. 2010. *Arctic Marine Synthesis: Atlas of the Chukchi and Beaufort Seas*. Audubon Alaska and Oceana, Anchorage.

Smith, M. A., N. J. Walker, C. M. Free, M. J. Kirchhoff, G. S. Drew, N. Warnock, and I. J. Stenhouse. 2014b. Identifying marine Important Bird Areas using at-sea survey data. *Biological Conservation* 172:180-189.

Spall, M. A. 2007. Circulation and water mass transformation in a model of the Chukchi Sea. *Journal of Geophysical Research: Oceans (1978–2012)* 112.

Stephen R. Braund and Associates, 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Anchorage, AK.

Stephen R. Braund and Associates, and Institute of Social and Economic Research. 1993. North Slope Subsistence Study: Wainwright, 1988 and 1989. Technical Report No.147. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Social and Economic Studies, Anchorage, AK.

Stirling, I. 1997. The importance of polynyas, ice edges, and leads to marine mammals and birds. *Journal of Marine Systems* 10:9-21.

Stringer, W. J., and J. Groves. 1991. Location and areal extent of polynyas in the Bering and Chukchi Seas. *Arctic*:164-171.

Suydam, R., and Alaska Department of Fish and Game. 2004. Beluga whale coastal concentration areas. *in North Slope Borough Area Wide Comprehensive Plan*. North Slope Borough, Barrow, AK.

Suydam, R., 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. Coastal Marine Institute and US Department of the Interior, Minerals Management Service, Alaska OCS Region.

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*:451-467.

U.S. Geological Survey, 2009-2013. Walrus radio-tracking in the Chukchi Sea. U.S. Geological Survey, Anchorage, AK. Accessed online at http://alaska.usgs.gov/science/biology/walrus/2009animation_Norseman_low.html.

US DOI Fish and Wildlife Service. 2013. Comments on the Call for Information and Nominations for Proposed Oil and Gas Lease Sale 237 in the Chukchi Sea Planning Area. US DOI FWS, Anchorage, AK.

USFWS. 1995. Habitat Conservation Strategy for Polar Bears in Alaska.

_____. 2010. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. Federal Register.

Walker, N. J., and M. A. Smith, 2014. Alaska Waterbird Database v1. Audubon Alaska, Anchorage, AK.

Weingartner, T., E. Dobbins, S. Danielson, P. Winsor, R. Potter, and H. Statscewich. 2013. Hydrographic variability over the northeastern Chukchi Sea shelf in summer-fall 2008–2010. *Continental Shelf Research* 67:5-22.

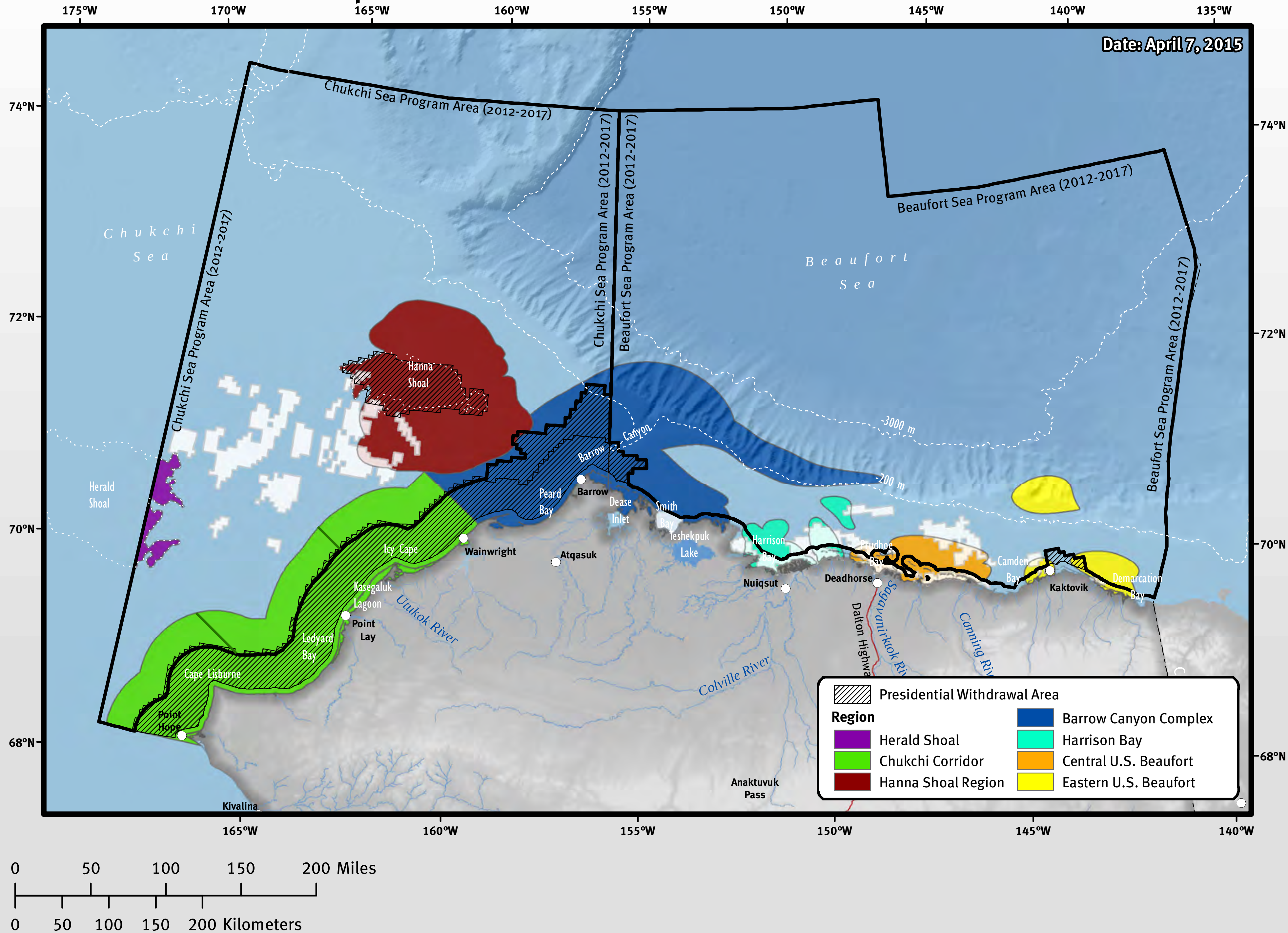
Weingartner, T. J., K. Aagaard, R. Woodgate, S. Danielson, Y. Sasaki, and D. Cavalieri. 2005. Circulation on the north central Chukchi Sea shelf. *Deep Sea Research Part II* 52:3150-3174.

Wilson, R. R., J. S. Horne, K. D. Rode, E. V. Regehr, and G. M. Durner. 2014. Identifying polar bear resource selection patterns to inform offshore development in a dynamic and changing Arctic. *Ecosphere* 5:art136.

Woodgate, R. A., K. Aagaard, and T. J. Weingartner. 2005. A year in the physical oceanography of the Chukchi Sea: Moored measurements from autumn 1990-1991. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3116-3149.

World Seabird Union, 2011. Seabird Information Network: North Pacific Seabird Data Portal. World Seabird Union, www.seabirds.net. Accessed online at http://axiom.seabirds.net/portal.php.

Important Areas of the U.S. Chukchi and Beaufort Seas



APPENDIX A

MAPS OF THE CHUKCHI SEA PROGRAM AREA

List of Figures

Fig 13. Beluga Whale Aerial Survey Fall Observations (September - October, 2000-2013)
Figs 14 and 15. Beluga Whale Fall Relative Density (September – October, 2000-2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)

Fig 16. Beluga and Bowhead Whale Spring Migration Corridors

1. Clarke et al. (2015)
2. Angliss and Outlaw (2008)
3. Audubon Alaska (2009), based on:
    a. Alaska Department of Fish and Game (2009)

Fig 17. Bowhead Whale Aerial Survey Fall Observations (September - October, 2000-2013)
Figs 18 and 19. Bowhead Whale Fall Relative Density (September – October, 2000-2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)

Fig 20. Bowhead Whale Fall Migration Concentration Areas (Telemetry from September 2008-2008)

1. Quakenbush et al. (2010)
2. Angliss and Outlaw (2008)
3. Audubon Alaska (2009), based on:
    a. Alaska Department of Fish and Game (2009)

Fig 21. Gray Whale Concentration Areas

1. Clarke et al. (2015)
2. Angliss and Outlaw (2008)

Fig 22. Gray Whale Aerial Survey Summer and Fall Observations (July - October, 2000-2013)
Fig 23. Gray Whale Summer and Fall Relative Density (July – October, 2000-2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)

Fig 24. Ice Seal Aerial Survey Summer and Fall Observations (July - October, 2000-2013)

1. NOAA Fisheries (2014)

Figs 25. Ringed Seal Winter and Spring Concentration Areas – Higher Quality Denning and Breeding Habitat

1. NOAA (1988)
2. Bengtson et al. (2005)
3. Frost et al. (2004)
4. Kelly et al. (2010)

Figs 26. Ringed Seal Fall Migration (Eight Juveniles, September 2001-2002)
Modified from:

1. Harwood et al. (2012)

Figs 27. Spotted Seal Concentration Areas

1. NOAA: Office of Response and Restoration (2005)
2. Huntington et al. (2012)
3. Lowry et al. (1998)
4. Rugh et al. (1997)
5. Alaska Department of Fish and Game Habitat and Restoration Division (2001)
6. Frost et al. (1993)
7. Boveng et al. (2009)

Fig 28. Combined Walrus Summer Foraging and Haulout Areas (Telemetry from June-Sept, 2008-2011)
Fig 29. Walrus Summer Foraging Areas, By Month (Telemetry from June-Sept, 2008-2011)

1. Robards et al. (2007)
2. Huntington et al. (2012)
3. Jay et al. (2012)
4. NOAA (1988)

Fig 30. Walrus Aerial Survey Summer Observations (July - August, 2000-2013)
Fig 31. Walrus Summer At-Sea Relative Density (July - August, 2000-2013)
Fig 32. Walrus Aerial Survey Fall Observations (September - October, 2000-2013)
Fig 33. Walrus Fall At-Sea Relative Density (September – October, 2000-2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)

Fig 34. Walrus Aerial Survey Summer and Fall Observations (July - October, 2000-2013)

1. NOAA Fisheries (2014)

Fig 35. Polar Bear Denning and Feeding Areas

1. USFWS (2010)
2. NOAA (1988)
3. US DOI Fish and Wildlife Service (2013)
4. Amstrup et al. (2005)

Fig 36. Predicted Polar Bear Habitat Use, By Season

1. Audubon Alaska (2014c), using resource selection models from:
    a. Durner et al. (2009)

Fig 37. Marine Bird Summer Nesting Colonies

1. World Seabird Union (2011)

Fig 38. Bird Observations, All Species (1974-2012)

1. Drew and Piatt (2013)
2. Walker and Smith (2014)
3. USFWS (2014)

Fig 39. Bird Observations (1974-2012): Survey Effort

1. Audubon Alaska (2014a), based on:
    a. Drew and Piatt (2013)
    b. Walker and Smith (2014)
    c. USFWS (2014)

Fig 40. Marine Birds: Relative Importance

1. Audubon Alaska (2015b), based on:
    a. Smith et al. (2014b)
    b. Drew and Piatt (2013)
    c. Walker and Smith (2014)

Fig 41. Important Bird Areas and Spectacled Eider Critical Habitat

1. Audubon Alaska (2014b), based on:
    a. Drew and Piatt (2013)
    b. Walker and Smith (2014)
    c. Smith et al. (2014a) and Smith et al. (2014b)
2. USFWS (2015)

Fig 42. Seabird and Marine Mammal Hotspots

1. Kuletz et al. (in press)

Fig 43. Important Ecological Area – Ecosystem Analysis

1. Oceana (2013b)

FIGURE REFERENCES

Alaska Department of Fish and Game. 2009. Summary maps of fall movements of bowhead whales in the Chukchi Sea.

Alaska Department of Fish and Game Habitat and Restoration Division. 2001. Oil Spill Contingency Planning: Most Environmentally Sensitive Areas (MESA) Along the Coast of Alaska, Volume I. ADFG, Anchorage, AK.

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.

Angliss, R. P., and R. B. Outlaw, 2008. Alaska marine mammal stock assessments, 2007.

Audubon Alaska, 2009. Bowhead Whale Extent of Range. Audubon Alaska, Anchorage, AK.

_____, 2013. Monthly Percent of Days with Sea Ice for the Northern Hemisphere, 2008-2012. Audubon Alaska, Anchorage, AK.

_____, 2014a. Analysis of Survey Effort for Marine Mammals, 1979-2012. Audubon Alaska, Anchorage, AK.

_____, 2014b. Important Bird Areas of Alaska, v3. Audubon Alaska, Anchorage, AK. Accessed online at http://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9.

_____, 2014c. Predicted Polar Bear Habitat Use, By Season. Audubon Alaska, Anchorage, AK.

_____, 2015a. Bathymetric Contours of the Arctic Ocean. Anchorage, AK.

_____, 2015b. Integrated Globally Significant Proportion. Anchorage, AK. Accessed online at

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.

BOEM. 2012. Chukchi Area Analytical Considerations Map *in* Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017. Department of the Interior, Bureau of Ocean Energy Management, Anchorage, AK.

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. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-200, Seattle, WA.

Braund, S. R., and D. Burnham. 1984. Subsistence Economics and Marine Resource Use Patterns. *in Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development*. Prepared by LGL Ecological Research Associates, Inc. Prepared for U.S. Department of Interior, Minerals Management Service and Department of Commerce, NOAA., Anchorage, AK.

Clarke, J. T., M. C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Arctic Region. *Aquatic Mammals*:94-103.

Drew, G. F., and J. Piatt, 2013. North Pacific Pelagic Seabird Database (NPPSD) v2. US Geological Survey Alaska Science Center & US Fish and Wildlife Service, Anchorage, AK.

Dunton, K. H., J. L. Goodall, S. V. Schonberg, J. M. Grebmeier, and D. R. Maidment. 2005. Multi-decadal synthesis of benthic-pelagic coupling in the western arctic: role of cross-shelf advective processes. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3462-3477.

Durner, G. M., D. C. Douglas, R. M. Nielson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. C. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. *Ecological Monographs* 79:107-120.

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. 2004. Factors affecting the observed densities of ringed seals, *Phoca hispida*, in the Alaskan Beaufort Sea, 1996-99. *Arctic* 57:115-128.

Grebmeier, J. M., L. W. Cooper, H. M. Feder, and B. I. Sirenko. 2006. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

_____. 2014. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

Harwood, L. A., T. G. Smith, and J. C. Auld, 2012. Fall migration of Ringed Seals (*Phoca hispida*) through the Beaufort and Chukchi seas, 2001-02 65.

Hauser, D. D., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). *Polar Biology*:1-13.

Huntington, H. P., M. Nelson, and L. T. Quakenbush. 2012. Traditional knowledge regarding walrus near Point Lay and Wainwright, Alaska.

Huntington, H. P., The Communties of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the eastern Chukchi and northern Bering Seas, Alaska. *Arctic* 52:49-61.

Impact Assessment Inc. 1989. Point Lay Case Study. Alaska OCS Social and Economic Studies Program, Technical Report No. 139. US Department of the Interior, Minerals Management Service, Anchorage, AK.

Jakobsson, M., L. Mayer, B. Coakley, J. A. Dowdeswell, S. Forbes, B. Fridman, H. Hodnesdal, R. Noormets, R. Pedersen, and M. Rebesco. 2012. The international bathymetric chart of the Arctic Ocean (IBCAO) version 3.0. *Geophysical Research Letters* 39.

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.

Kassam, K.-A. S., and Wainwright Traditional Council. 2001. *Passing on the knowledge : mapping human ecology in Wainwright, Alaska*. Arctic Institute of North America, Calgary.

Kelly, B. P., J. Bengtson, P. Boveng, M. Cameron, S. Dahle, J. Jansen, E. Logerwell, J. Overland, C. Sabine, and G. Waring. 2010. Status Review of the Ringed Seal (*Phoca hispida)*.

Kuletz, K. J., M. C. Ferguson, B. Hurley, A. E. Gall, E. A. Labunski, and T. C. Morgan. in press. Seasonal spatial patterns in seabird and marine mammal distribution in the Pacific Arctic: identifying biologically important pelagic areas. *Progress in Oceanography* 00:000-000.

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.

National Snow and Ice Data Center, 2013. IMS Daily Northern Hemisphere Snow and Ice Analysis at 4 km and 24 km Resolution. NSIDC, Boulder, CO. Accessed online at http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html#acq_proc):.

Nelson, R. K., c1982. Harvest of the Sea: Coastal Subsistence in Modern Wainwright. North Slope Borough's Coastal Management Program, Barrow, AK.

NOAA. 1988. Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas. Rockville, MD.

NOAA Fisheries, 2014. Aerial Survey of Arctic Marine Mammals, 1979-2013 (ASAMM; including the Historical BWASP and COMIDA Databases). NOAA Fisheries, Alaska Fisheries Science Center, National Marine Mammal Labratory, Anchorage, AK. Accessed online December 2014 at http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php.

NOAA: Office of Response and Restoration, 2005. Environmental sensitivity index, version 3.0. Seattle, WA. Accessed online at http://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html#Alaska.

Oceana, 2013a. Beluga Summer High Concentration Areas. Juneau, AK.

_____. 2013b. Oceana Comments on Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement, 78 FR 21347. Oceana, Juneau, AK.

Oceana, and Audubon Alaska, 2014a. Interpolated Benthic Biomass. Audubon Alaska, Anchorage, AK.

_____, 2014b. Interpolated Primary Productivity. Juneau, AK.

_____, 2015. Marine Mammal Species Core Area Analysis. Juneau and Anchorage, AK.

Pedersen, S. 1979a. Point Hope synopsis. *in Native Livelihood and Dependence: A Study of Land Use Values through Time*. U.S. Department of the Interior, Anchorage, AK.

_____. 1979b. Regional Subsistence Land Use, North Slope Borough, Alaska. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska., Fairbanks, AK.

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 within a potential petroleum development area. *Arctic* 63:289-307.

Robards, M., A. Kochnev, and S. Deming. 2007. Sharing Knowledge About Pacific Walrus (published map).

Rugh, D. J., K. E. Sheldon, and D. E. Withrow. 1997. Spotted Seals, Phoca largha, in Alaska. *Marine Fisheries Review* 59:1-18.

Smith, M., N. J. Walker, I. J. Stenhouse, C. M. Free, M. Kirchhoff, O. Romanenko, S. Senner, N. Warnock, and V. Mendenhall. 2014a. A new map of Important Bird Areas in Alaska, *in Alaska Bird Conference*. Juneau, AK.

Smith, M. A., N. J. Walker, C. M. Free, M. J. Kirchhoff, G. S. Drew, N. Warnock, and I. J. Stenhouse. 2014b. Identifying marine Important Bird Areas using at-sea survey data. *Biological Conservation* 172:180-189.

Stephen R. Braund and Associates. 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Bureau of Ocean Energy Management, MMS OCS Study No. 2009-003. Anchorage, Alaska.

_____. 2013. COMIDA: Impact Monitoring for Offshore Subsistence Hunting, Wainwright and Point Lay, Alaska. U.S. Department of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region, Anchorage, Alaska.

Stephen R. Braund and Associates, and Institute of Social and Economic Research. 1993a. North Slope Subsistence Study: Barrow, 1987, 1988, and 1989. Technical Report No. 149. U.S. Department of Interior, Minerals Management Service, Alaska OCS Region, Social and Economic Studies, Anchorage, AK.

_____. 1993b. North Slope Subsistence Study: Wainwright, 1988 and 1989. Technical Report No.147. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Social and Economic Studies, Anchorage, AK.

US Fish and Wildlife Service: Marine Mammals Management, 2013. Hanna Shoal Walrus Use Area Outer Boundary.

USFWS. 2010. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. Federal Register.

_____, 2014. At-Sea Surveys of Seabirds from Ships of Opportunity. USFWS, Anchorage, AK.

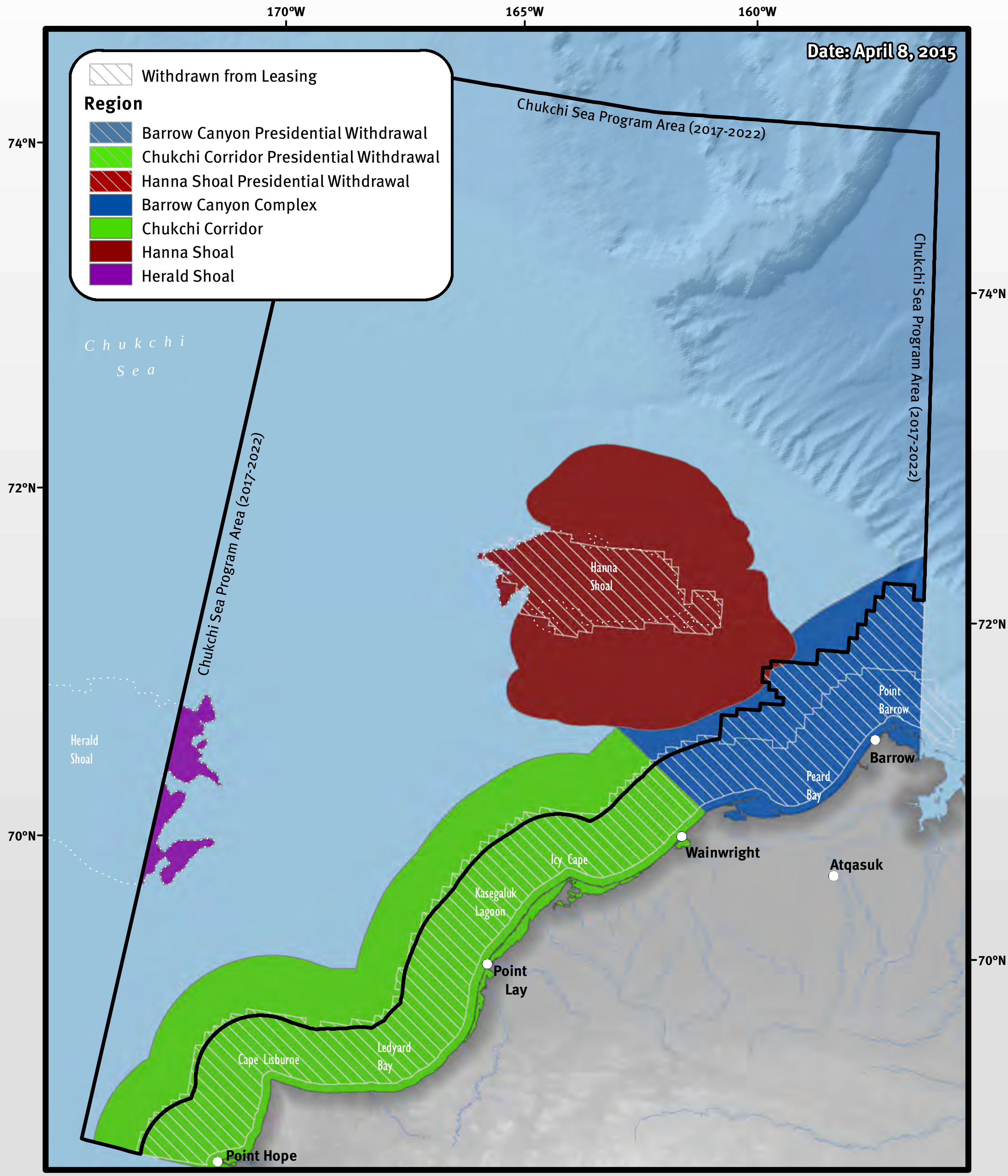
_____, 2015. FWS Critical Habitat for Threatened and Endangered Species. Accessed online at http://ecos.fws.gov/crithab/.

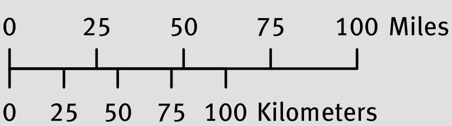
Walker, N. J., and M. A. Smith, 2014. Alaska Waterbird Database v1. Audubon Alaska, Anchorage, AK.

World Seabird Union, 2011. Seabird Information Network: North Pacific Seabird Data Portal. World Seabird Union, www.seabirds.net. Accessed online at http://axiom.seabirds.net/portal.php.

Figure 1.

Important Areas of the U.S. Chukchi Sea





These important areas were drawn using the following wildlife and habitat areas:

Walrus concentration areas: (1) Summer foraging, 50% isopleth, Jay et al. 2012. (2) Walrus Use Area, USFWS 2013.

Important Bird Areas: (3) Audubon Alaska 2014b. Based on: (a) Drew and Piatt 2013. (b) Smith et al. 2014a,b. (c) Walker and Smith 2014.

Bowhead whale fall core areas: (4) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.

Gray whale summer/fall core areas: (5) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.

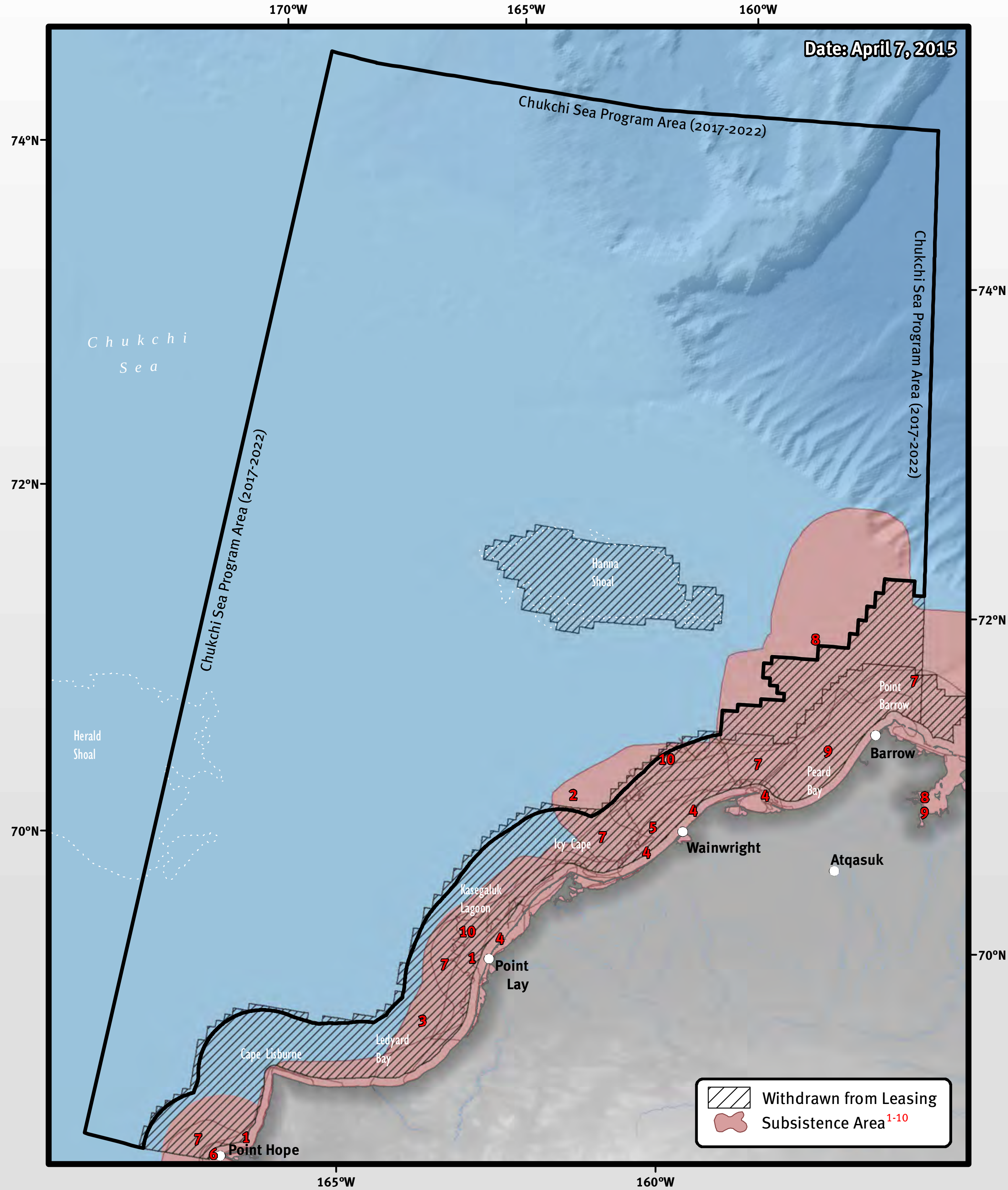
Beluga whale summer core area (Barrow Canyon): (6) Hauser et al. 2014.

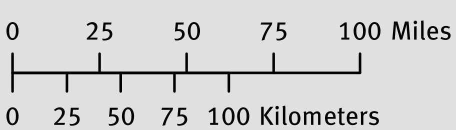
Hanna and Herald Shoal: (7) -40 m isobaths, Audubon Alaska 2015a. Based on: (a) IBCAO v3, Jakobsson et al. 2012.

Zone of life: 50-mile buffer of the coastline: These areas are well supported with additional data documenting wildlife concentration areas and key habitats, as shown by the associated set of ecological maps and described in the accompanying report.

Figure 2.

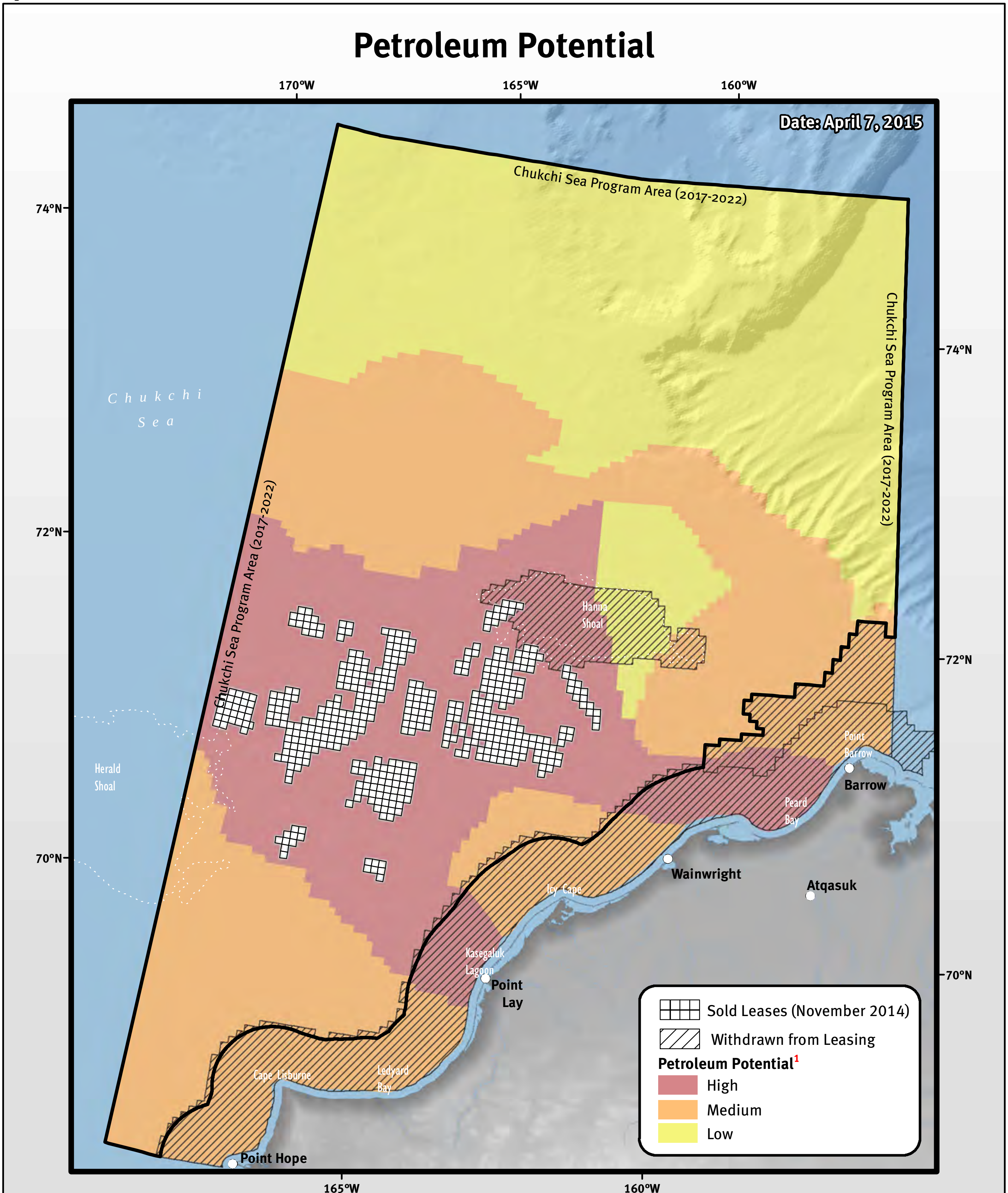
Summary of Publicly Available Subsistence Studies





Principal Sources (labeled on map): (1) Braund and Burnham 1984. (2) Stephen R. Braund and Associates and Institute for Social and Economic Research 1993a. (3) IAI 1989. (4) Kassam and Wainwright Traditional Council 2001. (5) Nelson c1982. (6) Pedersen 1979a. (7) Pedersen 1979b. (8) Stephen R. Braund and Associates 2010. (9) Stephen R. Braund and Associates and Institute for Social and Economic Research 1993b. (10) Stephen R. Braund and Associates 2013.

Figure 3.



Principal Sources: (1) BOEM 2012.

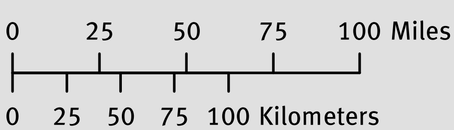
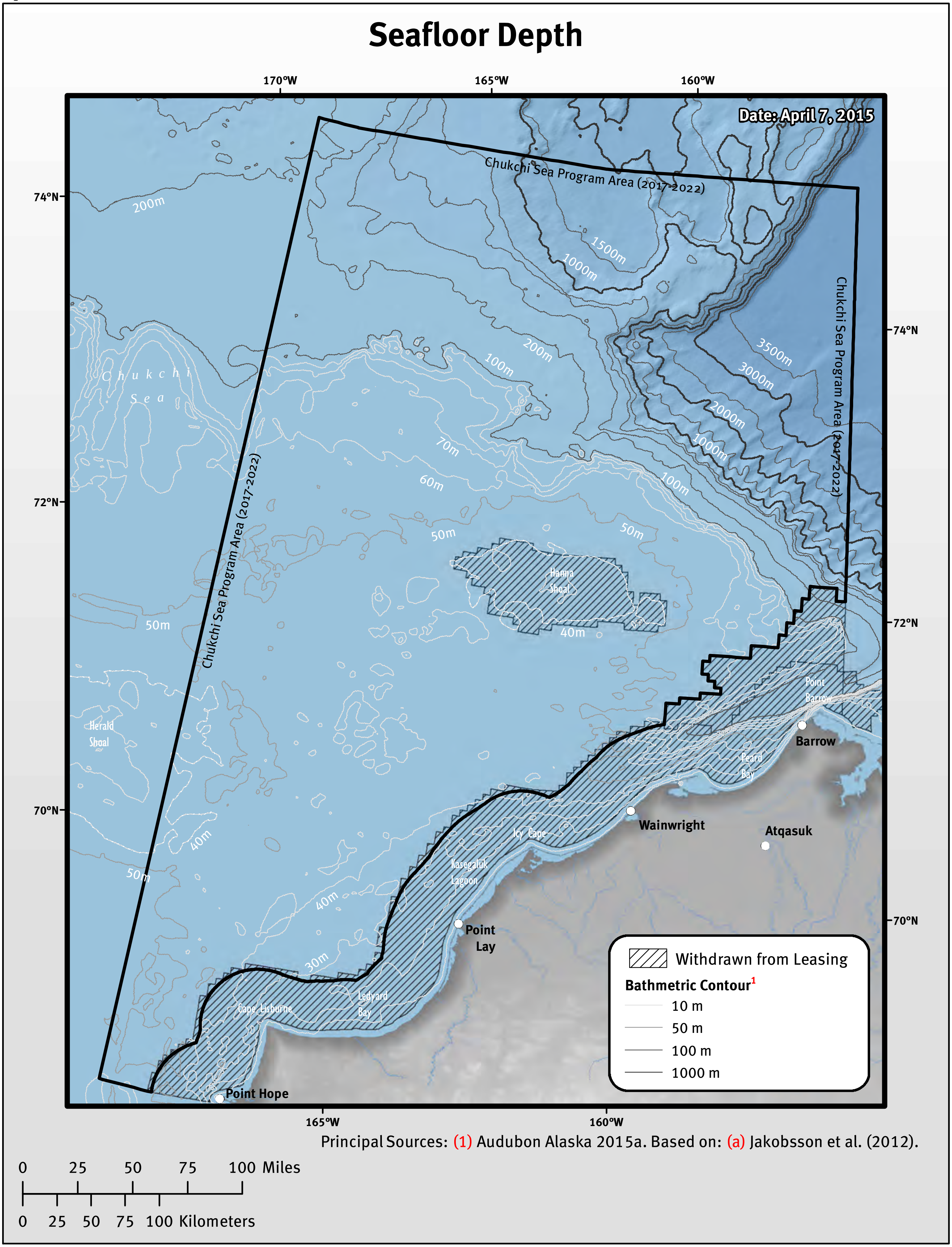


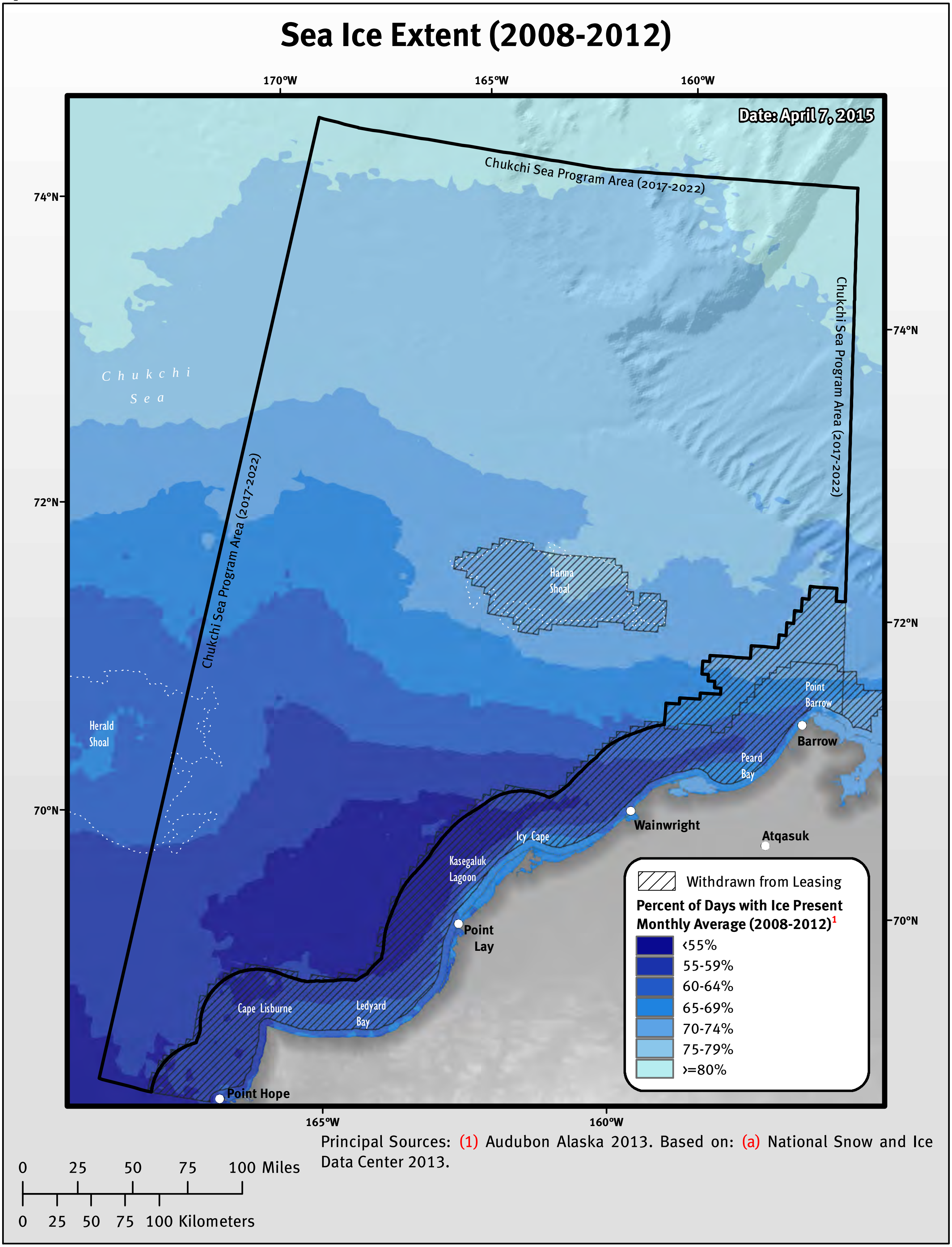
Figure 4.

Seafloor Depth



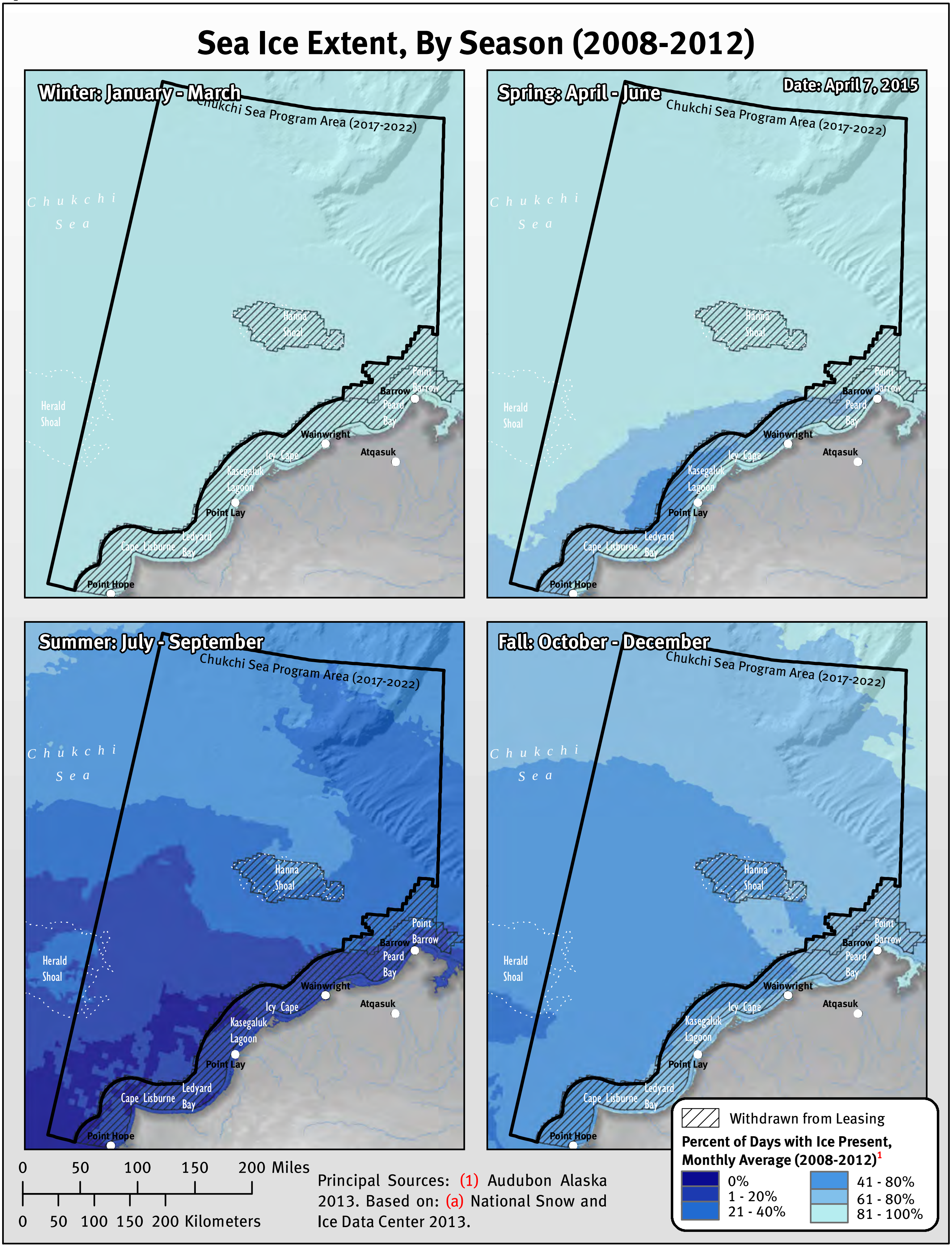
Principal Sources: (1) Audubon Alaska 2015a. Based on: (a) Jakobsson et al. (2012).

Figure 5.



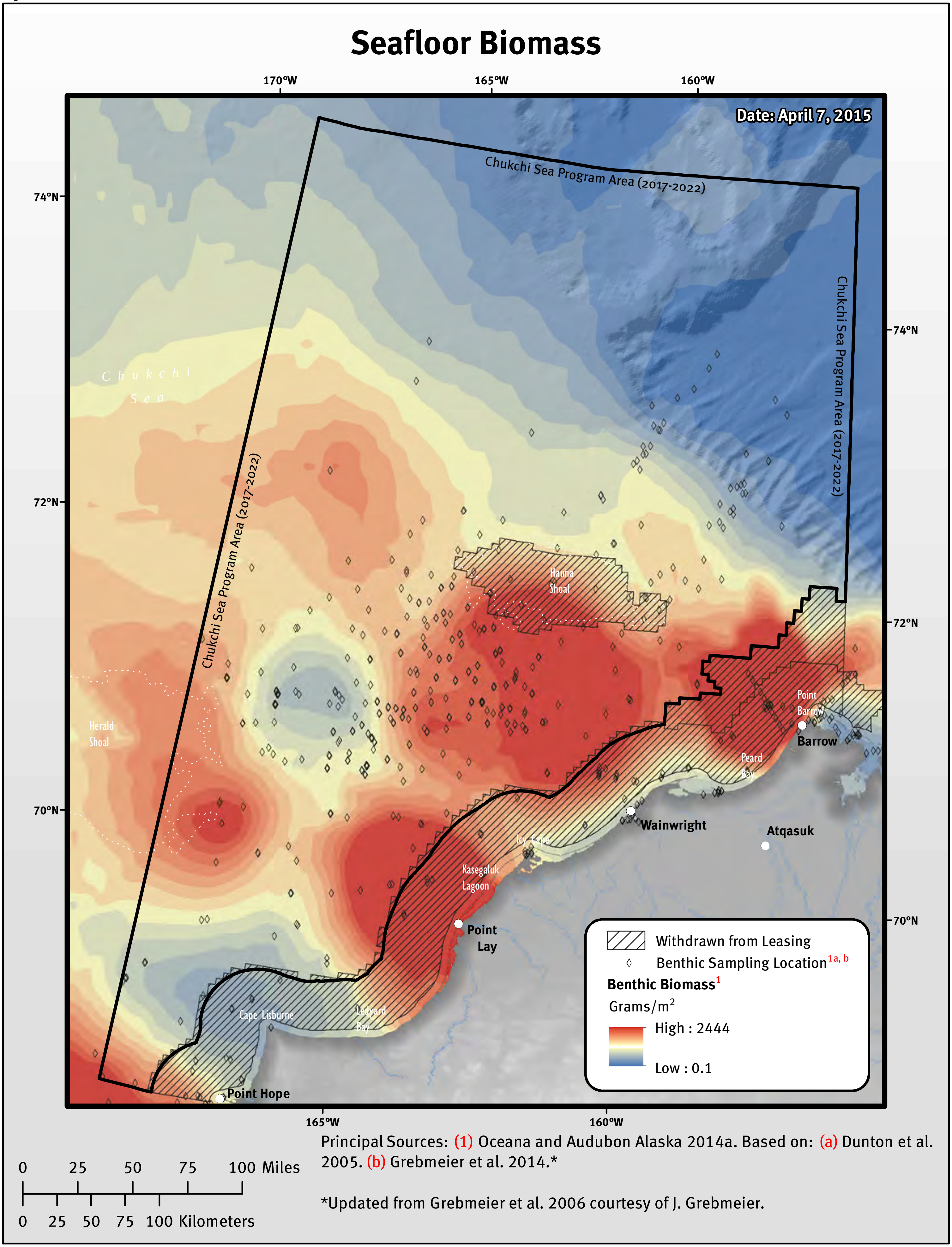
Principal Sources: (1) Audubon Alaska 2013. Based on: (a) National Snow and Ice Data Center 2013.

Figure 6.



Sea Ice Extent, By Season (2008-2012)
Winter: January - March
Spring: April - June
Summer: July - September
Fall: October - December
Date: April 7, 2015
Chukchi Sea Program Area (2017-2022)
Chukchi Sea
Hanna Shoal
Herald Shoal
Point Barrow
Barrow
Peard Bay
Wainwright
Atqasuk
Icy Cape
Kasegaluk Lagoon
Point Lay
Ledyard Bay
Cape Lisburne
Point Hope
0 50 100 150 200 Miles
0 50 100 150 200 Kilometers
Principal Sources: (1) Audubon Alaska 2013. Based on: (a) National Snow and Ice Data Center 2013.
Withdrawn from Leasing
Percent of Days with Ice Present, Monthly Average (2008-2012)[1]
0%
1 - 20%
21 - 40%
41 - 80%
61 - 80%
81 - 100%

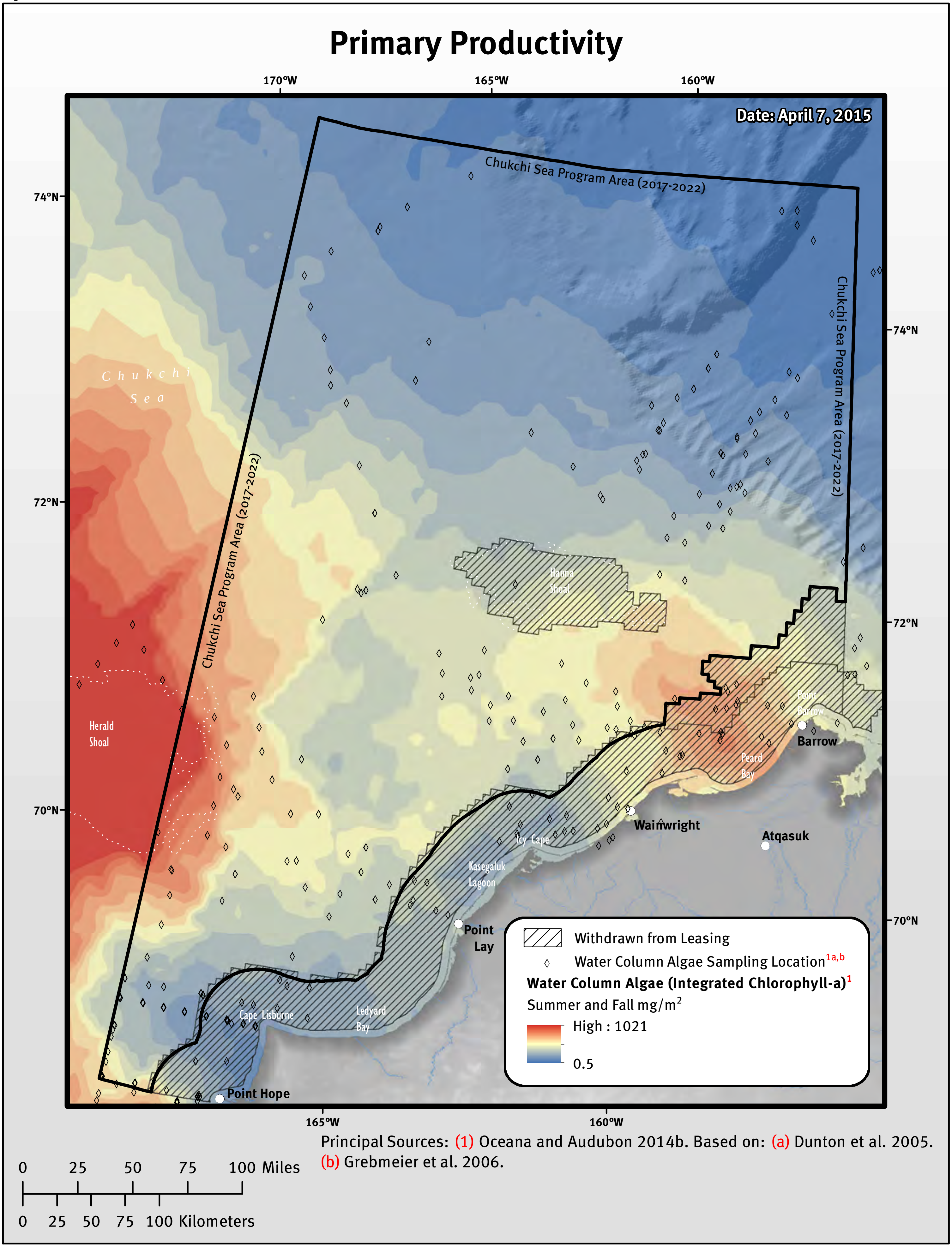
Figure 7.



Principal Sources: (1) Oceana and Audubon Alaska 2014a. Based on: (a) Dunton et al. 2005. (b) Grebmeier et al. 2014.*

*Updated from Grebmeier et al. 2006 courtesy of J. Grebmeier.

Figure 8.



Principal Sources: (1) Oceana and Audubon 2014b. Based on: (a) Dunton et al. 2005. (b) Grebmeier et al. 2006.

Figure 9.

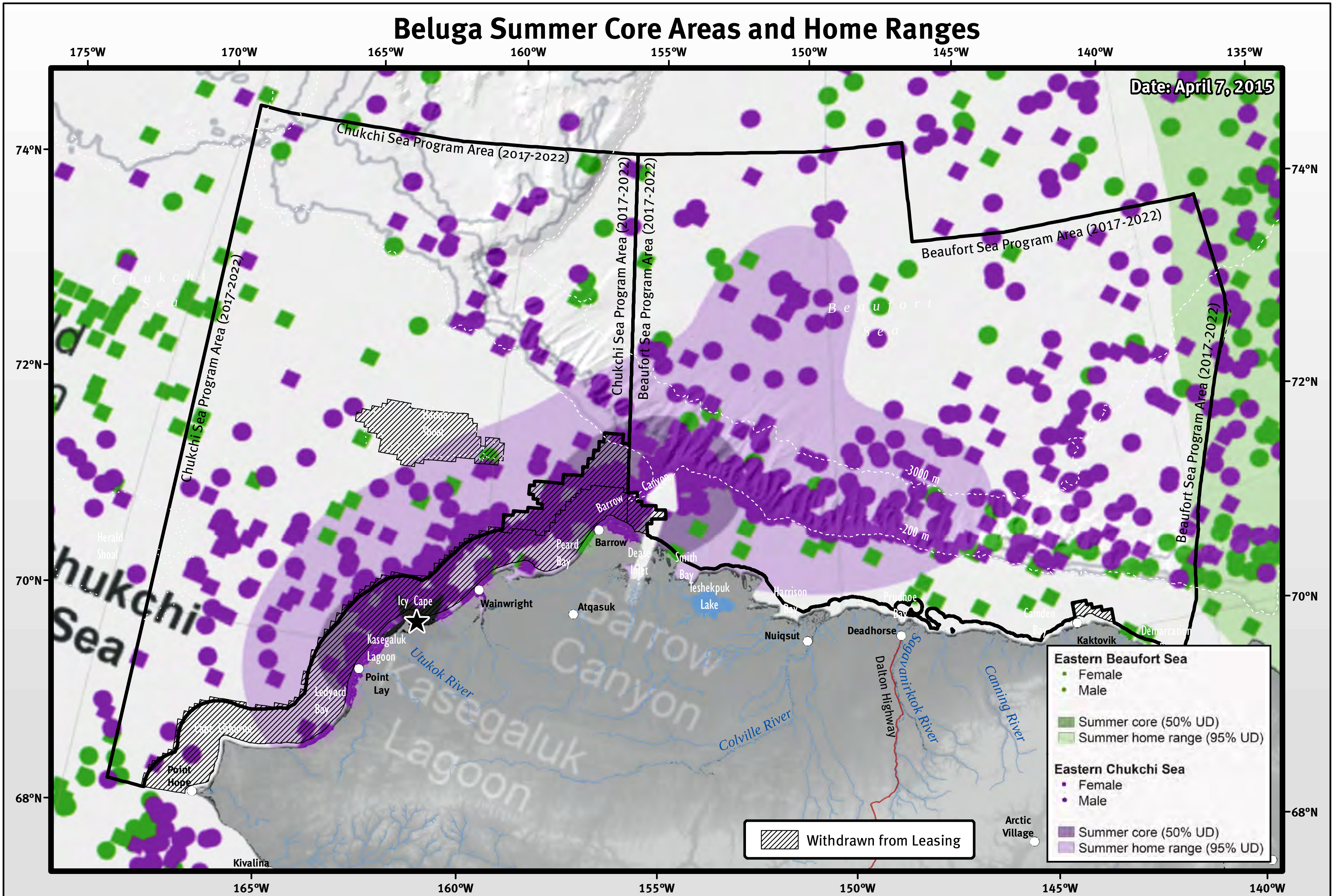
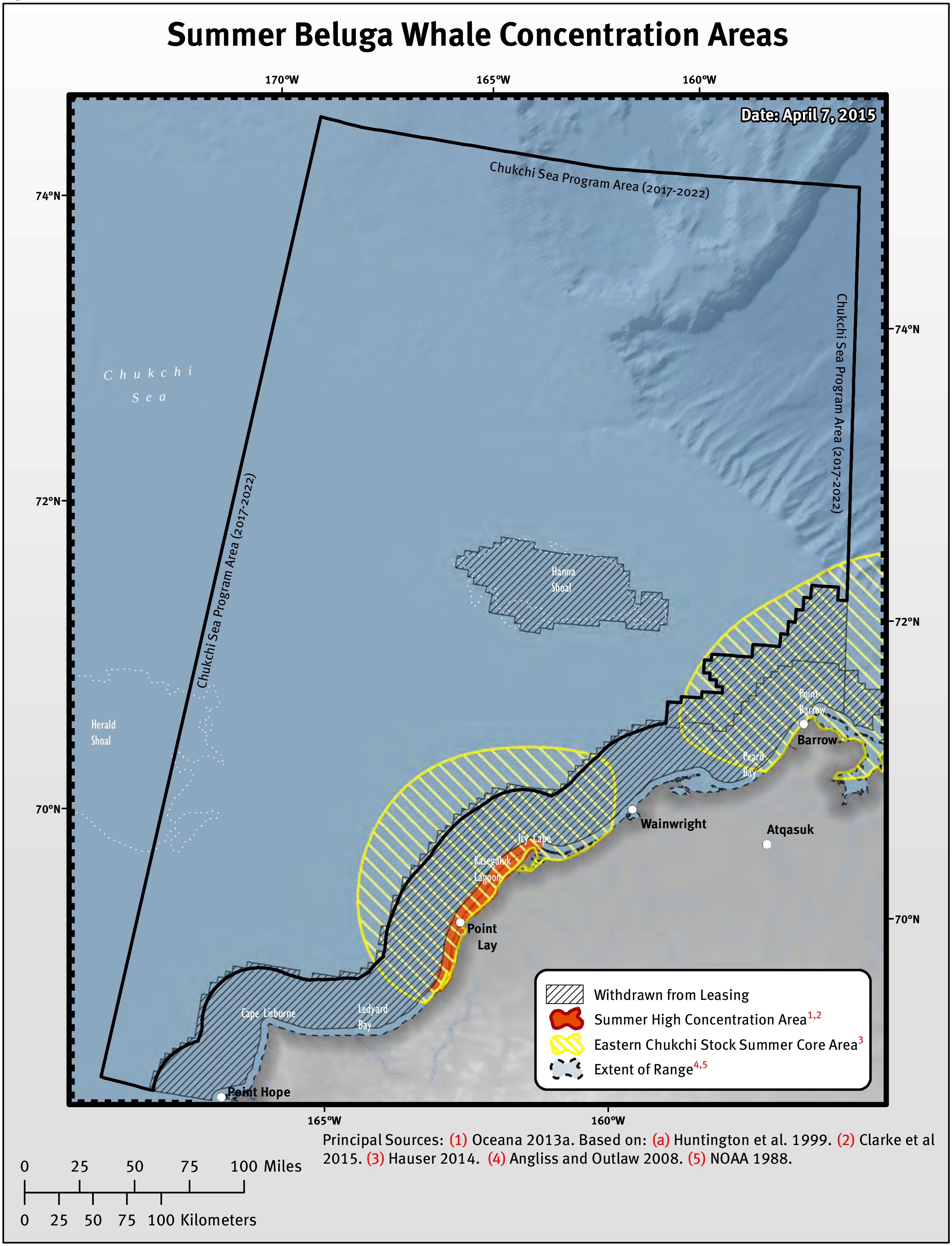


Figure modified from Hauser et al. 2014.

Daily locations of BS and ECS satellite-tagged beluga whales (n = 40 and 24, respectively), July–November, and place names mentioned in the text. Shaded polygons represent the summer (i.e., July and August) core areas [50 % probability contour of the utilization distribution (UD)] and home range (95 % probability). Black stars indicate approximate tagging locations.

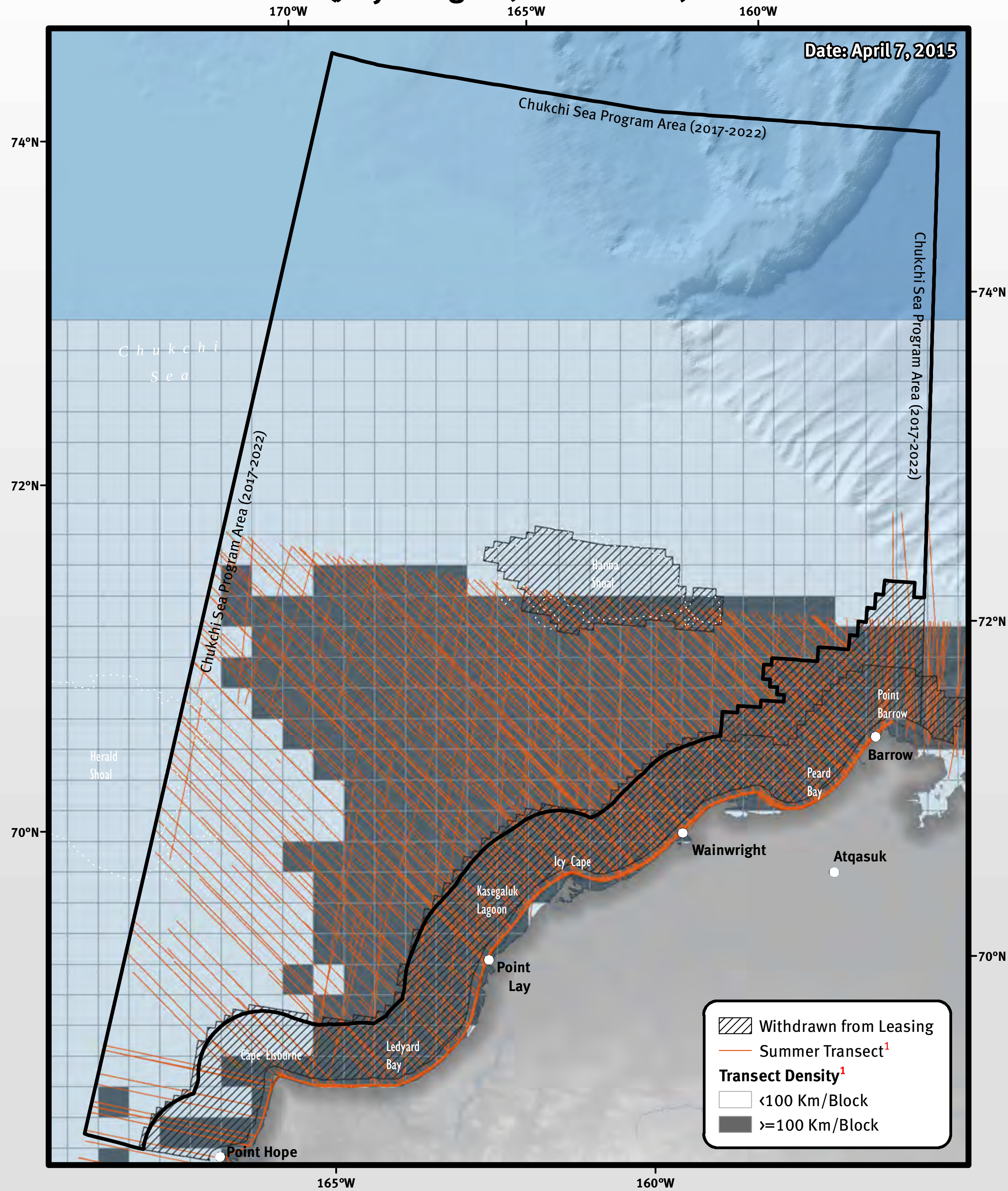
Figure 10.

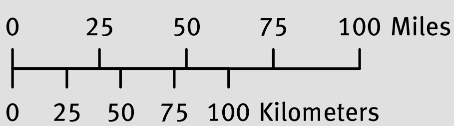


Principal Sources: (1) Oceana 2013a. Based on: (a) Huntington et al. 1999. (2) Clarke et al 2015. (3) Hauser 2014. (4) Angliss and Outlaw 2008. (5) NOAA 1988.

Figure 11.

Marine Mammal Aerial Survey Summer Transects
(July - August, 2000-2013)

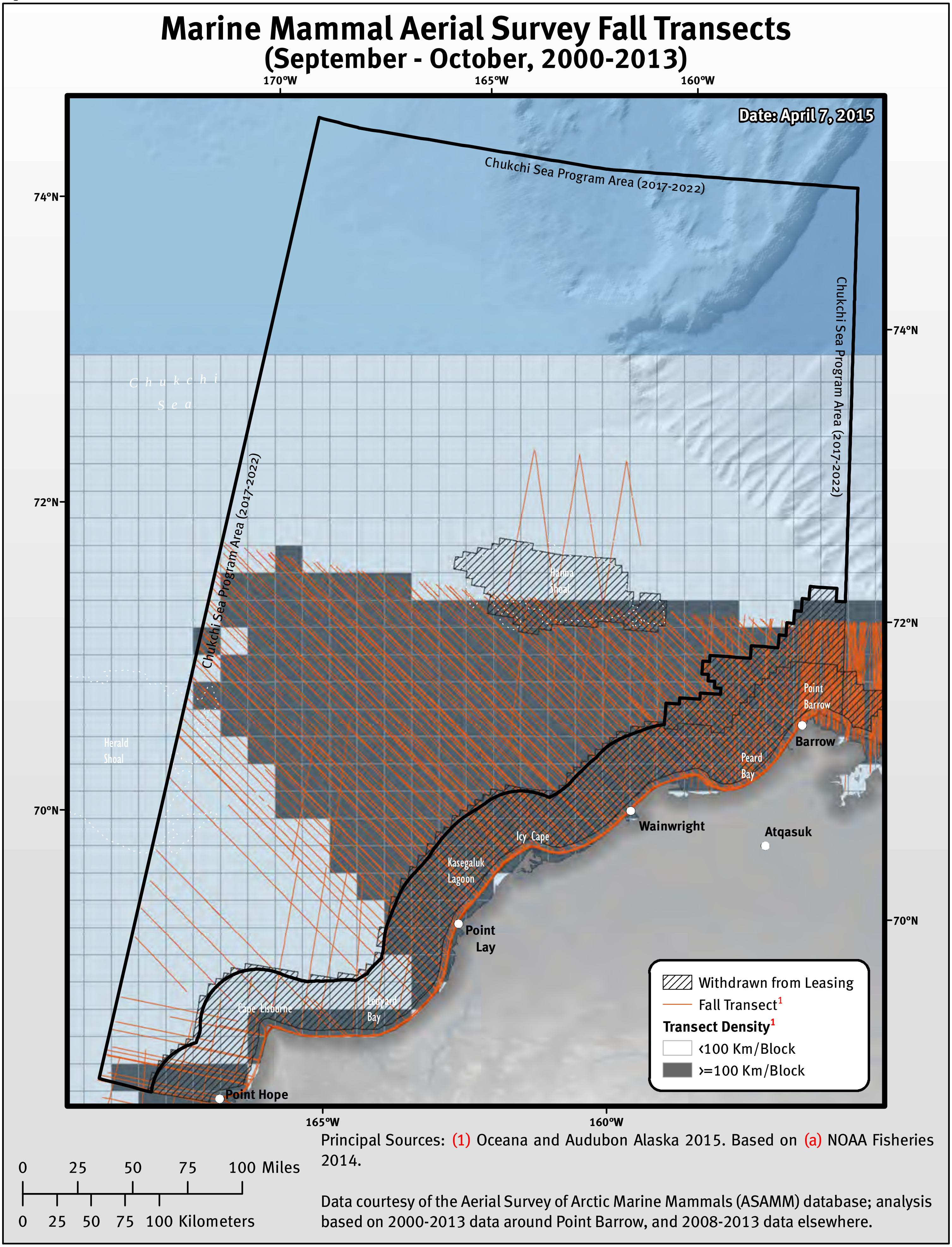




Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 12.

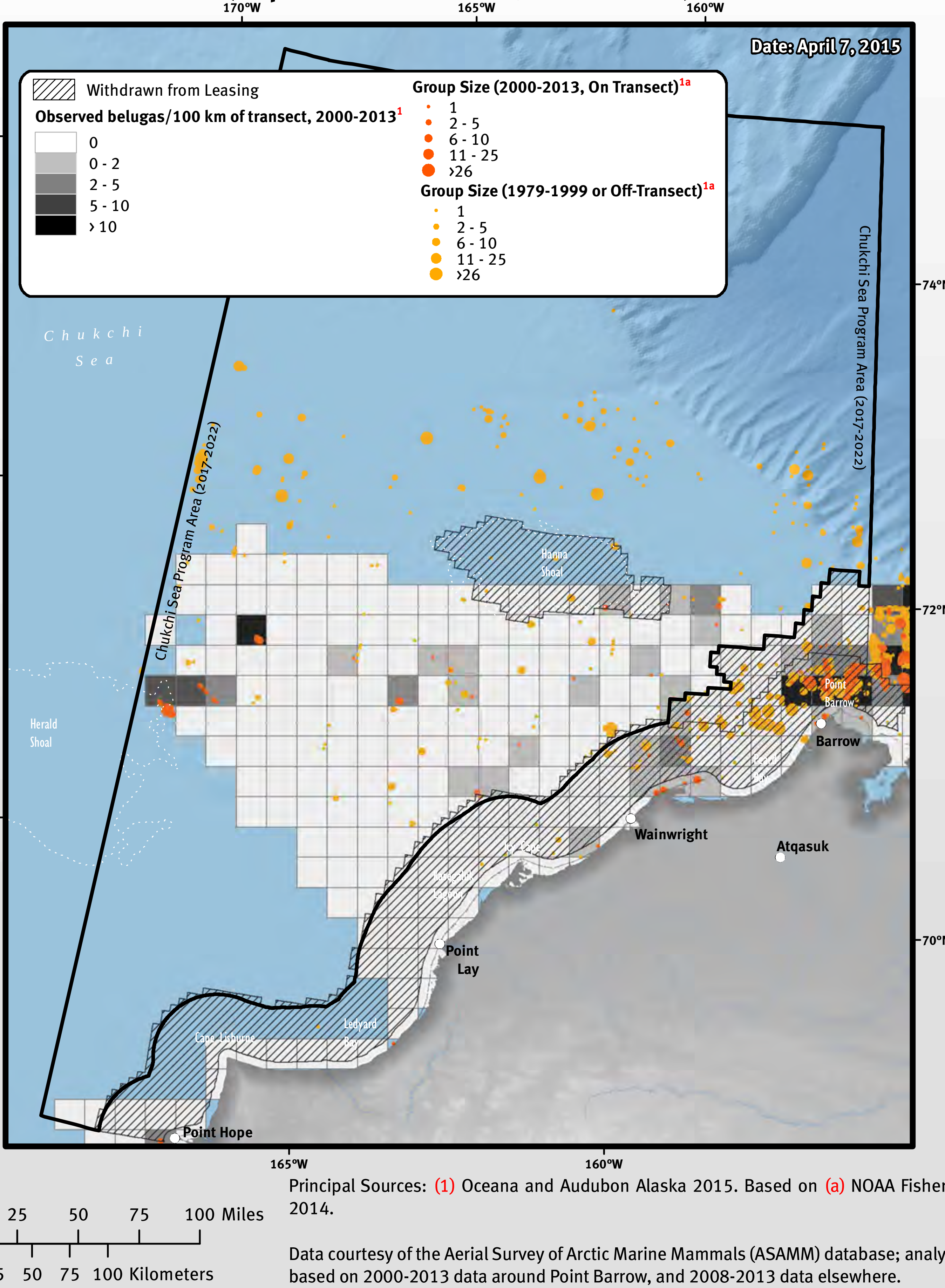


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 13.

Beluga Whale Aerial Survey Fall Observations
(September - October, 2000-2013)



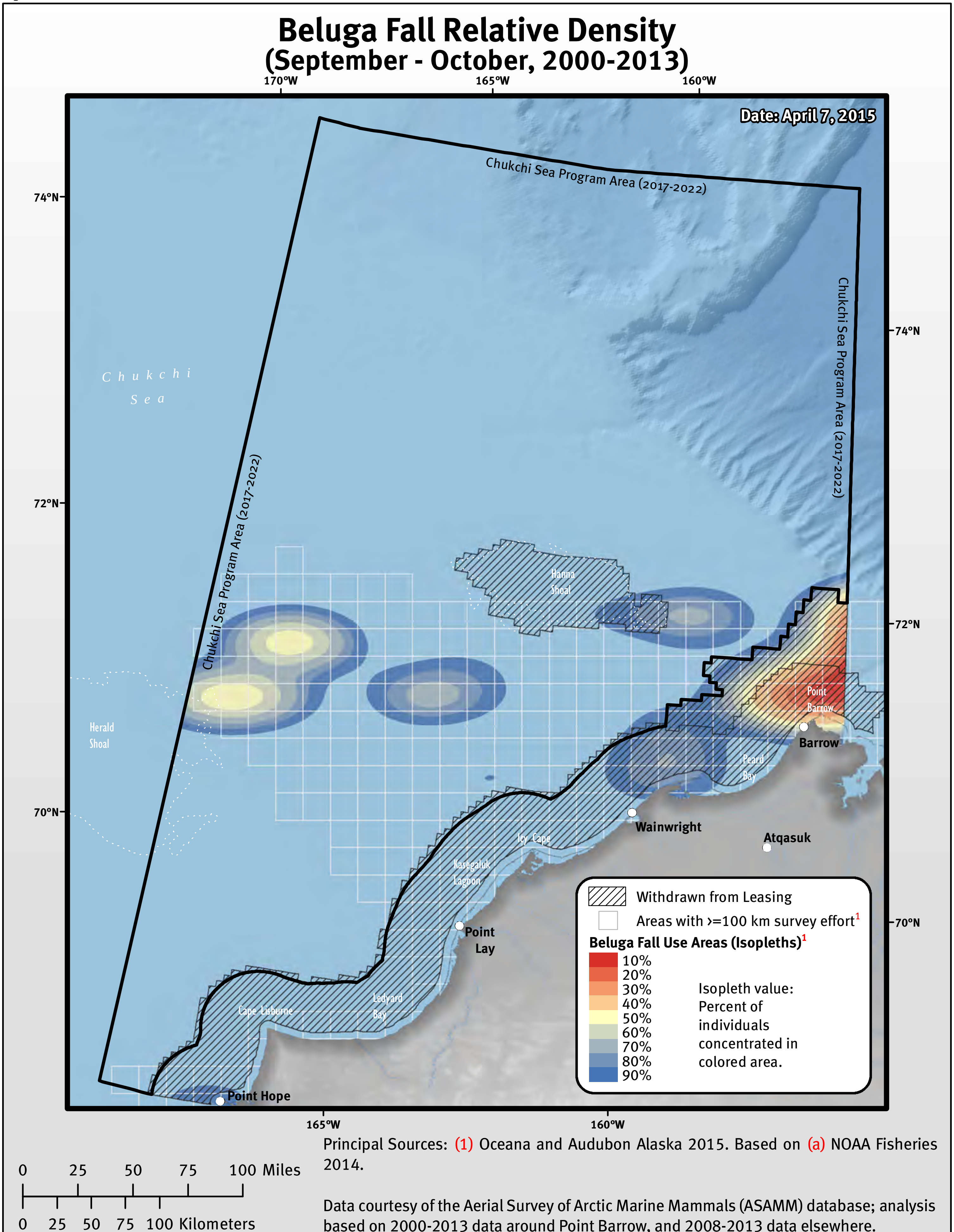
Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

0 25 50 75 100 Miles

0 25 50 75 100 Kilometers

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

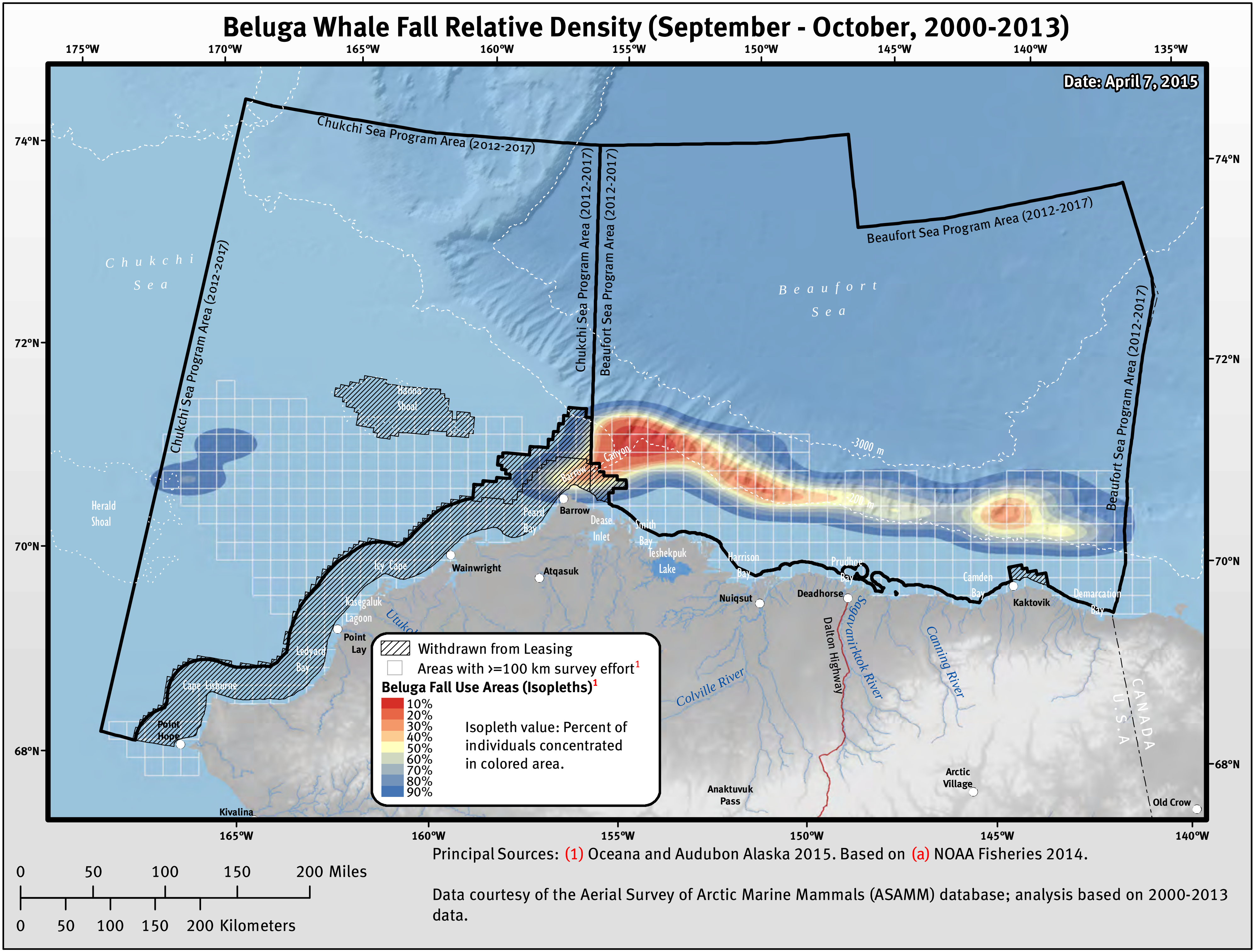
Figure 14.



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 15.

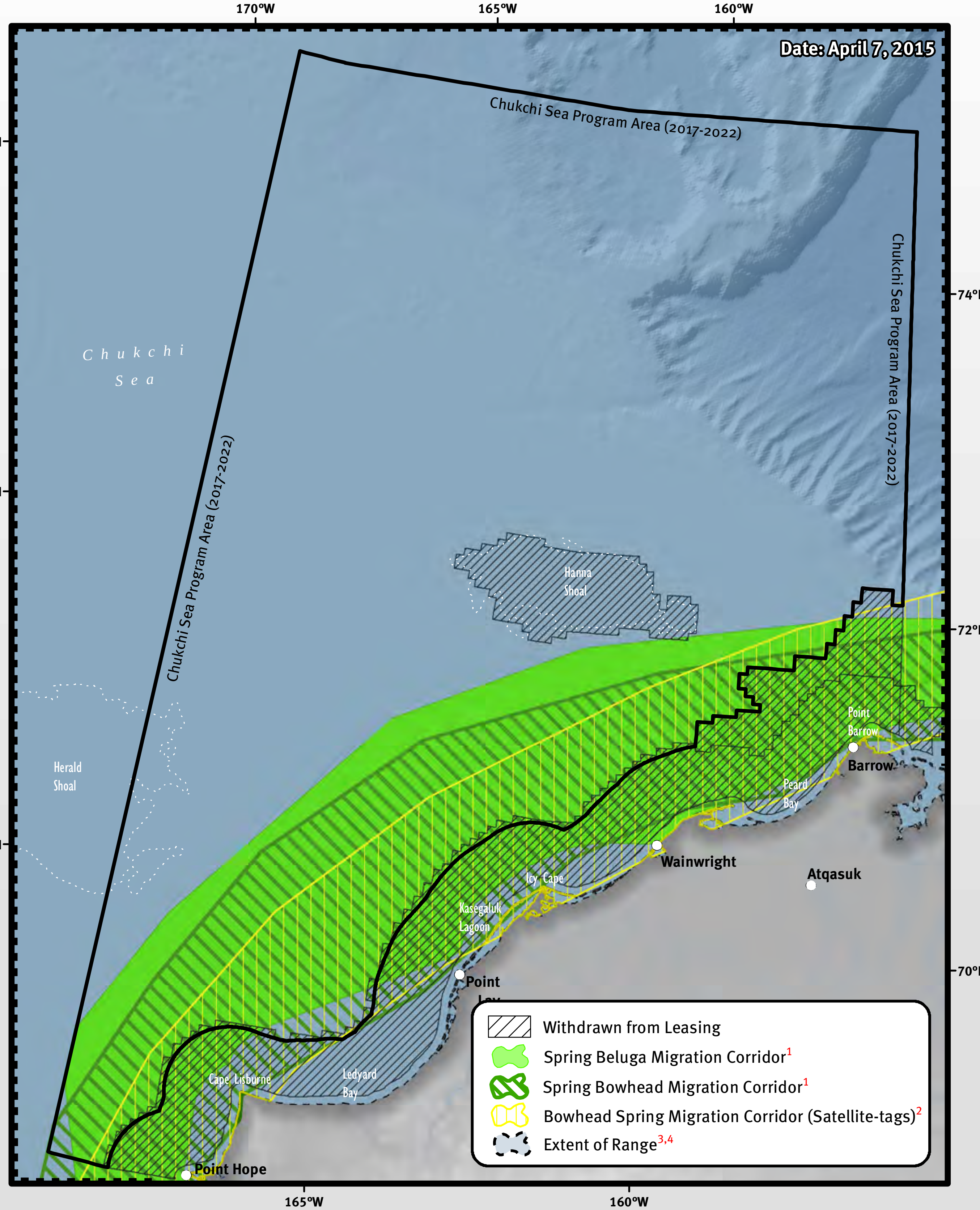


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.

Figure 16.

Beluga and Bowhead Whale Spring Migration Corridors



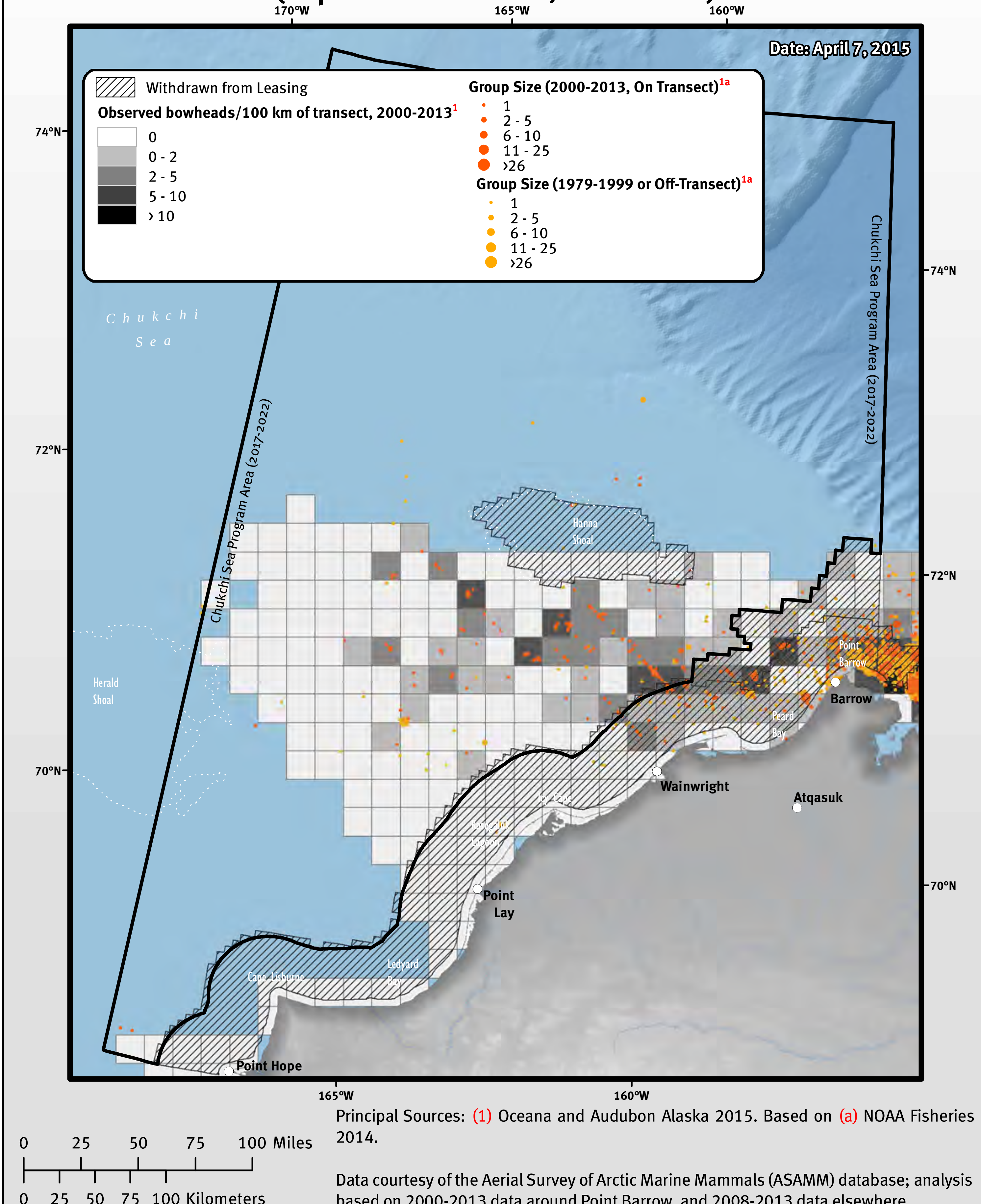
Principal Sources: (1) Clarke et al. 2015. (2) Quakenbush 2013. (3) Angliss and Outlaw 2008. (4) NOAA 1988.

0 25 50 75 100 Miles

0 25 50 75 100 Kilometers

Figure 17.

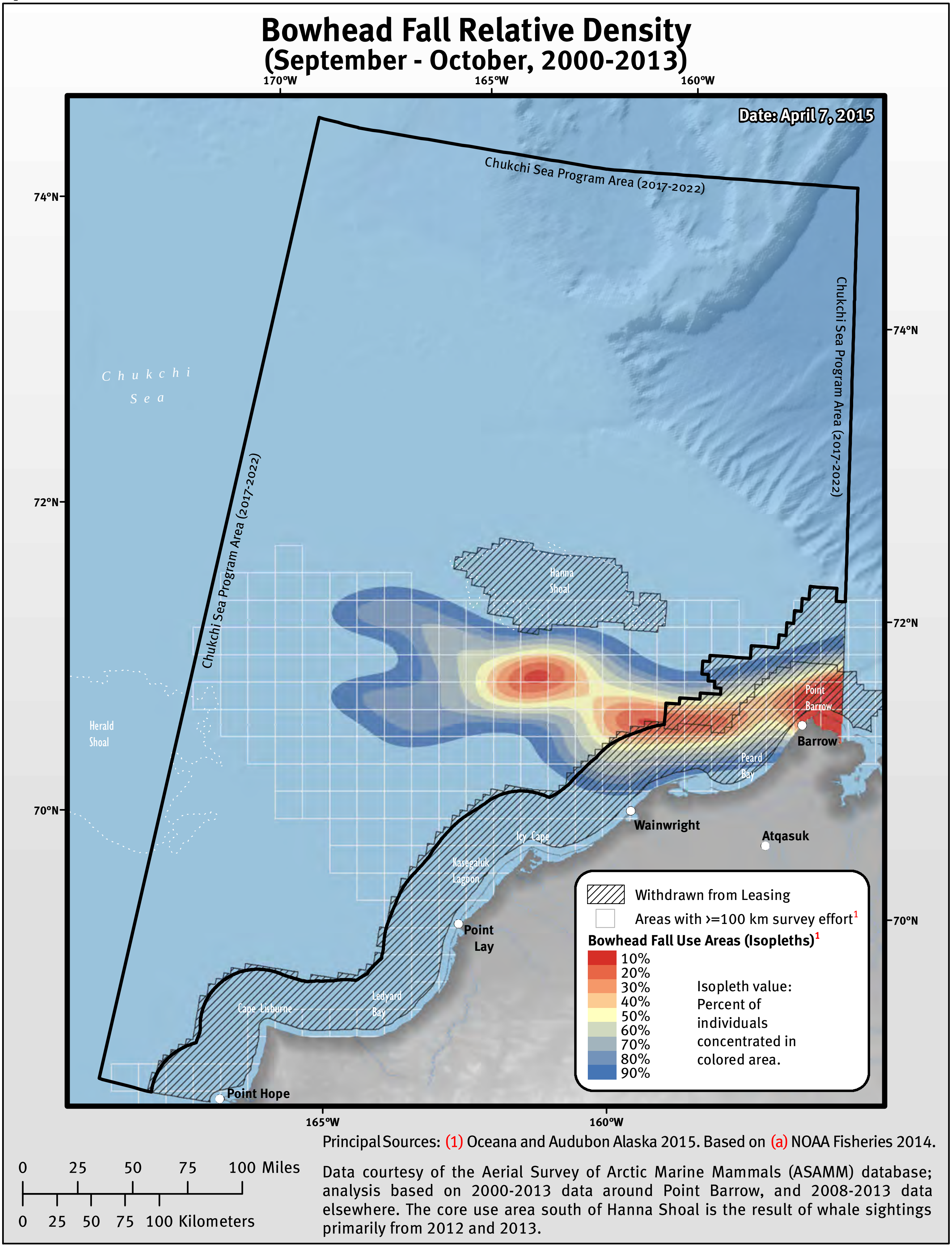
Bowhead Whale Aerial Survey Fall Observations
(September - October, 2000-2013)



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 18.

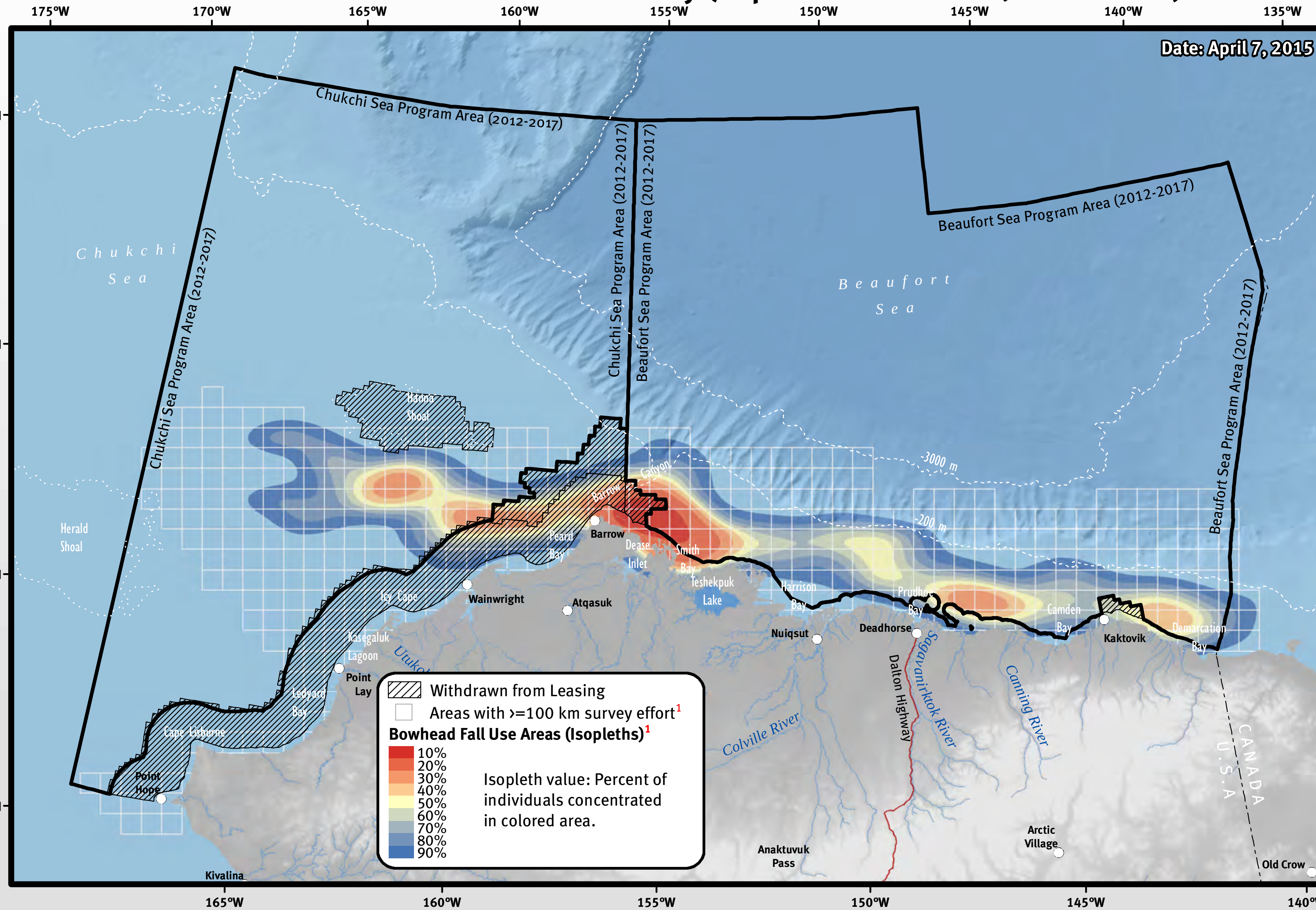


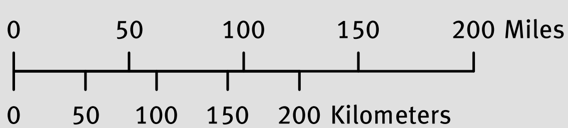
Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere. The core use area south of Hanna Shoal is the result of whale sightings primarily from 2012 and 2013.

Figure 19.

Bowhead Whale Fall Relative Density (September - October, 2000-2013)



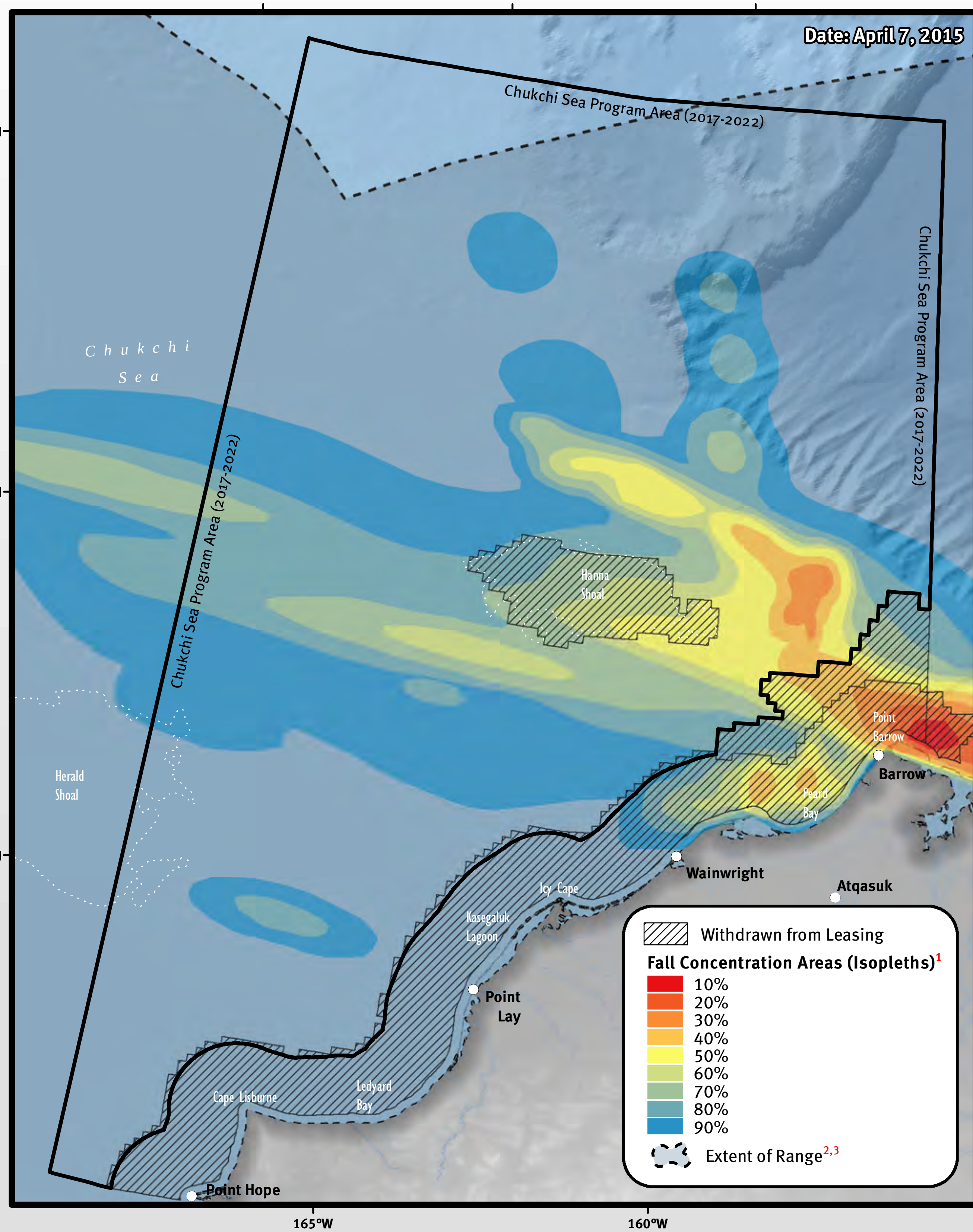


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data. The core use area south of Hanna Shoal is the result of whale sightings primarily from 2012 and 2013.

Figure 20.

Bowhead Whale Fall Migration Concentration Areas
(Telemetry from September 2006-2008)



0 25 50 75 100 Miles

0 25 50 75 100 Kilometers

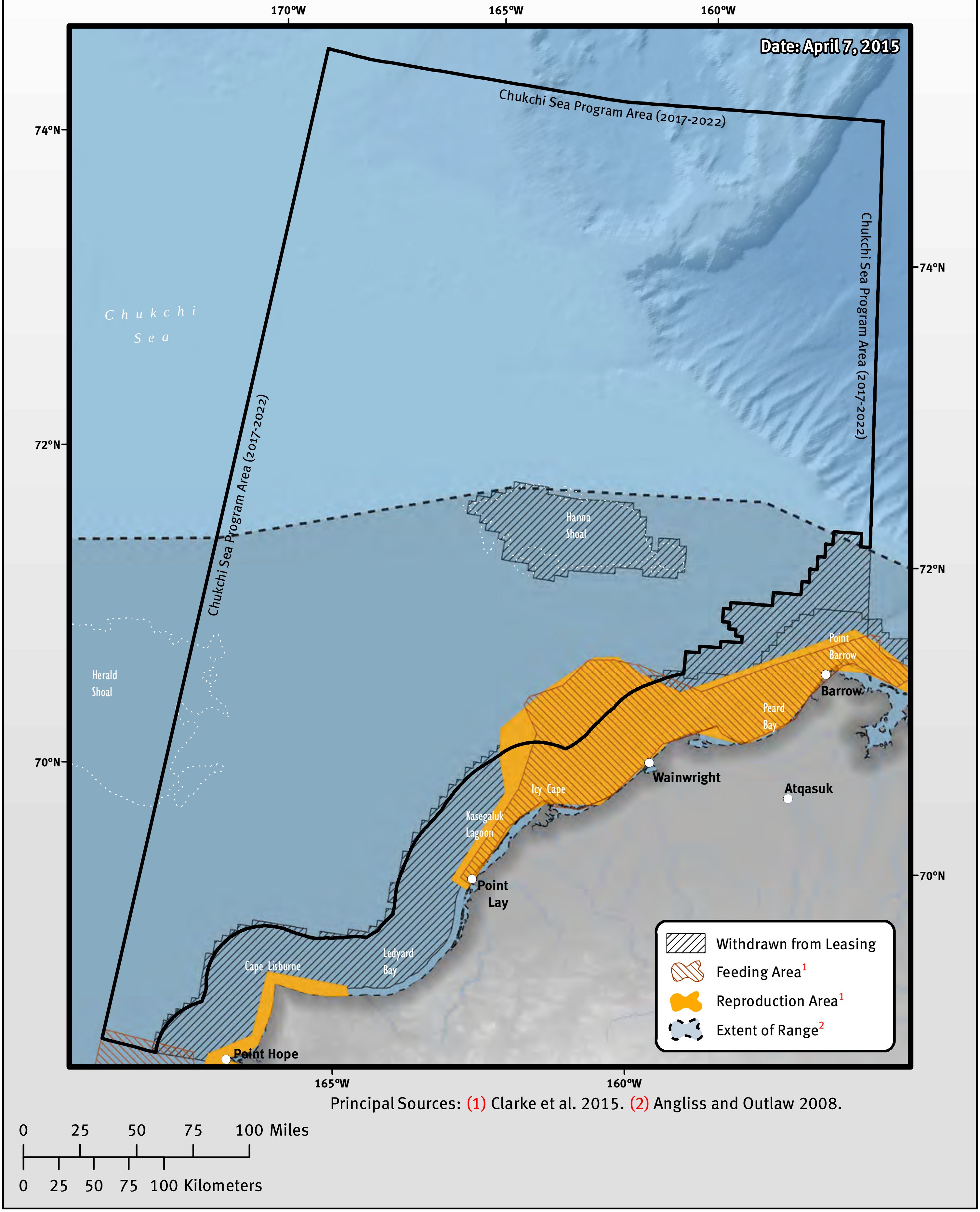
Principal Sources: (1) Quakenbush et al. 2010. (2) Angliss and Outlaw 2008. (3) Audubon Alaska 2009. Based on: (a) ADFG 2009.

Isopleth value: Percent of locations concentrated in colored area.

Note: This map is based on only two years of data: additional recent data were not available at the time of publication.

Figure 21.

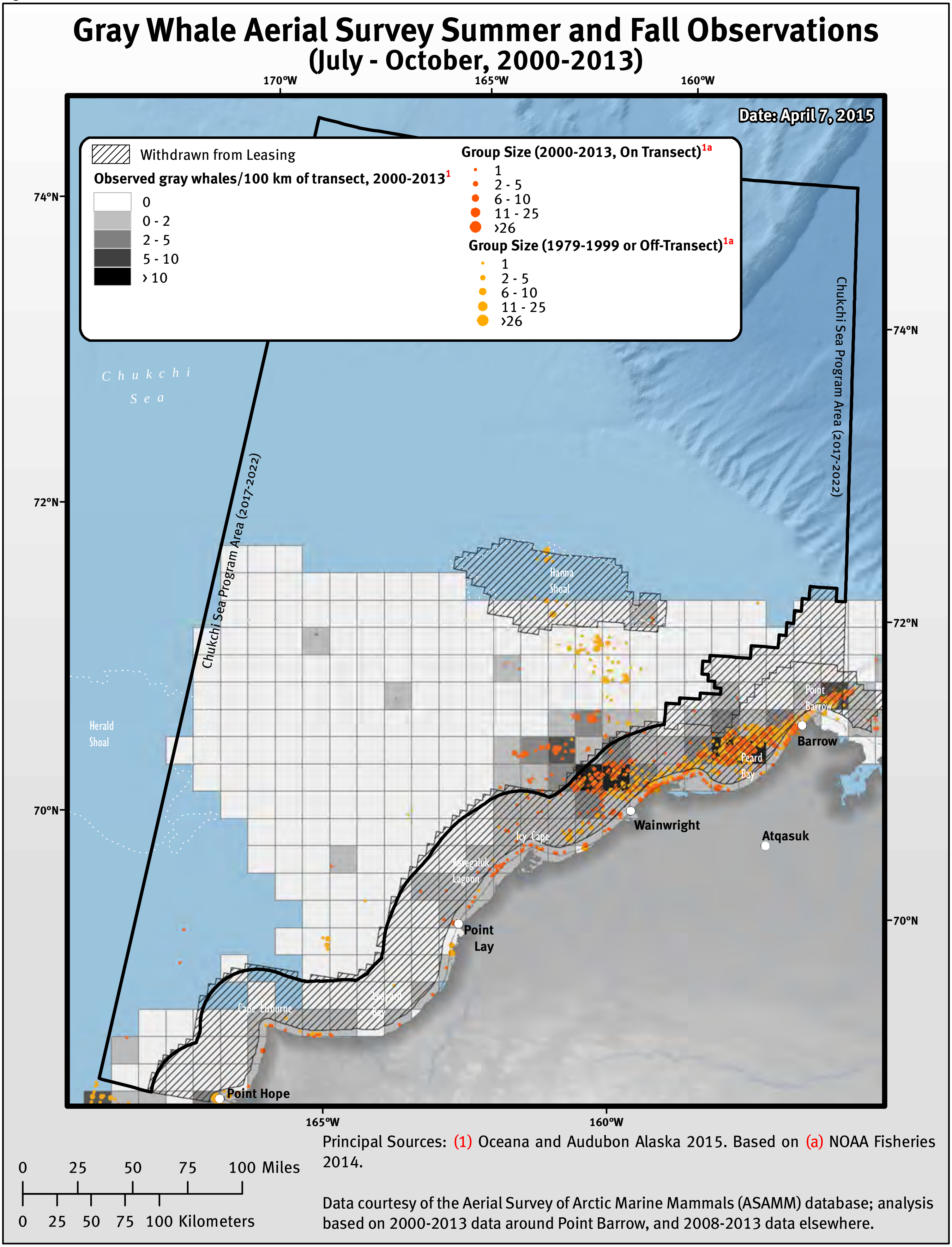
Gray Whale Concentration Areas



Principal Sources: (1) Clarke et al. 2015. (2) Angliss and Outlaw 2008.

Figure 22.

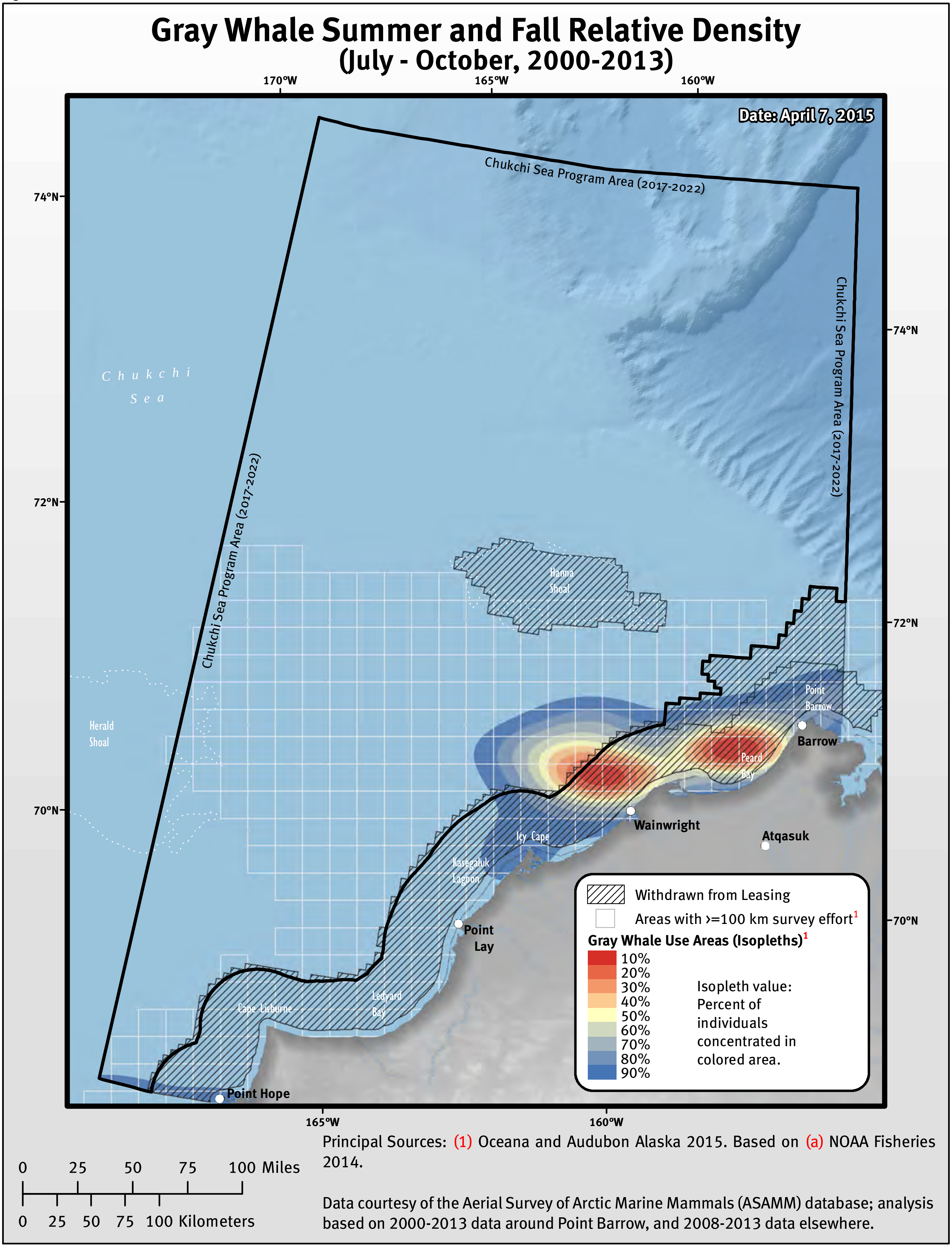
Gray Whale Aerial Survey Summer and Fall Observations
(July - October, 2000-2013)



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 23.

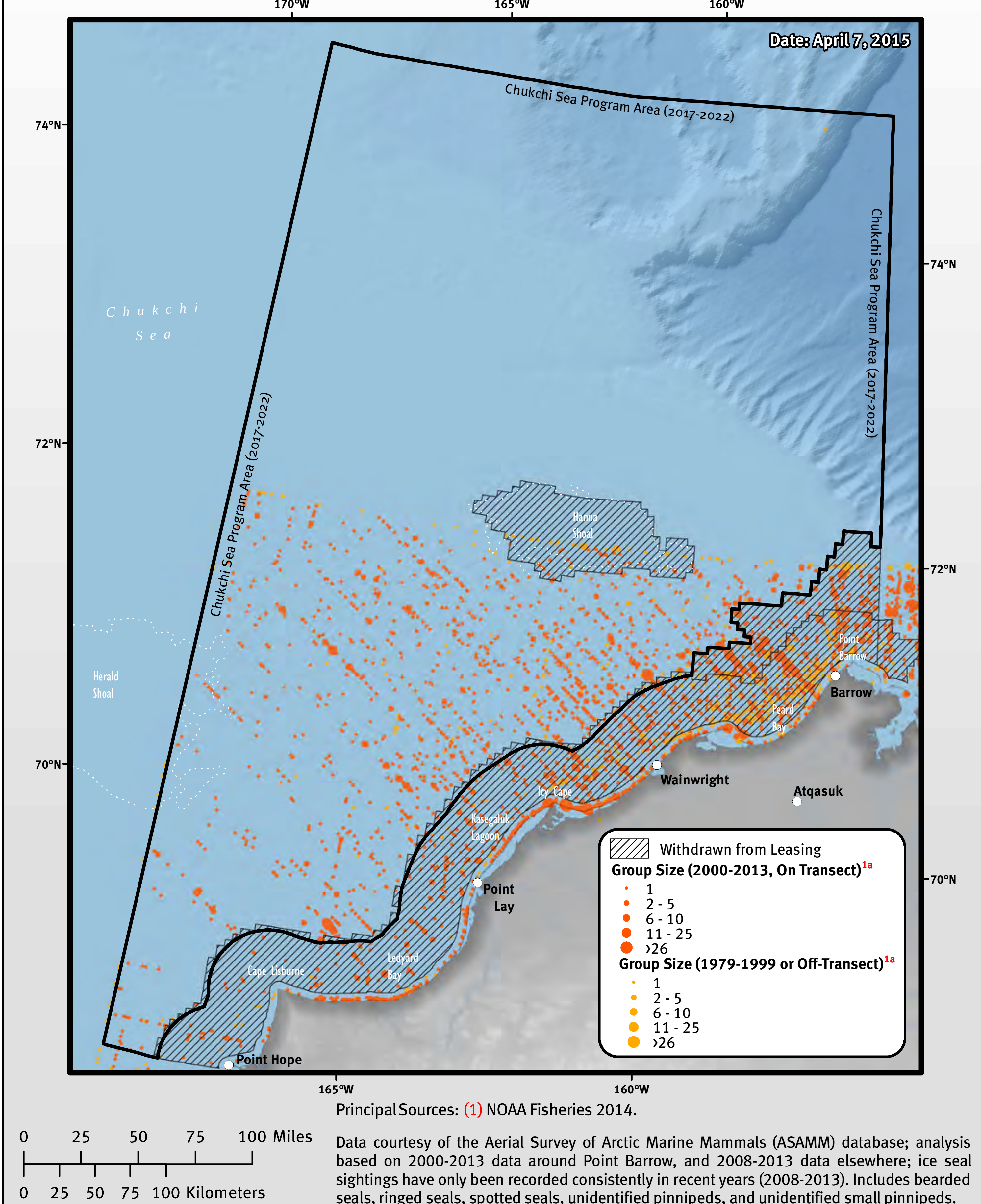


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 24.

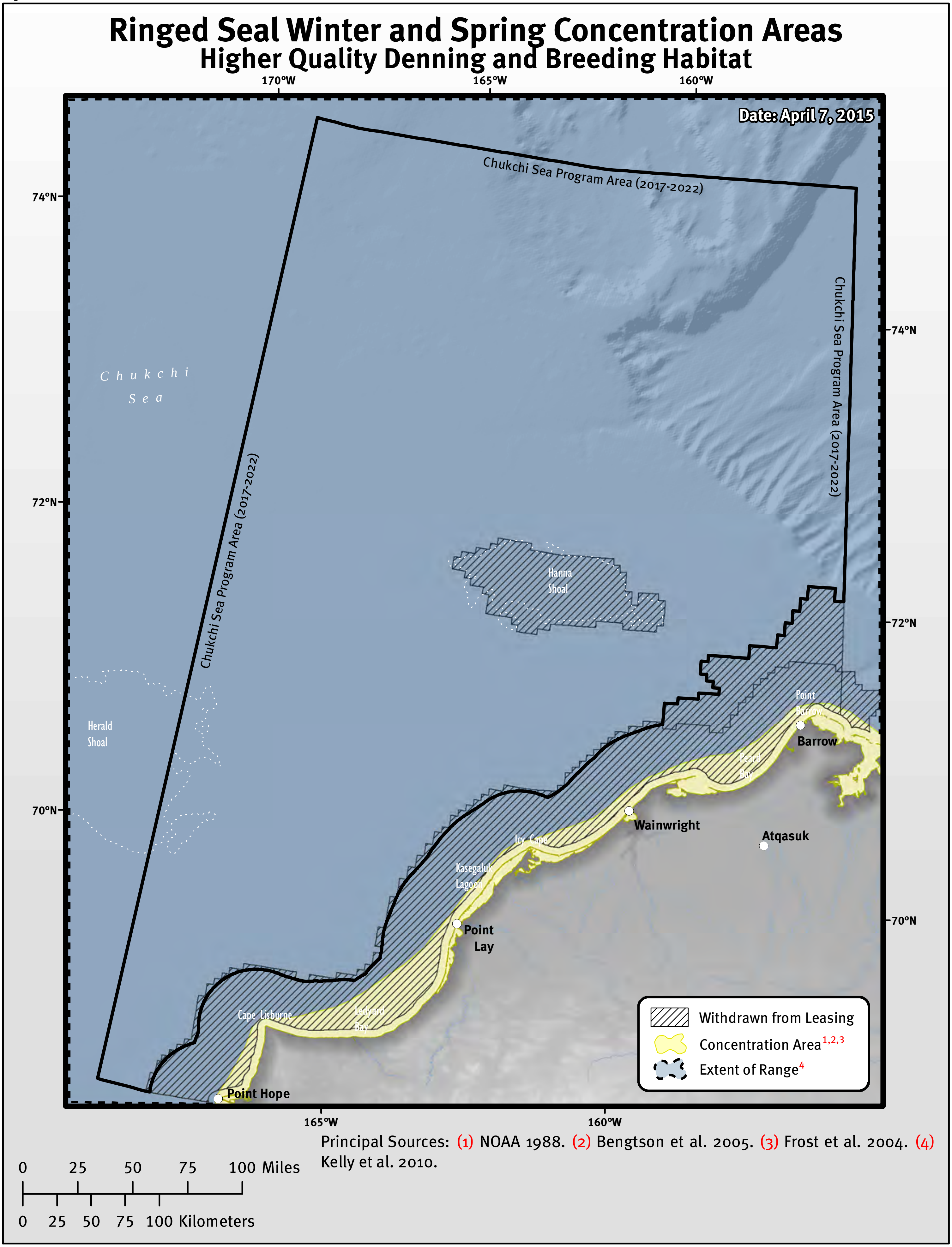
Ice Seal Aerial Survey Summer and Fall Observations
(July - October, 2000-2013)



Principal Sources: (1) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere; ice seal sightings have only been recorded consistently in recent years (2008-2013). Includes bearded seals, ringed seals, spotted seals, unidentified pinnipeds, and unidentified small pinnipeds.

Figure 25.



Principal Sources: (1) NOAA 1988. (2) Bengtson et al. 2005. (3) Frost et al. 2004. (4) Kelly et al. 2010.

Figure 26.

Ringed Seal Fall Migration (Eight Juveniles, September 2001-2002)

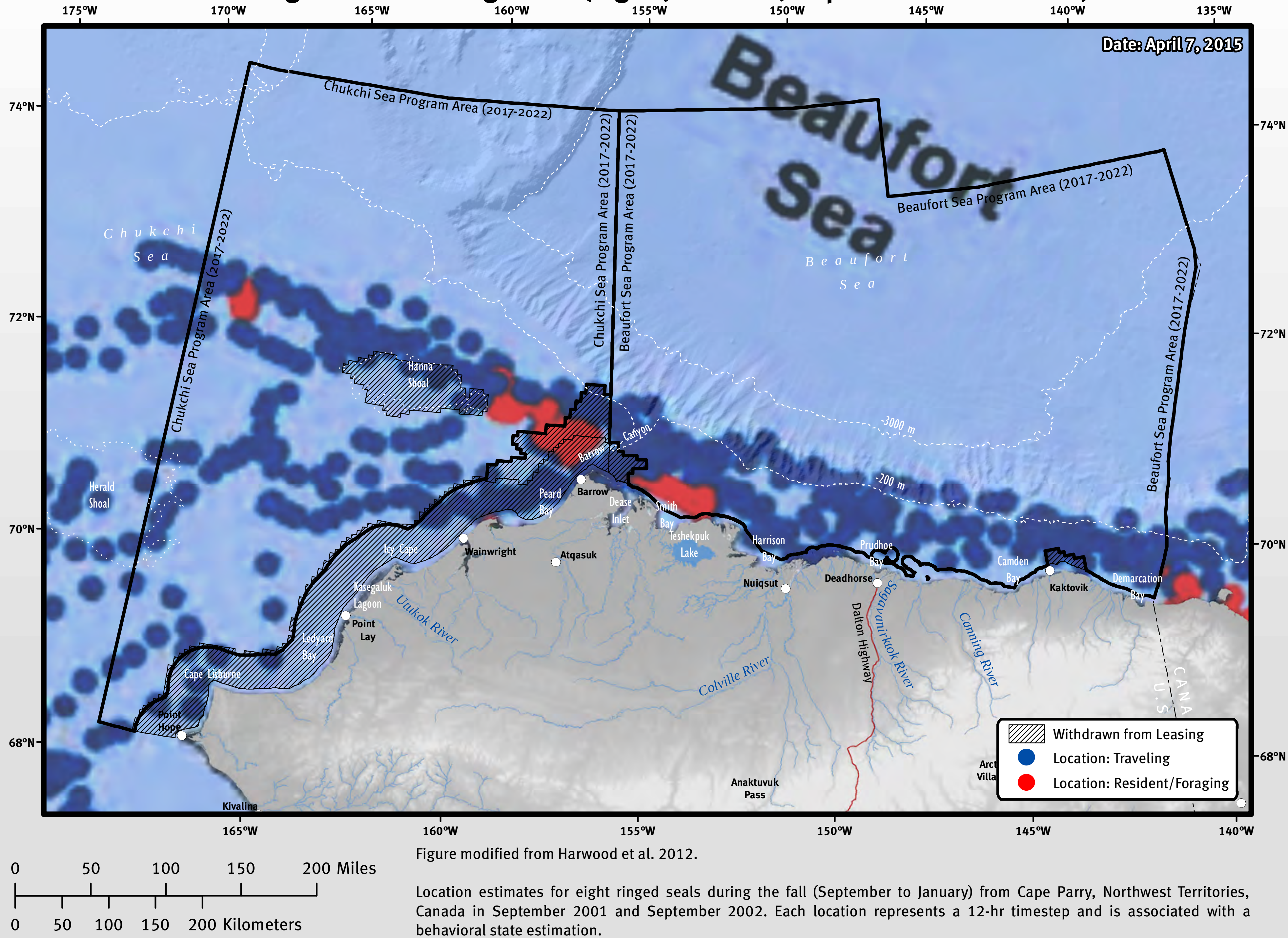
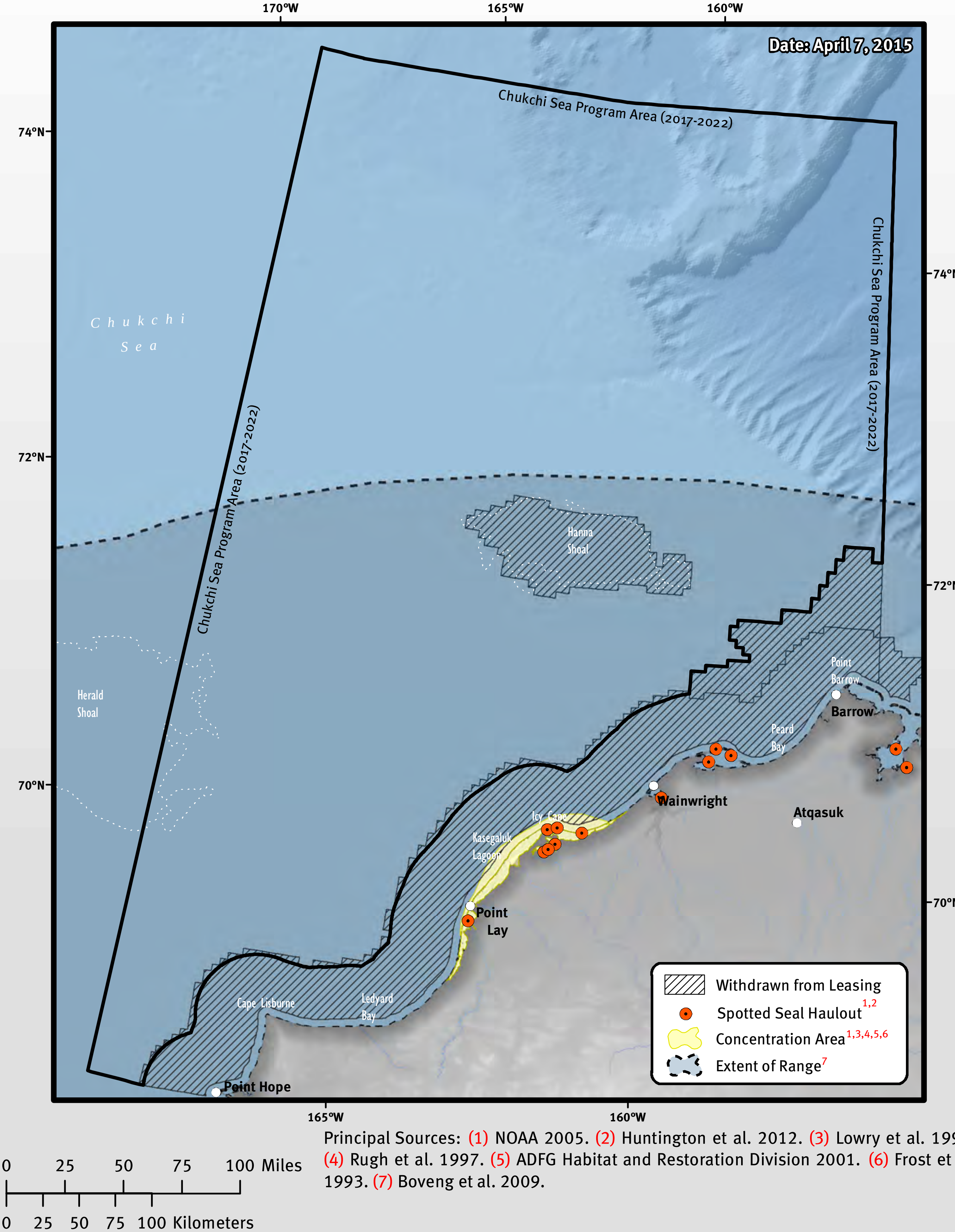


Figure modified from Harwood et al. 2012.

Location estimates for eight ringed seals during the fall (September to January) from Cape Parry, Northwest Territories, Canada in September 2001 and September 2002. Each location represents a 12-hr timestep and is associated with a behavioral state estimation.

Figure 27.

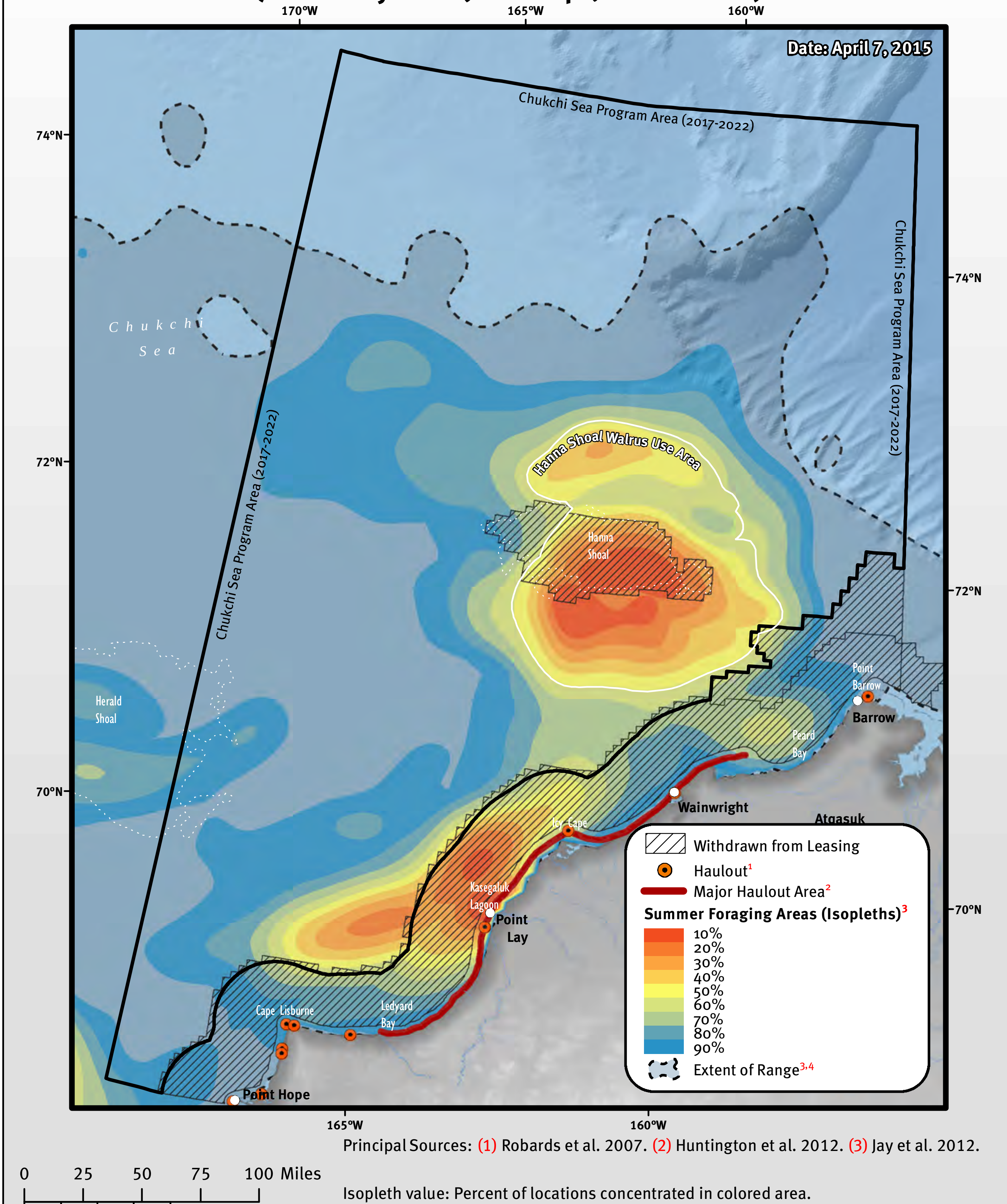
Spotted Seal Concentration Areas



Principal Sources: (1) NOAA 2005. (2) Huntington et al. 2012. (3) Lowry et al. 1998. (4) Rugh et al. 1997. (5) ADFG Habitat and Restoration Division 2001. (6) Frost et al. 1993. (7) Boveng et al. 2009.

Figure 28.

Combined Walrus Summer Foraging and Haulout Areas
(Telemetry from June-Sept, 2008-2011)



Principal Sources: (1) Robards et al. 2007. (2) Huntington et al. 2012. (3) Jay et al. 2012.

Isopleth value: Percent of locations concentrated in colored area.

Note: This map combines data from multiple months (2008-2011): see monthly distribution maps to compare foraging areas between June and September.

Figure 29.

Walrus Summer Foraging Areas, By Month
(Telemetry from June-Sept, 2008-2011)

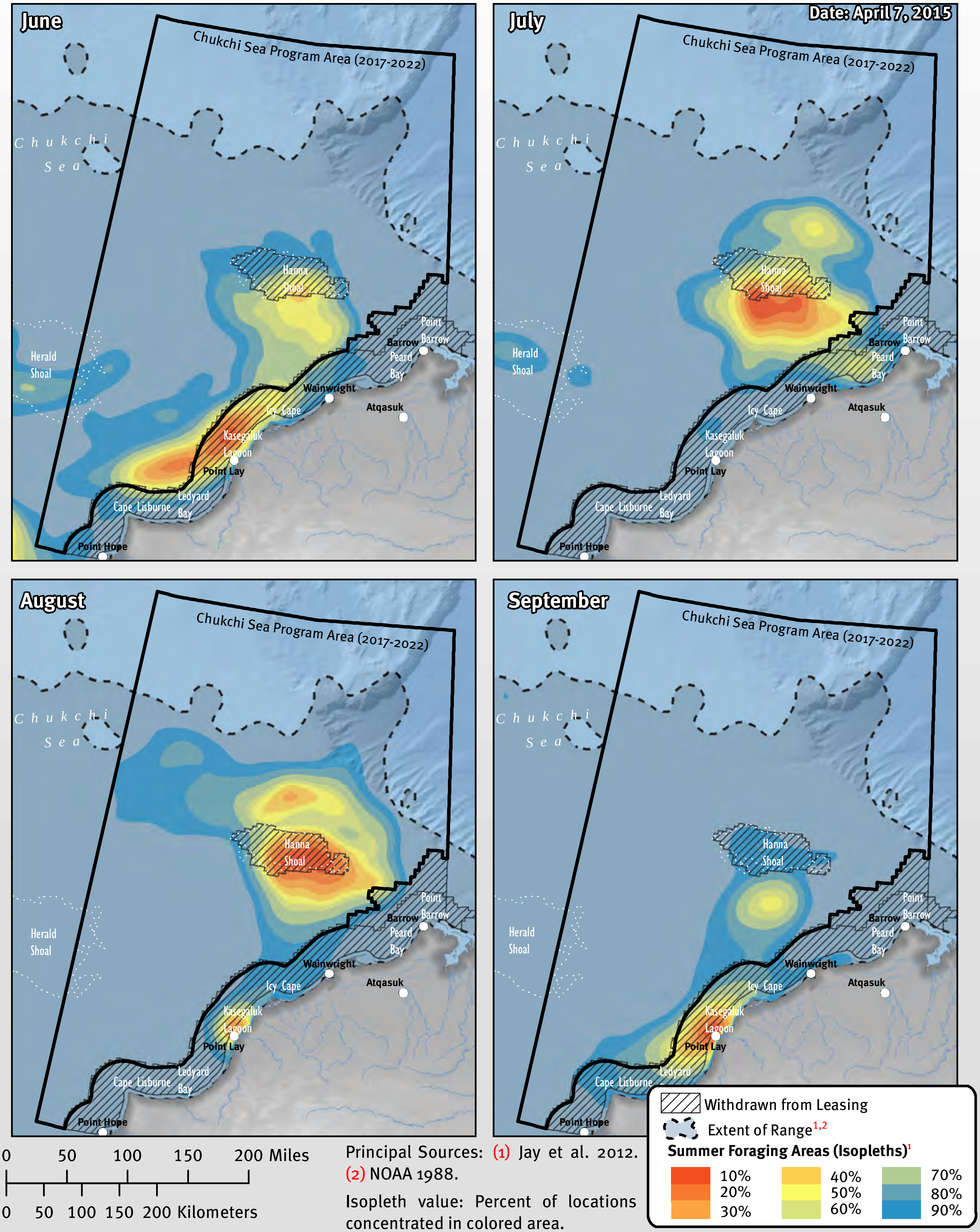
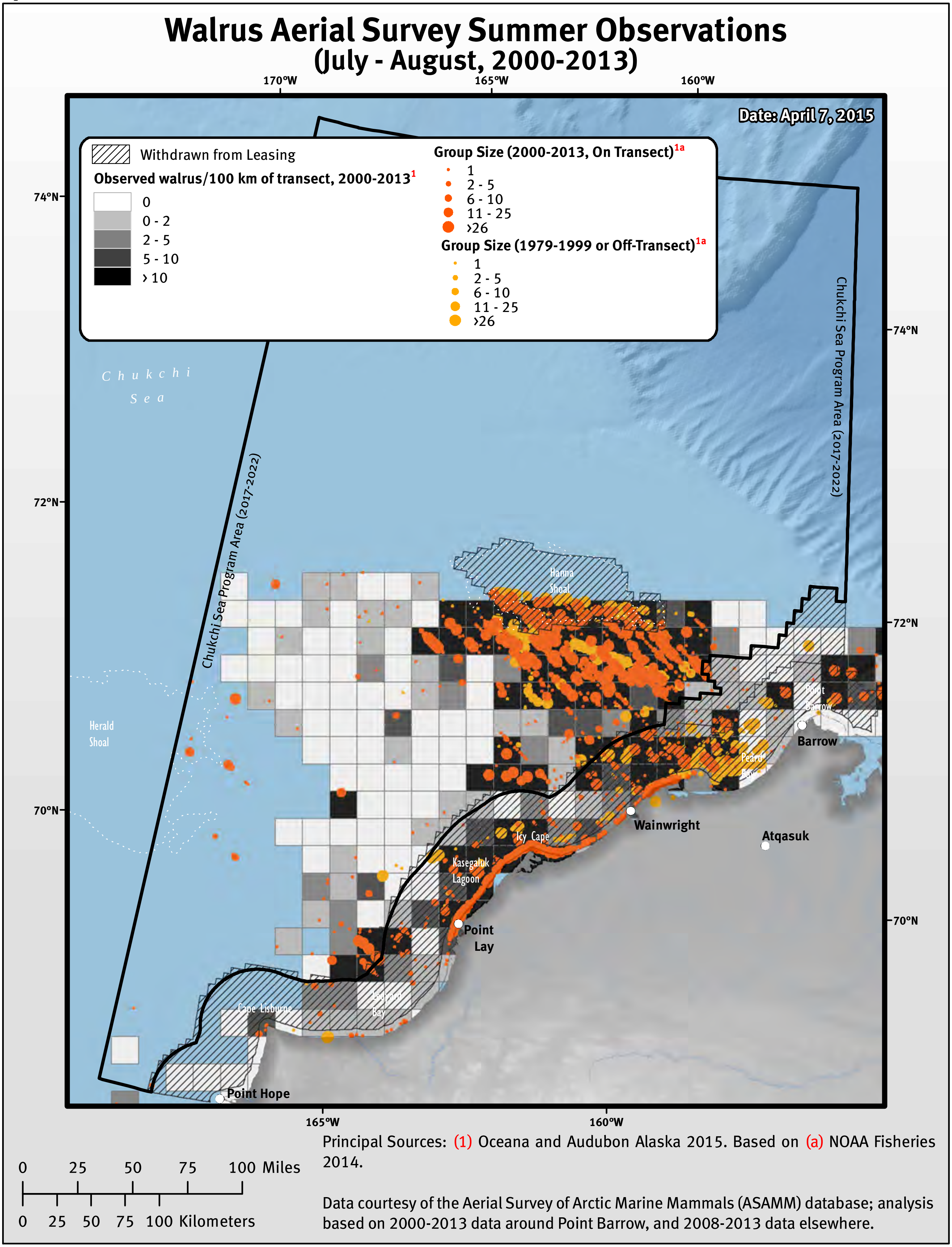


Figure 30.

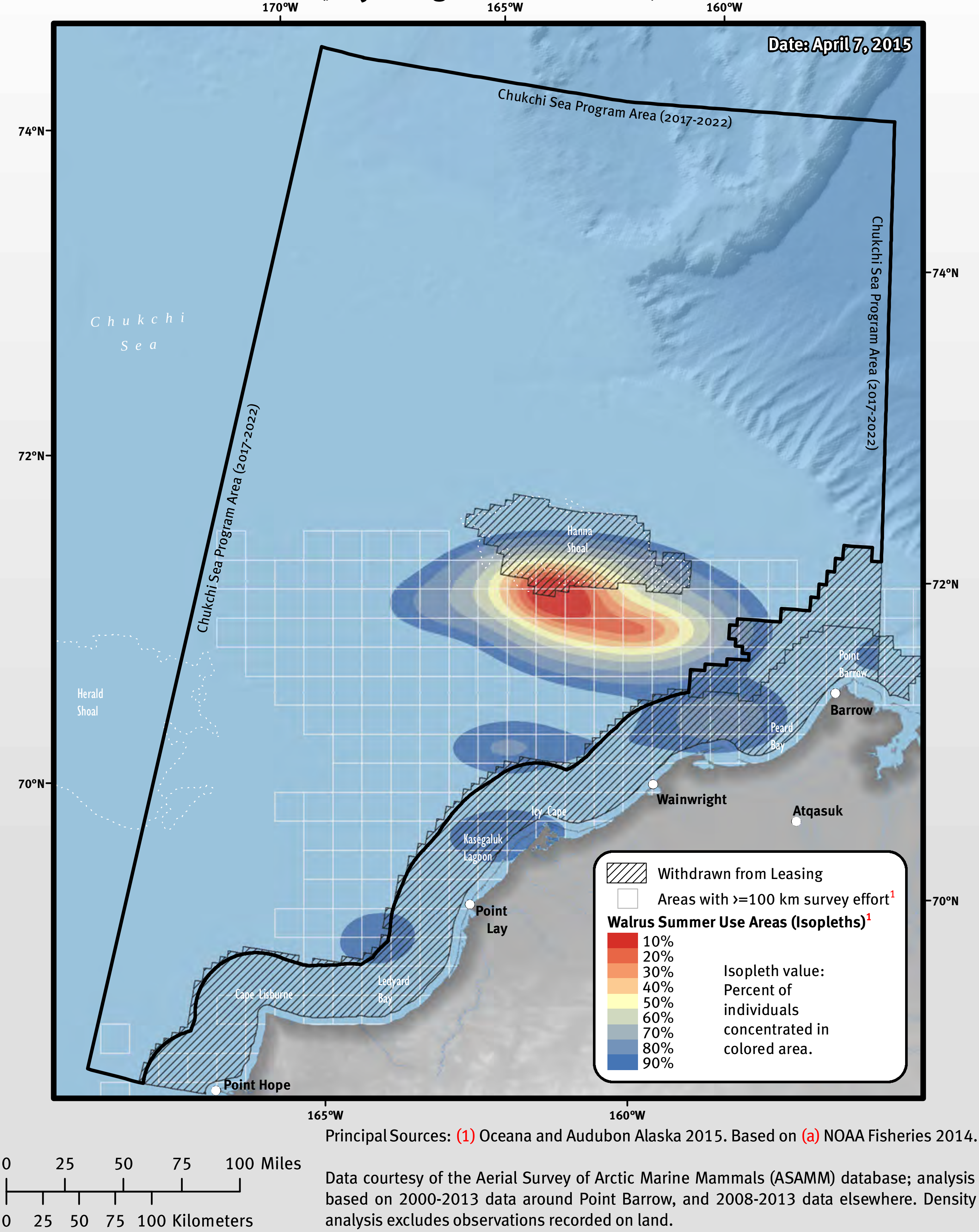


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 31.

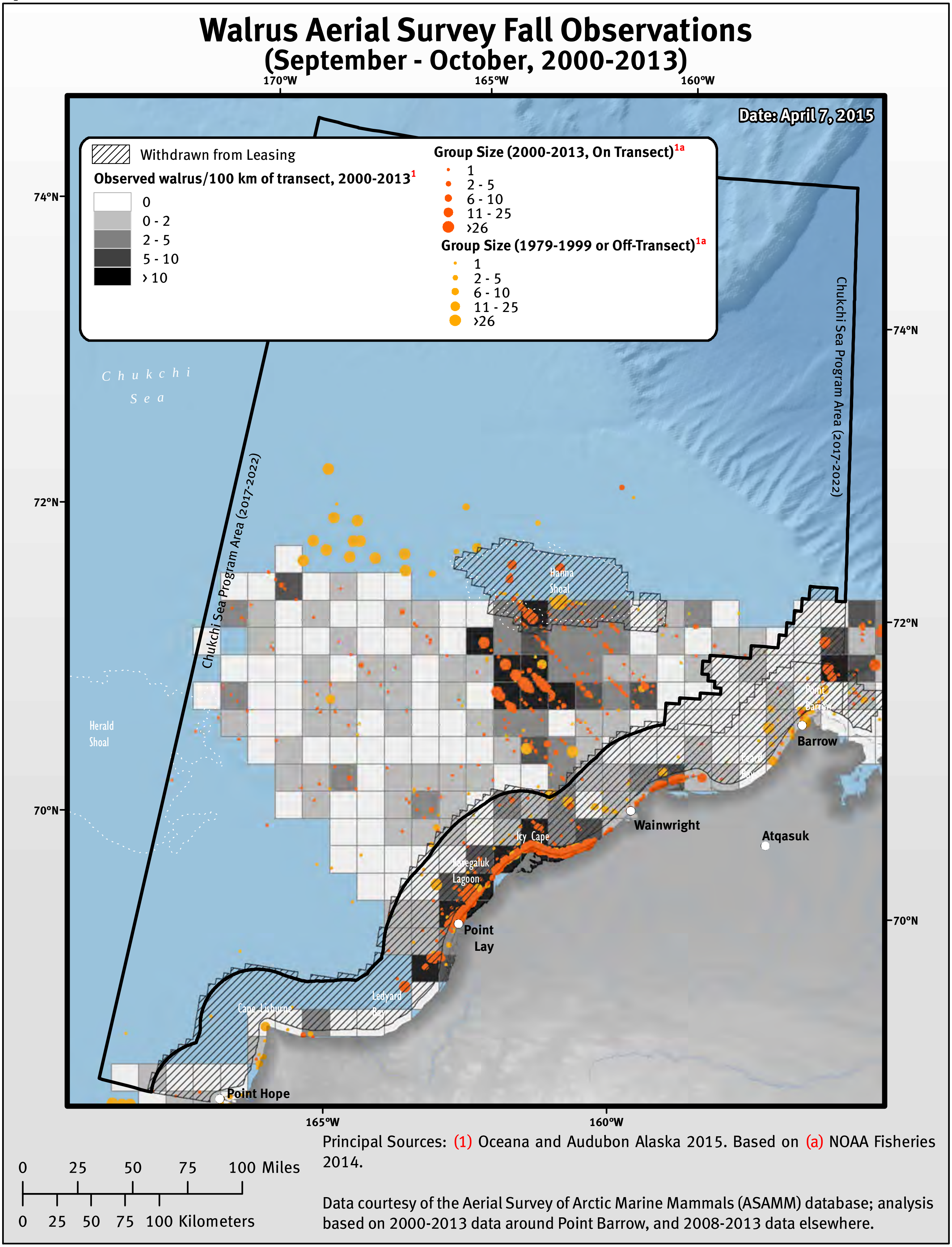
Walrus Summer At-Sea Relative Density
(July - August, 2000-2013)



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere. Density analysis excludes observations recorded on land.

Figure 32.

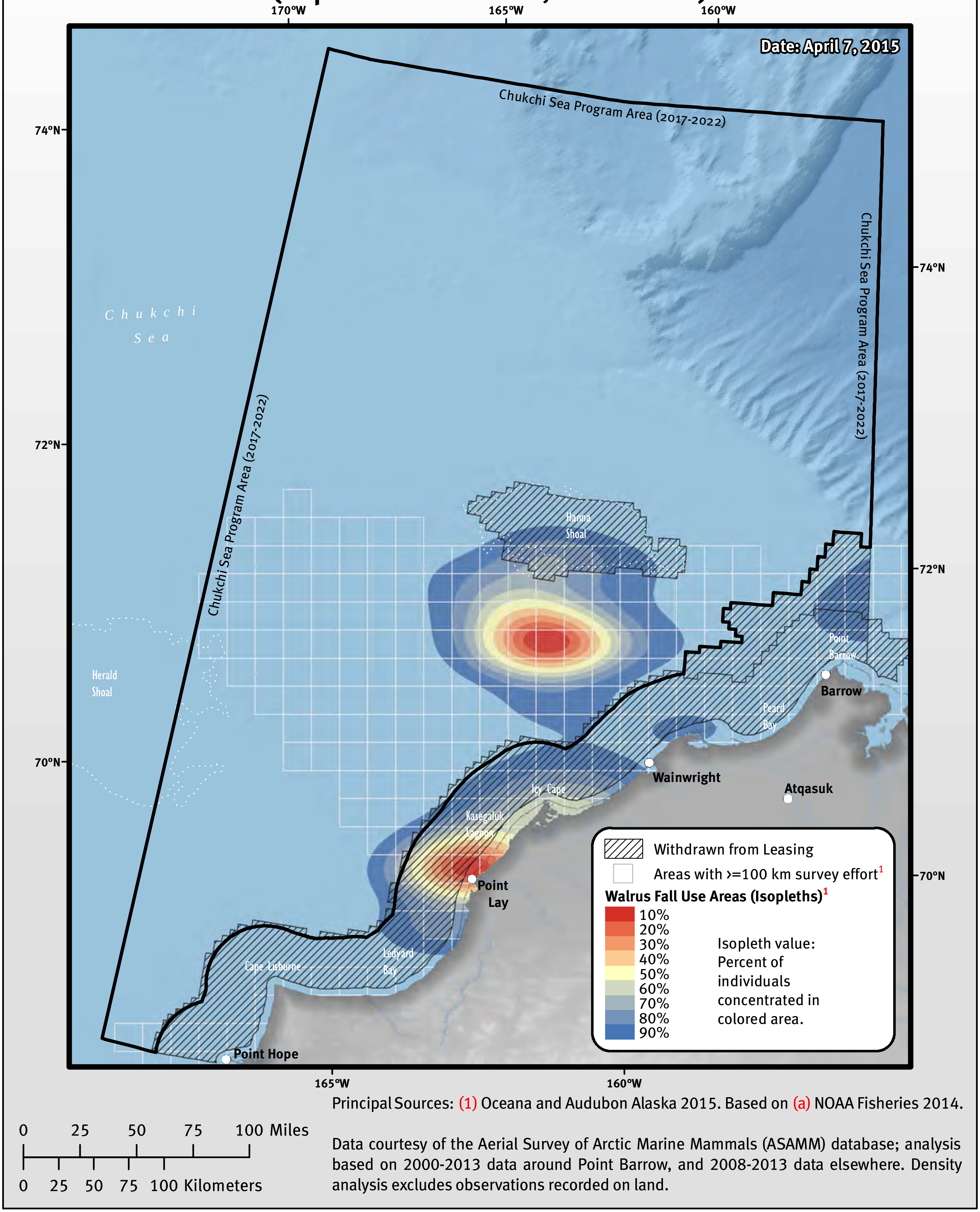


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 33.

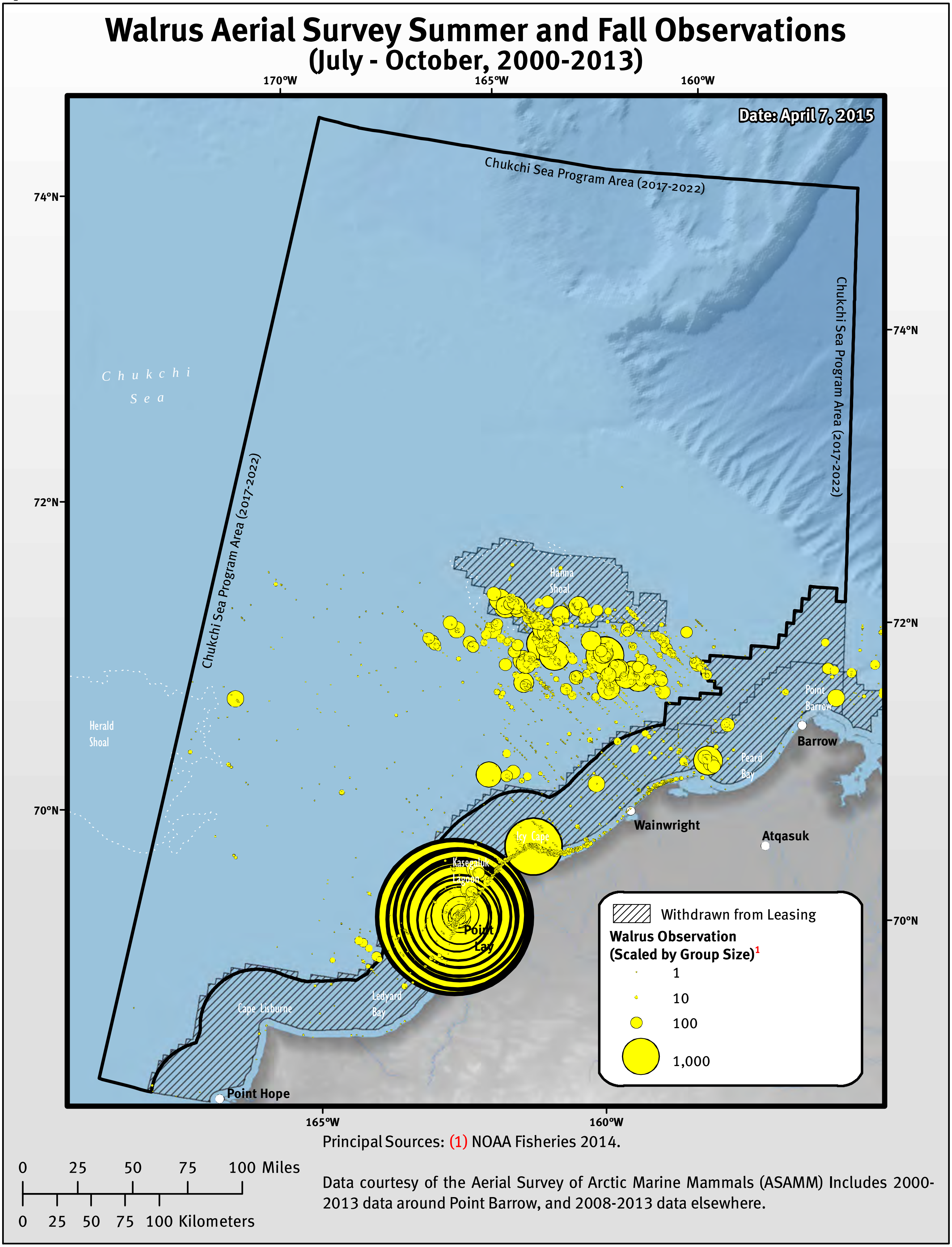
Walrus Fall At-Sea Relative Density
(September - October, 2000-2013)



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere. Density analysis excludes observations recorded on land.

Figure 34.

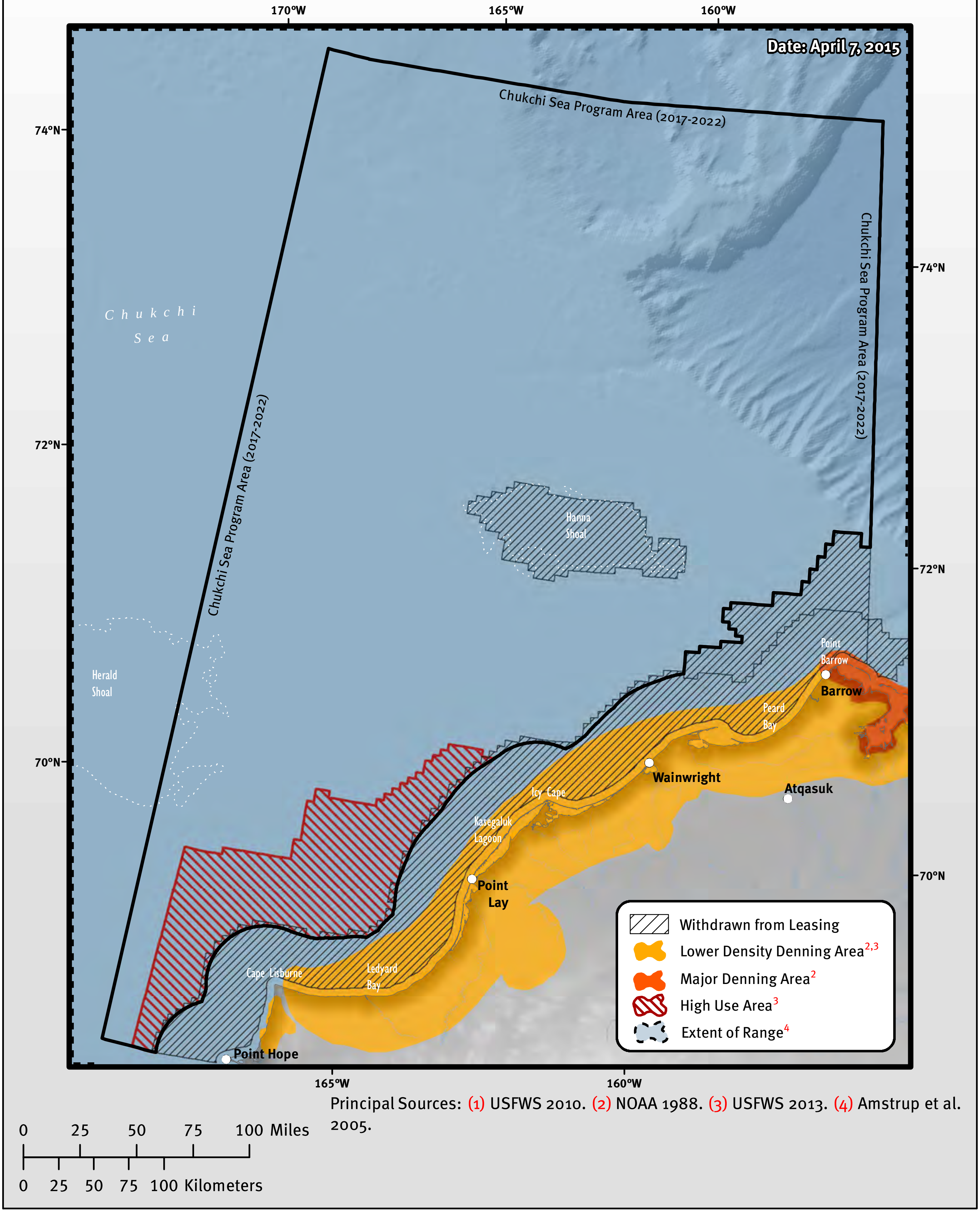


Principal Sources: (1) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) Includes 2000-2013 data around Point Barrow, and 2008-2013 data elsewhere.

Figure 35.

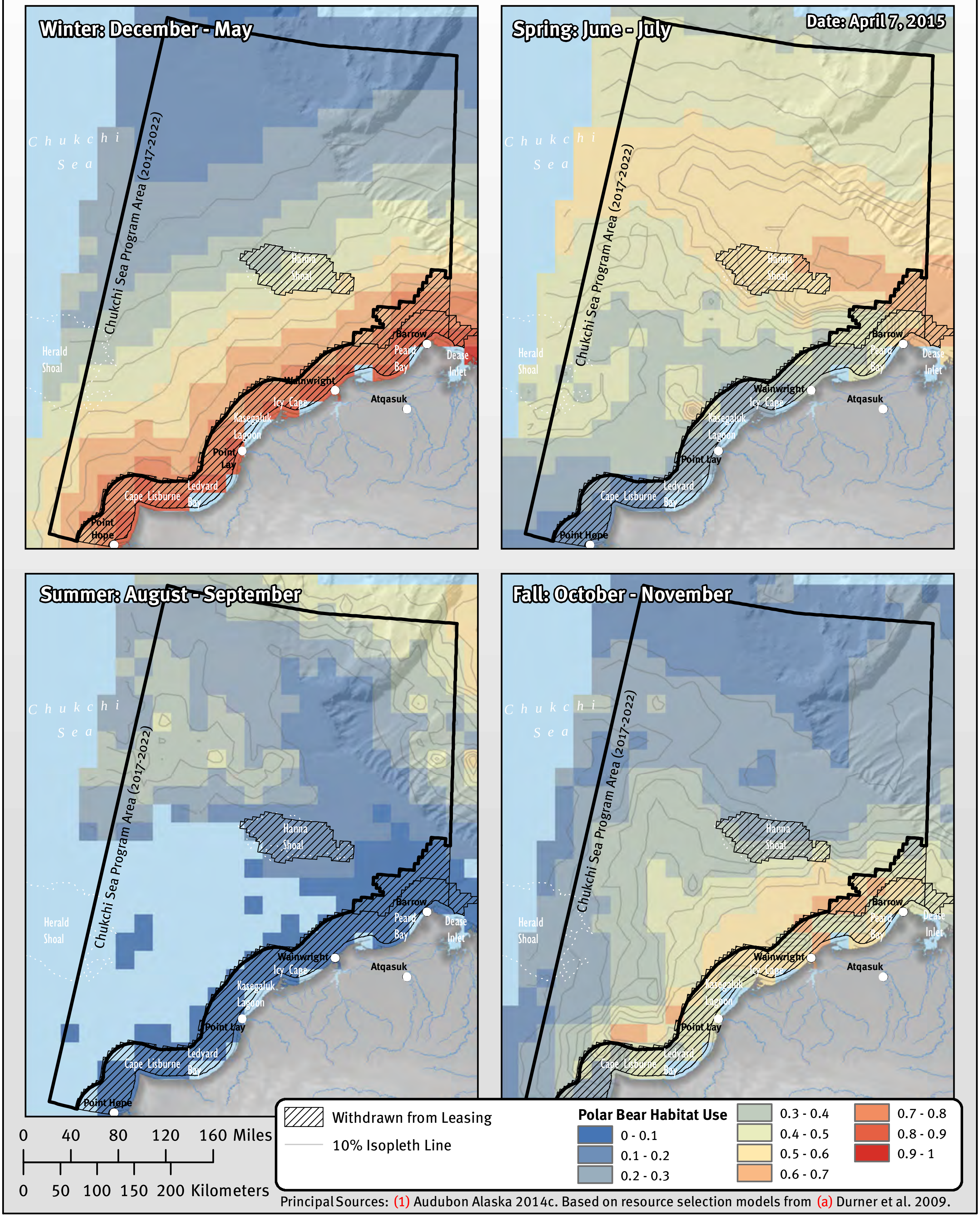
Polar Bear Denning And Feeding Areas



Principal Sources: (1) USFWS 2010. (2) NOAA 1988. (3) USFWS 2013. (4) Amstrup et al. 2005.

Figure 36.

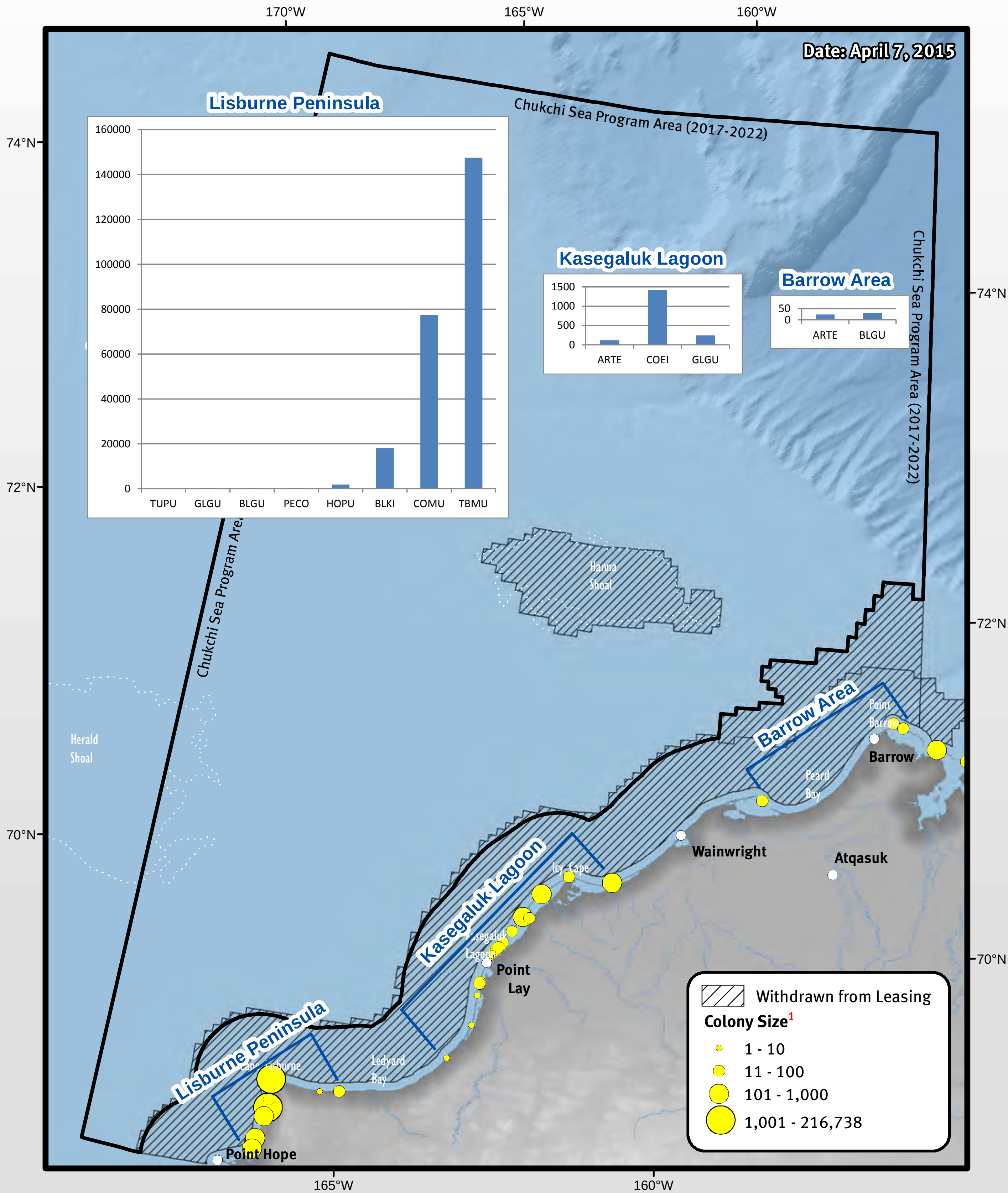
Predicted Polar Bear Habitat Use, By Season

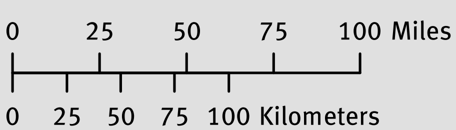


Principal Sources: (1) Audubon Alaska 2014c. Based on resource selection models from (a) Durner et al. 2009.

Figure 37.

Marine Bird Summer Nesting Colonies



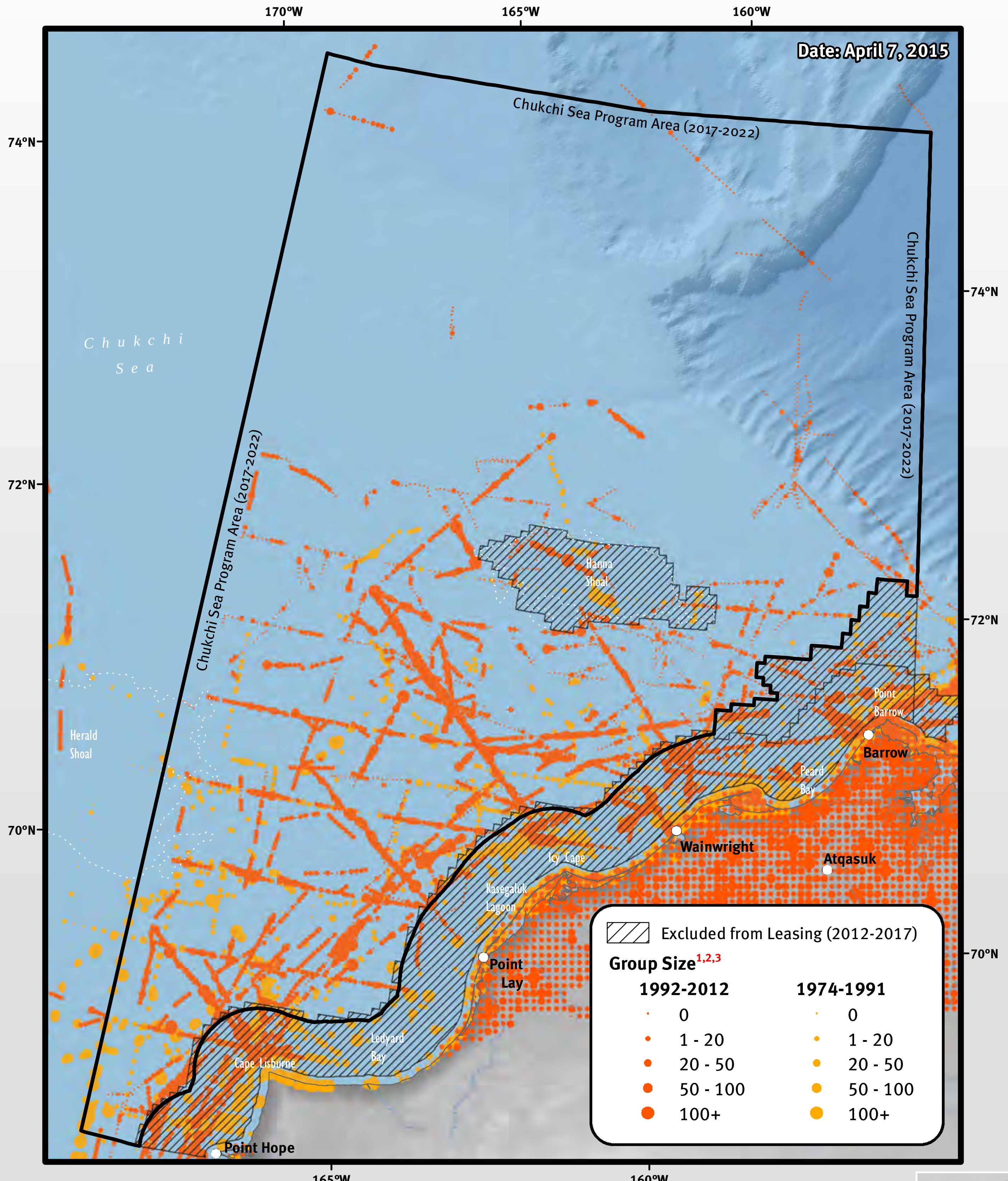


Principal Sources: (1) World Seabird Union 2011.

ARTE: Arctic tern; BLGU: black guillemot; BLKI: black-legged kittiwake; COEI: common eider; COMU: common murre; GLGU: glaucous gull; HOPU: horned puffin; PECO: pelagic cormorant; TBMU: thick-billed murre; TUPU: tufted puffin.

Figure 38.

Bird Observations, All Species (1974-2012)



Principal Sources: (1) Drew and Piatt 2013.* (2) Walker and Smith 2014. (3) USFWS 2014.

*Data courtesy of North Pacific Pelagic Seabird Database.

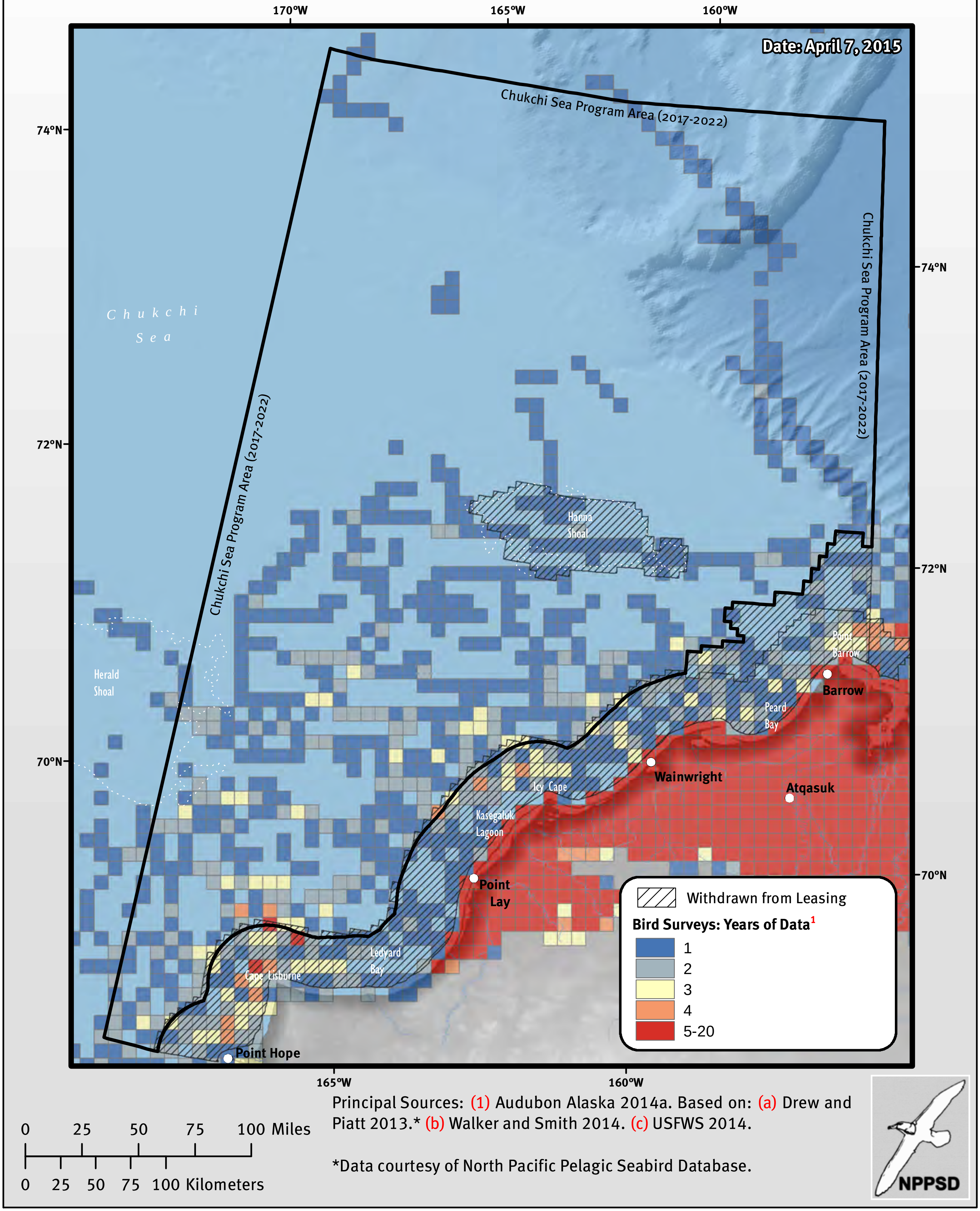
0 25 50 75 100 Miles

0 25 50 75 100 Kilometers

NPPSD

Figure 39.

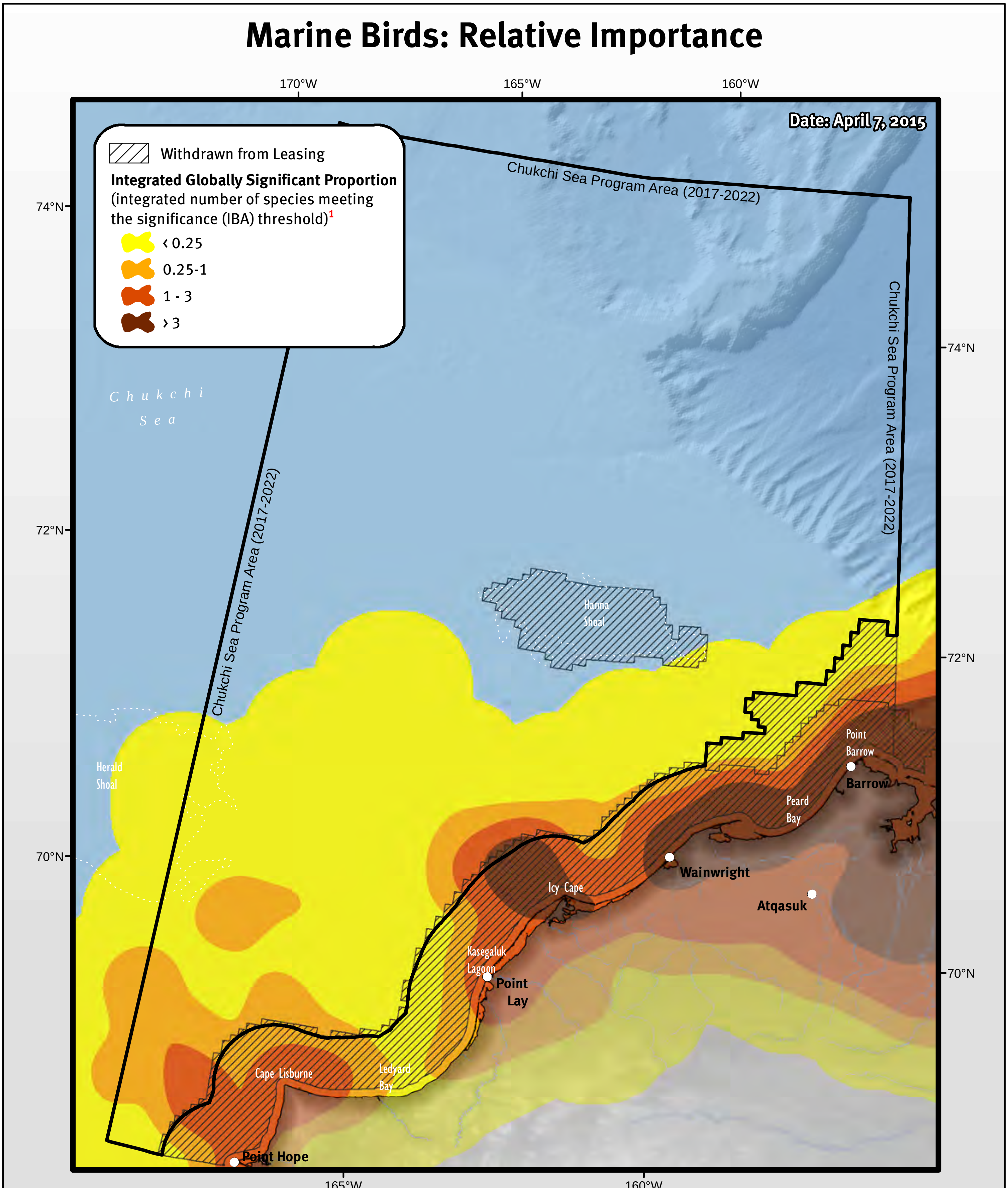
Bird Observations (1974-2012): Survey Effort



Principal Sources: (1) Audubon Alaska 2014a. Based on: (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. (c) USFWS 2014.

*Data courtesy of North Pacific Pelagic Seabird Database.

Figure 40.

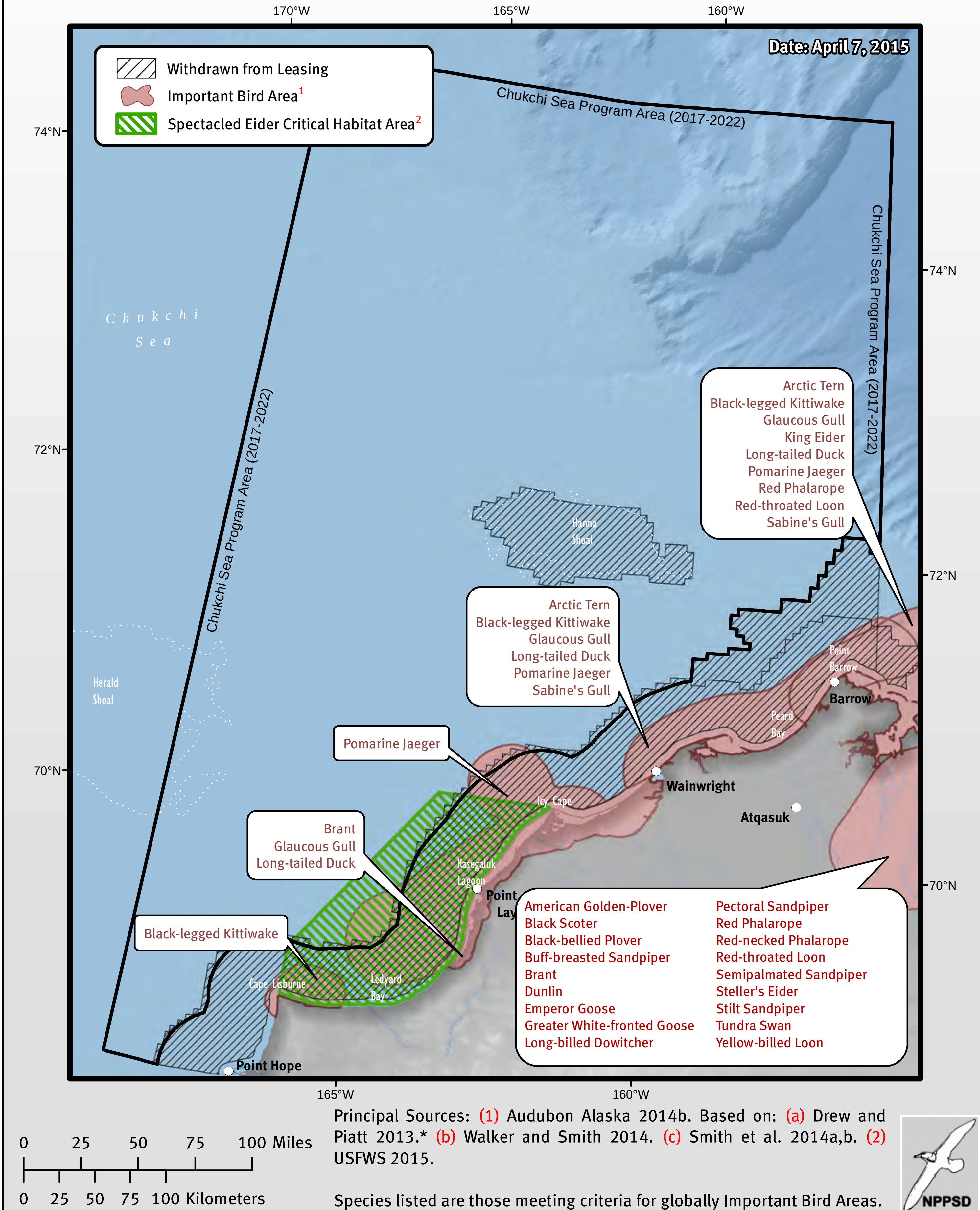


Principal Sources: (1) Audubon Alaska 2015b. Based on: (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. *Data Courtesy of North Pelagic Seabird Database.

The integrated globally significant proportion of birds provides a measure of importance by looking at a combination of both species abundance and species rarity, integrated over multiple species. The data indicates relative importance using abundance normalized by population size, using the % of IBA threshold achieved, summed (integrated) for all regularly occurring species. The IBA threshold is 1% of the population, based on global population numbers for seabirds or on continental population numbers for waterbirds.

Figure 41.

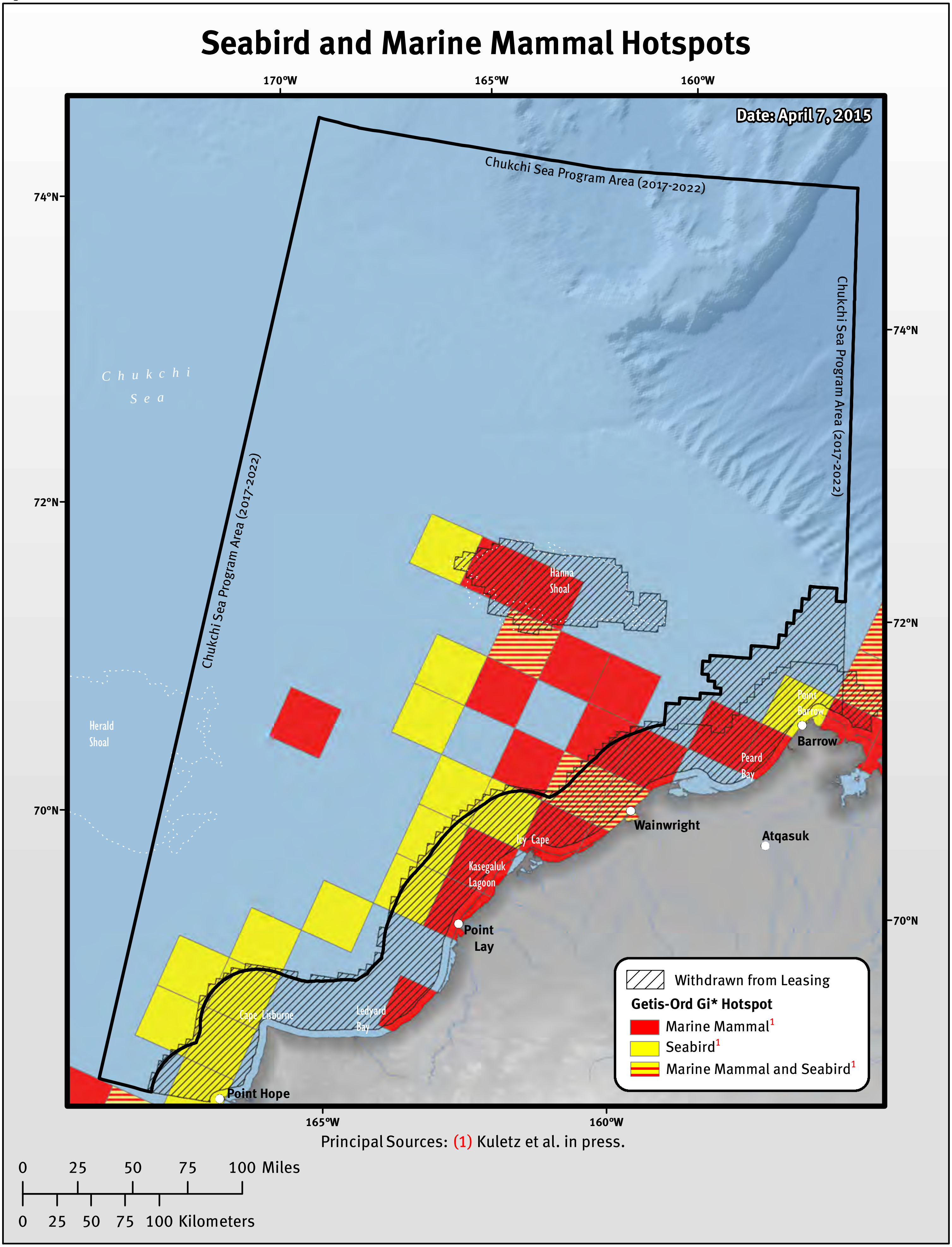
Important Bird Areas and Spectacled Eider Critical Habitat



Principal Sources: (1) Audubon Alaska 2014b. Based on: (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. (c) Smith et al. 2014a,b. (2) USFWS 2015.

Species listed are those meeting criteria for globally Important Bird Areas.

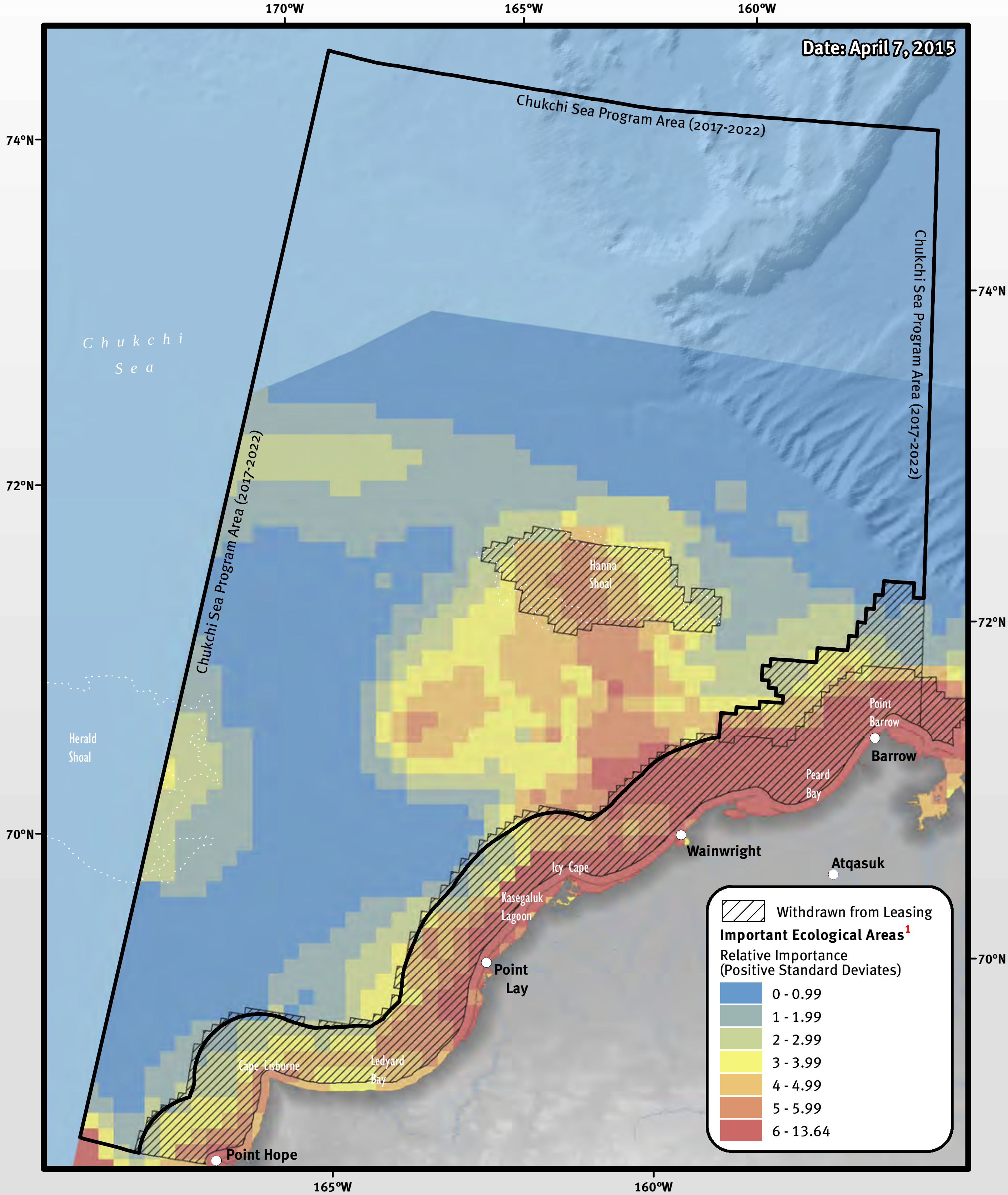
Figure 42.

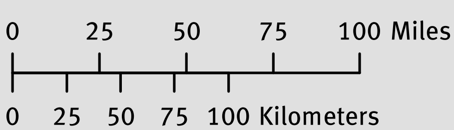


Seabird and Marine Mammal Hotspots
Date: April 7, 2015
170°W
165°W
160°W
74°N
72°N
70°N
Chukchi Sea Program Area (2017-2022)
Chukchi Sea
Herald Shoal
Hanna Shoal
Point Barrow
Barrow
Peard Bay
Wainwright
Atqasuk
Icy Cape
Kasegaluk Lagoon
Point Lay
Cape Lisburne
Ledyard Bay
Point Hope
Withdrawn from Leasing
Getis-Ord Gi* Hotspot
Marine Mammal[1]
Seabird[1]
Marine Mammal and Seabird[1]
Principal Sources: (1) Kuletz et al. in press.
0 25 50 75 100 Miles
0 25 50 75 100 Kilometers

Figure 43.

Important Ecological Area - Ecosystem Analysis





Principal Sources: (1) Oceana 2013b.

This analysis combined information on ecological features of the ecosystem: subsistence, marine mammals, seabirds, seafloor biomass, primary productivity, and sea ice habitat features. Importance values >0 indicate places that are above average for one or more ecological features. Higher relative values indicate importance for multiple overlapping features. The study area over which relative importance was measured includes most of the U.S. Chukchi and Beaufort waters north of 68° latitude and south of 73° latitude. Analysis specifics and citations for source data analyzed are available at http://www.regulations.gov/#!documentDetail;D=NOAA-NMFS-2013-0054-0070 or by contacting ckrenz@oceana.org.

APPENDIX B

BIOLOGICAL VALUES AND SUPPORTING SCIENCE FOR

CHUKCHI SEA IMPORTANT AREAS

This appendix describes the data sources and spatial information cited on our Chukchi Sea maps and used in our spatial analyses. It provides information relating to:

- Cetaceans (bowhead whales, beluga whales, and gray whales);
- Pinnipeds (walrus, ringed seal, spotted seal, and bearded seal);
- Polar bears;
- Marine birds;
- Lower trophic levels and physical features (primary productivity, benthic biomass, sea ice);
- Subsistence; and
- Important ecological areas (IEAs).

We begin with a brief introduction of each topic, focusing on the key features relative to the Chukchi Sea Planning Area. Then, we list and explain the principal data sources that informed our spatial analyses. We summarize the key information from each source, and document with reference to specific page and figure numbers the text or maps that describe concentration areas or other relevant data.

1. CETACEANS

1.1 Bowhead Whale

The bowhead whale (*Balaena mysticetus*) population that uses the Chukchi Sea Planning Area is the Western Arctic Stock (Allen and Angliss 2013). The Western Arctic Stock winters (December to March) in the Bering Sea, and migrates to the Beaufort Sea in spring (April through May) to summertime foraging grounds. In the fall (October through December) they migrate back to the Bering Sea (Moore et al. 1993). Bowhead whales are closely associated with sea ice for much of the year, with the exception of their time at summering grounds, particularly in recent years. Their spring migration route travels along the shear zone between the shorefast and pack ice. In the Chukchi Sea, their route passes the coastal communities of Point Hope, Point Lay, Wainwright, and Barrow (Quakenbush et al. 2013, Clarke et al. 2015). During the fall migration, bowhead whales follow continental slope habitat along the Beaufort Sea coast (Moore 2000). After passing Point Barrow, they move across the Chukchi Sea toward the Russian coastline toward the Bering Strait and St. Lawrence Island. There is high variability from year to year in how they cross the northeastern Chukchi Sea shelf; however, there is evidence that their migration route is influenced by feeding hotspots (Quakenbush et al. 2013, Citta et al. 2015). Along these migratory pathways are important areas for foraging and resting, known by systematic surveys (Moore et al. 2010), satellite tagging studies (Citta et al. 2014), and traditional knowledge of hunters (Huntington and Quakenbush 2009, Huntington 2013). The bowhead whale subsistence hunt has a central cultural role in the subsistence way of life of some coastal communities, and it plays an important role in the health and well-being of many Arctic peoples, from communities in the Bering Strait region to the Beaufort Sea.

The mapped concentration areas for bowhead whales are based on the following scientific source materials.

- **Analysis of Aerial Surveys of Arctic Marine Mammals (ASAMM) data for the Beaufort and Chukchi seas**
    - Summer and fall bowhead whale, beluga whale, gray whale, and walrus core use areas were delineated by analyzing the Bureau of Ocean Energy Management (BOEM)-funded ASAMM data for the Beaufort and Chukchi seas (formerly Bowhead Whale Aerial Survey Project – BWASP, and Chukchi Offshore Monitoring in Drilling Area – COMIDA). Megan Ferguson and Janet Clarke, the points of contact for this database and associated reports, were consulted and provided valuable advice and feedback on the analyses used to delineate the fall bowhead whale migration corridor. Aerial survey methods, data, and metadata for the ASAMM database are readily available at: http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php. We used the following methods to analyze the ASAMM data:
        - Confined the analyses to 2000–2013 survey data (note Chukchi surveys have only been conducted from 2008 onwards except around Point Barrow), which are the recent years for which data are available and better represents current distribution patterns;
        - Utilized data for the fall bowhead whale migration as well as the summer and fall beluga whale, gray whale, and walrus use areas. We defined summer as July and August and fall as September to the end of October (note: surveys were not conducted past the end of October during 2000–2013). For gray whales that did not show significant seasonal variability, we pooled data across the two seasons;
        - Used only on-transect survey effort, versus including all observations of whales that included off-transect search effort;
        - Established a 20×20km grid over the Beaufort Sea and Chukchi Sea planning areas;
        - Calculated survey effort as the distance surveyed in each 20×20 km grid cell (total over all years);
        - Removed grid cells with less than 100 km of total survey effort from the rest of the analysis to establish adequate sampling;
        - Calculated an observation rate (i.e., relative density) for each whale species and walrus in each grid cell by dividing the observed number of animals over all years by the measure of total transect length over all years;
        - Smoothed grid cell values by first converting the grid cell values into point data with one point per grid cell at the centroid, and then running an anisotropic kernel density function with a 40 km north-south search radius and a 80 km east-west search radius;

    - Used the 50% isopleth (concentration of 50% of sightings) of the kernel density analysis to identify core areas—places with high relative density within the migration corridor. The 50% isopleth is the standard isopleth most often used to identify species core areas (e.g. Person et al. 2007, Western Arctic Caribou Herd Working Group 2011, Jay et al. 2012, Sexson et al. 2012). Migration corridors for bowhead whales and beluga whales were delineated by using the 80% isopleth;
    - Analyses were run for each planning area separately (Beaufort Sea Planning Area and Chukchi Sea Planning Area) as well as both planning areas together. In the accompany maps, if only one planning area is shown than the analysis only covered that planning area unless noted otherwise. If both planning areas are shown on the same map, than the analysis was across both planning areas.
    - While previous research has documented a difference in the bowhead migration path that is related to whether the year is a heavy or light ice year (Moore 2000), the data we analyzed is for light ice years. With the rapid loss of Arctic sea ice, we presume this analysis of light ice years is representative of current conditions that are predicted to continue into the near future (Overland and Wang 2013).

- **Spring migration corridor following the Chukchi nearshore lead system**
  - Spring migration routes for bowhead whales in the Chukchi Sea are known from traditional knowledge documentation (Kassam and Wainwright Traditional Council 2001).
    - Figure 17, found on page 35, depicts a generalized map showing bowhead whale hunting sites along the Chukchi Sea nearshore lead system.
    - Page 61 describes the importance of bowhead whales to the community and the sensitivity of bowhead whales to disturbance during the spring migration. "*Spring bowhead hunting is essential to the community of Wainwright from both a dietary and a cultural point of view. Preparation for the hunt is undertaken at both household and community levels…. Bowhead hunting is very sensitive to sea ice conditions and seismic activities by the oil and gas sector*."
  - Spring migration movements of bowhead whales relative to shoreline points in the Chukchi Sea are known from recent traditional knowledge documentation (Quakenbush and Huntington 2010).
    - Quakenbush and Huntington (2010) conducted semi-directed interviews with a single group discussion consisting of seven bowhead whaling captains with 35 years of combined whaling experience.
    - Page 7 describes seasonal spring movements. "*The movements of bowhead whales near Wainwright are determined primarily by ice conditions. Leads in the local area affect local distribution, whereas the condition of leads to the south influences the timing of the migration as a whole. The prevailing east-northeast winds tend to open the leads near Wainwright, with currents playing a role, too. West winds tend to close the lead, making whaling impossible. When the lead is closed, the whales*

travel farther from the shorefast ice. Currents are stronger by Point Belcher, and there is a strong current near the Kuk River mouth by Wainwright in late May and early June (Fig. 1). The whales often follow the shorefast ice edge, but may also travel directly from the Icy Cape area to the Point Belcher area, staying farther offshore as they pass the village. Wainwright whalers hear from St. Lawrence Island whalers and from Point Hope whalers that bowheads are migrating. They expect bowhead whales to reach the Wainwright area about a week after they reach Point Hope, depending on ice conditions in between."

  - Figure 2, found on page 17, shows the migration path, feeding areas and calving areas relative to the shoreline features of the Chukchi Sea coastline.
  - Page 12 discusses the sensitivity to disturbance of bowhead whales during spring migration: "*The whalers are concerned about how seismic operations may affect whaling and recalled an event in 1968 where they believe seismic activity on the ice in the spring affected their whaling success. Information about seismic testing in the 1960s is difficult to obtain. Federal records at the MMS office in Anchorage show permits were issued for open water seismic in 1968 for fall only. We have no information about such activities in state waters. The best available harvest records show that Wainwright landed two bowhead whales in 1968 and none in 1967 (Marquette and Bockstoce 1980) indicating that the year of the event may have been different. Regardless of the specific details of what occurred in the late 1960s, the whalers base their concerns about seismic activity on their past experiences as well as available information about current and planned activities.*"

- Satellite tracking results from 2006–2010 document bowhead whales migrating during spring along the nearshore Chukchi Sea lead system (Quakenbush et al. 2012).
  - Between the years 2006 and 2010, 57 satellite transmitters were deployed primarily by subsistence hunters. Thirty-seven transmitters were deployed near Barrow, Alaska with seven of these during the spring migration and 30 during the fall migration. Twenty were deployed near the Mackenzie River delta, all during the fall migration.
  - Areas of concentrated use were determined by kernel density estimation. Quakenbush et al. (2010a) page 293 describes the methodology. "*Kernel density estimation is a non-parametric method for calculating the probability that an animal occurs within a defined area. Such probability distributions are also known as utilization distributions (e.g., Kernohan et al., 2002); however, we use the term "kernel density" because it describes the method used to generate the probability distribution of animal locations.*"
  - While this method may help identify where tagged bowhead whales may have spent more time where their signal may be picked up at the surface, it may underestimate

the importance of areas where tagged bowhead whales may spend less time at the surface of the water.

- In 2009 the tagged bowhead whales departed the Bering Sea between 31 March and 27 April beginning their annual spring migration to the Arctic Ocean. In 2010, 5 of 6 tagged bowhead whales left the Bering Sea between 10 and 22 April.
- Page 9 describes the timing of the migration at Point Barrow, where the migrating bowhead whales move from the Chukchi Sea into the Beaufort Sea. "*The tracks northward to Point Barrow varied in distance from shore but most traveled on the U.S. side of the International Dateline (Fig. 9). A total of 12 tagged bowhead whales passed the spring bowhead survey station (i.e., "the observation perch") near Point Barrow; five bowhead whales passed between 16 April and 7 May in 2009, four passed between 23 April and 1 May in 2010, and three passed between 19 April and 5 May in 2011. Half of the tagged whales (6 of 12) passed the observation perch when leads were closed and whales could not be visually counted by observers. Leads were closed when one whale passed in 2009 (Fig 10a), when three passed in 2010 (Fig. 10b), and when two passed in 2011… However, it was clear that all tagged whales migrated within 20 km of the observation perch (Citta et al. In prep.).*"

o Page 9 describes both the distance from shore and the routing animals traveled past Point Barrow, where the migrating bowhead whales move from the Chukchi Sea into the Beaufort Sea. "*Bowhead whales traveled 6–18 km north of Point Barrow before turning east to cross the Beaufort Sea. The route used by a whale in 2006 was farther north than that used by seven whales in 2009 (Fig. 11). In 2009, all whales used a similar route, despite not traveling together. In 2010, however, two of eight whales used a similar route to the 2006 whale while the other six used a route similar to the 2009 whales.*"Satellite tracking results from 2010–2012 document bowhead whales migrating during spring along the nearshore Chukchi Sea lead system (Quakenbush et al. 2013).

- Page 26 describes the route that satellite tagged bowhead whales traveled along the nearshore Chukchi Sea lead system and use of the northeastern Chukchi Sea during the spring migration. "*Until 2010, tagged whales traveled north along the Alaska coast mostly east of the eastern boundary of the Chukchi lease sale area (Fig. 19) towards Point Barrow then on to Amundsen Gulf, Canada (Fig. 20). Whale B09-09, however, migrated later in the spring than the other tagged whales, leaving the Bering Sea ~26 May and traveled up the west side of the Chukchi Sea instead of the east side (Fig. 21). By 14 June 2010 this whale was west of Wrangel Island (Fig. 8) (Quakenbush et al. 2010b, 2012). Between mid June and 21 August 2010, B09-09 remained in the Chukchi Sea (Fig. 8) and this is the only whale tagged during the spring in any year that has not passed Barrow and entered the Beaufort Sea.*"
- Page 30 describes the migratory pathway of satellite tagged bowhead whales in the nearshore Chukchi Sea lead system. "*Chukchi Sea Lease Area 193. The route of the*

spring migration follows the Alaska coast to Point Barrow and few whales entered Area 193 or the leased blocks (Fig. 19). During the spring migration, whales transmitted within Area 193 between 16 April and 5 May (Fig. 23)."

- Spring migration, reproduction, and feeding areas from a recent synthesis of biologically important areas (BIAs) for cetaceans in the U.S. Arctic Ocean (Clarke et al. 2015)
  - Page 95 and Figure 8.1(a) describe and show the location of a reproduction BIA during the spring migration. "*BIAs for bowhead whale reproduction in spring and early summer (April–June) were based on neonate (recently born) calf sightings collected near Barrow during two studies (Figure 8.1a; Table S8.1). In the first study, calves were photographed in leads in the sea ice north and northeast of Point Barrow during aerial surveys conducted by the North Slope Borough and NOAA Fisheries in 2011 for the purposes of abundance estimation (Mocklin et al., 2012). These surveys started on 19 April, but the first cow-calf pair was not sighted until 9 May. In the second study, neonate calf sightings were recorded during ice-based counts conducted by the North Slope Borough and others from 1978 to 2001 (George et al., 2004). Segregation of size classes during the spring bowhead whale migration near Point Barrow has been documented, with cow-calf pairs generally the later migrants (Zeh et al., 1993; George et al., 2004). Bowhead whale cow-calf pairs are found in greatest density in this reproductive BIA from late May to early June.*"
  - Pages 95–96 and Figure 8.2 describe and show the location of a feeding BIA near Point Barrow and Barrow Canyon during the spring migration. "*Bowhead whales feed on a variety of zooplankton, including copepods, euphausiids, mysids, and amphipods (Lowry, 1993), taking advantage of food sources near the seafloor, in the water column, and at the water surface. Feeding behavior is likely under-represented in aerial survey data due to the difficulty of identifying feeding behavior in the brief periods of time when whales are observed. Some indications of feeding can be observed during initial sightings, including open mouth at the surface, mud on the rostrum, and echelon "V" formation (Lowry, 1993).*" … "*The BIA for bowhead whale feeding in May was based on aerial photographs of muddy whales taken in 1985, 1986, 2003, and 2004 (Mocklin et al., 2011) during the annual bowhead whale spring migration past Barrow (Figure 8.2; Table S8.2).*" While not documented in this synthesis, we note that feeding likely occurs in other areas of the spring migration corridor during the spring migration, but research has not been conducted to document feeding in other portions of the spring migration corridor.
  - Pages 97–98 and Figure 8.3 describe and show the spring bowhead whale migratory corridor BIA along the coast of the northeastern Chukchi Sea and along the continental slope area of the Beaufort Sea.

    "*In spring, most bowhead whales migrate north within the lead system that occurs annually in the Chukchi Sea along the Alaska coast*." … "*In the northeastern Chukchi Sea, the lead system is relatively well defined due to the* *warm water transported from the Pacific Ocean, high percentage of first-year ice compared to multi-year ice, and variable surface winds that move ice toward and away from the coastline (Mahoney, 2012).*"

"*The bowhead whale spring migration continues past Point Barrow before turning east to cross the Beaufort Sea in continental slope waters. Leads in the Beaufort Sea are fewer and more isolated, due to the movement of sea ice parallel to the coastline (under the influence of the Beaufort Gyre) and the higher percentage of multi-year ice (Mahoney, 2012). Bowhead whales are capable of breaking ice up to 18-cm thick to create breathing holes (George et al., 1989), and they have been detected acoustically (Clark et al., 1986) and satellite tracked in areas of very heavy ice (Quakenbush et al., 2010a). Based on data from aerial surveys conducted from 1979 to 1984 (Ljungblad et al., 1985); ice-based studies from 1978 to 2001 (George et al., 2004); and satellite-tagged whales (n = 16) in 2006, 2009, and 2010 (Quakenbush et al., 2010a, 2010b), the spring migratory corridor BIA was delineated by the Chukchi Sea lead system and the continental slope area of the western Alaskan Beaufort Sea (Figure 8.3; Table S8.3).*"

- Spring migration routes from NOAA (1988).
  - Section 3.75 of the NOAA (1988) atlas states that in "April–June: occur mostly from vicinity of St. Lawrence Island through Bering Strait to vicinity of Pt. Hope, then along eastern Chukchi flaw zone to Pt. Barrow, and via offshore leads to Banks Island." In addition, the accompanying map therein includes the Chukchi lead system as a "Major Adult Area" for the month of May.

- **Fall migration corridor through the central Chukchi Sea from Barrow Canyon across Hanna Shoal**
  - We conducted an analysis of ASAMM data to delineate the bowhead whale fall migration corridor and high relative density areas. To identify core use areas in the Chukchi Sea, we ran analyses of sightings just within the Chukchi Sea as well as sightings across both the Chukchi and Beaufort seas. The patterns of core use areas in the Chukchi Sea between the two analyses were nearly identical. Driven by sightings in 2012 and 2013, we identified core use areas that stretch from Point Barrow west to a region south of Hanna Shoal. These analyses indicate the importance of the head of Barrow Canyon and southern portion of the greater Hanna Shoal region to Bowhead whales during the fall migration. However, the use of these areas in the Chukchi Sea was driven primarily by sightings of bowhead whales during the falls of 2012 and 2013. As highlighted above, the use of this region may vary from year to year (Quakenbush et al. 2013, Clarke et al. 2014, Citta et al. 2015).

  - Bowhead whale feeding areas during the fall migration have been identified from satellite telemetry tracking (Quakenbush et al. 2010a).
    - Areas of concentrated use were determined by kernel density estimation.

- Figure 4, page 297, depicts important areas used by bowhead whales. These areas are determined from contours showing probability of use by tagged bowhead whales, from September 2006–2008.
- Page 302 describes the usefulness of kernel density maps for determining foraging hot spots, but how they may not adequately document important migratory corridors. "*Hence, on the basis of areas identified as important by our kernel density maps, substantial observations from the early 1970s to the present, and oceanographic characteristics (i.e., features favoring advection and trapping of zooplankton), we suspect that the areas where tagged bowhead whales spent more time are important for feeding. Although areas of high probability of use are likely important to bowhead whales, areas of low probability of use may also be important. For example, kernel density maps are not useful for identifying migratory corridors. Kernel densities are based upon the number of satellite locations per whale per month. Because whales moved quickly between areas of concentrated use, migratory corridors contained few locations and therefore exhibited a low probability of use.*"

o Bowhead whale migration pathways and potential feeding areas during the fall migration have been identified from satellite telemetry tracking results between 2006 and 2010 (Quakenbush et al. 2012).

- Between the years 2006 and 2010 57 satellite transmitters were deployed primarily by subsistence hunters. Thirty-seven transmitters were deployed near Barrow, Alaska with seven of these during the spring migration and 30 during the fall migration. Twenty were deployed near the Mackenzie River delta, all during the fall migration.
- Areas of concentrated use were determined by kernel density estimation.
- Page 16 describes the timing of the fall migration for tagged bowhead whales at Point Barrow. "*Whales passed Point Barrow during the fall migration between 21 July and 2 November*."
- Page 16 describes the routing of the fall migration for tagged bowhead whales across the Chukchi Sea. "*Once past Barrow, most tagged bowhead whales traveled across the Chukchi Sea to Wrangel Island, and then south to the Chukotka coast (Fig. 19).*"
- Figure 19, found on page 16, shows the tracks of 33 satellite tagged bowhead whales migrating through the Chukchi Sea Planning Area from August through December for the time period 2006–2010.
- Figure 20, found on page 17, illustrates the "*kernel density contours showing the probability of use (%) by bowhead whales in October, 2006–2008*." The region around Barrow and moving towards Hanna Shoal and the area from Point Barrow

moving towards Peard Bay show high probability of use that corresponds with our depiction for fall concentration areas for bowhead whales.

- Bowhead whale migration pathways and potential feeding areas during the fall migration have been identified from satellite telemetry tracking results between 2010 and 2012 (Quakenbush et al. 2013).
    - This is the second report on long-term study of bowhead whale satellite telemetry. The first report covered the time period from 2006 to 2010 (Quakenbush et al. 2012). Quakenbush et al. (2013) report on animals tagged between the years 2010–2013; however, the movement analyses covers bowhead whales tagged between 2006 and 2012.
    - 17 bowhead whales were tagged between June 2010 and December 2012 for a total of 41 bowhead whales tagged over the duration of the longer-term study. 26 of the 41 tagged bowhead whales were immature.
    - The results from this study suggest that there is high interannual variability with respect to where and when bowhead whales migrate through the northeastern Chukchi Sea. The authors propose that the high variability is dependent upon where and when prey aggregates.
    - Page 23 summarizes the general use of the northeastern Chukchi Sea. "*General Use of Chukchi Lease Sale Area including during drilling. Prior to 2012, virtually all whales (33 of 34) crossed the lease sale area, but no whales spent significant time within the sale area (Fig. 12). Whales typically crossed the Chukchi Sea quickly and then traveled slowly southward along the Chukotka coast, eventually into the Bering Sea. In contrast to this, most whales in 2012 lingered within the Chukchi Sea lease sale area (Fig. 13), co-occurring with drilling operations by Shell at the Burger Prospect (Fig. 14). Whales remained in the central Chukchi Sea until sea ice formed along the northwestern coast of Chukotka. Whales then traveled to the coast of Chukotka near Bering Strait and entered the Bering Sea in early December (Fig. 13).*"
    - Page 30 describes the timing that tagged bowhead whales were typically found within the Chukchi Sea Lease Area 193. "*Chukchi Lease Area 193: …The main period that tagged whales were present within Area 193 was in fall from approximately 28 August to 26 November, although some whales were sporadically present from 6 July to 25 December. On average, tagged whales were present within Area 193 for 10 days (range = 1 to 36 days, n = 45 whales).*"
    - Page 31 describes the residency patterns of tagged bowhead whales within the Chukchi Sea Lease Area 193. "*Residence patterns within the leased blocks were similar to those within the larger area (Fig. 23). Because the leased blocks represent a small area, fewer whales were found within the block boundaries….Tagged whales were present within the leased blocks on most days between 3 September and 25 November. A single whale tagged in 2010 was present within the leased blocks on 23*

and 24 July. Because the leased blocks are relatively small, residence times in the greater lease area are probably more representative of when whales might be found within leased blocks than the data from leased blocks alone. During the fall migration, 40 of 41 tagged whales (97.6%) entered the lease area (Table 4)."

- Page 55 describes the fall migratory pathway from Point Barrow to the Bering Strait. "*The fall migratory corridor between Barrow and the Bering Strait, however, is more variable. We think this is related to prey availability, which is also related to the timing of whale movements. Krill is concentrated by oceanographic factors, which vary in space and time. This results in complex movement patterns as individual whales travel to different feeding areas at different times.*"

o Further analysis of bowhead whale satellite tagging data presented in (Quakenbush et al. 2013) for the northeastern Chukchi Sea is being conducted with a focus on what biological oceanographic conditions may lead to the use of the lease sale areas by bowhead whales (information from Citta et al. (2015) poster presentation at the Alaska Marine Science Symposium).

o COMIDA/ASAMM aerial surveys document the presence of bowhead whales in the Chukchi Sea (Clarke et al. 2013).

- The Chukchi Sea Offshore Monitoring in Drilling Area (COMIDA) aerial surveys were conducted by the Minerals Management Service (MMS), now BOEM, and NOAA from 2008 through present (now called Aerial Surveys of Arctic Marine Mammals). MMS surveyed Chukchi Sea Planning Area from 1979 through 1991. COMIDA surveys marine mammal distribution, relative density and behavior during the open water period, mid-June or early July through October.
- Clarke et al. (2013) summarizes aerial surveys conducted from 30 June through 28 October, 2012. A total of 132 flights were flown with 433 sightings of 648 bowhead whales.
- COMIDA/ASAMM survey block 14 in the northeastern Chukchi Sea had the highest overall sighting rate in the entire study area (Beaufort and Chukchi Seas) for the COMIDA/ASAMM 2012 study period. Figure 7, on page 39, shows the ASAMM bowhead whale sightings plotted by month, with transect, search and circling effort for 2012. Survey block 14 is depicted on Figure 1, on page 6, and is generally north of Wainwright where depth of 36–50m changes into the 51–200m depth zone, which is presented in Figure 3, page 16.

- Sightings of bowhead whales in September and October were an order of magnitude higher compared with same time periods in 2011, with similar effort.

- Page v describes the predominant trends for bowhead whale sightings in 2012. "*In the northeastern Chukchi Sea, bowhead whales were scattered near shore in July and were not sighted in August, with the majority of sightings occurring in fall west of Barrow between 71°N and 72°N. Fall sighting rates (number of whales per km* *surveyed) of bowhead whales on transect in the western Beaufort Sea were comparable to sighting rates in recent years. The survey block with the highest overall sighting rate in the entire study area was block 14 in the northeastern Chukchi Sea. Sighting rate per depth zone between 140°W and 154°W in the western Beaufort Sea was highest in the 51–200 m depth zone in summer and the 21–50 m depth zone in fall. Sighting rates in summer and fall were highest in the ≤20 m depth zone in the Barrow Canyon area (154°W to 157°W) and in the 51–200 m North depth zone in the northeastern Chukchi Sea.*"

- o ASAMM aerial surveys documented the presence of bowhead whales in the northeastern Chukchi Sea during 2013 (Clarke et al. 2014).
  - ▪ Page 31 and 37 and Figure 7 describe and show the sightings of bowhead whales in the northeastern Chukchi Sea. *"Sightings in the Chukchi Sea were mostly west of Barrow between 71°N and 72°N. In early July, bowhead whales were seen scattered nearshore in the vicinity of Point Franklin and northwest of Icy Cape (Figure 6). In August, bowhead whales were seen scattered in the northernmost part (71.5°N to 72°N) of the study area. In September, distribution in the Chukchi Sea was mostly west of Barrow (71°N to 72°N). Bowhead whales were not seen south of 70.5°N. The greatest number of bowhead whales were seen in block 13 (n=46). Relatively few whales were seen in block 14 where the greatest numbers of bowhead whales were seen in 2012. Bowhead whale sightings in the northeastern Chukchi Sea in September 2013 reinforce previous observations from aerial surveys, satellite tracking (Quakenbush et al. 2010a), and acoustics (Delarue et al. 2011), describing a migration path that spreads across the CSPA. Bowhead whales were last observed in the northeastern Chukchi Sea on 30 September when 12 whales were seen approximately 250 to 400 km west-northwest of Barrow. The lack of bowhead whale sightings in the northeastern Chukchi Sea in October was likely due to lack of survey effort due to the government shutdown (1–17 October) and poor weather conditions (19–30 October) (Figure 6). Several bowhead whales were observed in the northeastern Chukchi Sea in October 2013 during vessel surveys conducted by the oil industry (L. Aerts, LAMA Ecological, pers comm. to J. Clarke, 10 February 2014)."*

- ➢ **Fall feeding area at Point Barrow near Barrow Canyon**
  - o Satellite telemetry of bowhead whales and analysis of physical and biological oceanography documents the importance of feeding areas near Barrow Canyon (Citta et al. 2014).
    - ▪ Page 17 and Figures 2 and 6 describe and show the use of Point Barrow as an important feeding area. *"The core-use area we identified using bowhead tag locations (Fig. 2) closely corresponded with the area identified by Ashjian et al. (2010) as having a high density of krill (see Fig. 9 in Ashjian et al., 2010) and a high density of whale sightings (see Fig. 13 in Ashjian et al., 2010 and Fig. 5a and b in Okkonen et al., 2011). However, the krill trap was difficult to identify with the oceanographic model because of its episodic nature and how we were summarizing*

(averaging) model results. Zooplankton must first be available to seed the shelf. East winds are then necessary to advect zooplankton onto the shelf and then must relax to trap zooplankton. If east winds do not relax, zooplankton exit the shelf to the northwest. This process was impossible to identify using salinity or temperature gradients because we averaged model results across years while whales were present. Instead, we illustrated the krill trap by plotting velocity under different wind regimes (Fig. 6e and f). We could only do so because we knew what pattern we were trying to identify; hence, the oceanographic model, as we applied it, was generally not useful for identifying features that may aggregate zooplankton near Point Barrow over shorter time frames."

- Satellite telemetry of bowhead whales documents the importance of feeding areas near Barrow Canyon (Quakenbush et al. 2010a).
  - Quakenbush et al. (2010a) used Kernel Density Estimation to identify areas of concentrated use. Page 293 describes the methodology. "*Kernel density estimation is a non-parametric method for calculating the probability that an animal occurs within a defined area. Such probability distributions are also known as utilization distributions (e.g., Kernohan et al., 2002); however, we use the term "kernel density" because it describes the method used to generate the probability distribution of animal locations.*"
  - While this method may help identify where tagged bowhead whales may have spent more time where their signal may be picked up at the surface, it may underestimate the importance of areas where tagged bowhead whales may spend less time at the surface of the water.
  - Figure 4 on page 297 illustrates contours showing probability of use by bowhead whale, September 2006–2008. "*In September, the highest probability of use was concentrated northeast of Point Barrow and extended to the east and west, south of the shelf break and the 200 m isobaths (Fig. 4).*"
- Satellite telemetry of bowhead whales documents importance of feeding areas from tagging conducted from 2006 to 2010 (Quakenbush et al. 2012).
  - Between the years 2006 and 2010, 57 satellite transmitters were deployed primarily by subsistence hunters. Thirty-seven transmitters were deployed near Barrow, Alaska with seven of these during the spring migration and 30 during the fall migration. Twenty were deployed near the Mackenzie River delta, all during the fall migration.
  - Areas of concentrated use were determined by kernel density estimation. Quakenbush et al. (2010a) page 293 describes the methodology. "*Kernel density estimation is a non-parametric method for calculating the probability that an animal occurs within a defined area. Such probability distributions are also known as utilization distributions (e.g., Kernohan et al., 2002); however, we use the term*

"kernel density" because it describes the method used to generate the probability distribution of animal locations."

  - While this method may help identify where tagged bowhead whales may have spent more time where their signal may be picked up at the surface, it may underestimate the importance of areas where tagged bowhead whales may spend less time at the surface of the water.
  - Barrow Canyon was identified as an important area, overall, on page 17. "*Areas where tagged bowhead whales spent the most time during the fall migration included Point Barrow, Wrangel Island, and along the northern coast of Chukotka, from Cape Schmidt to Uelen (Fig. 20). These areas should be considered important habitats for feeding given our data (Quakenbush et al. 2010a) and the observations of others (Moore et al. 1995, Zelensky et al. 1995)*."
  - Figure 20, on page 17, shows the kernel density contours showing the probability of use (%) by bowhead whales in October, 2006–2008. The region around Barrow and toward Hanna Shoal shows a high probability of use.

- Satellite telemetry tracking results from 2006–2012 show the importance of Barrow Canyon for tagged bowhead whales (Quakenbush et al. 2013).
  - Figure 30, on page 47, shows "*tagged bowhead locations by density using pooled location data (2006–2012). The highest density areas are in red*." In Alaska the key core area for bowhead whales is the region in both the Chukchi and Beaufort Sea around Point Barrow.
- COMIDA/ASAMM aerial survey sighting (Clarke et al. 2013).
  - Sighting rates in summer and fall were highest in the ≤20 m depth zone in the Barrow Canyon area (154°W to 157°W).
  - Page v describes the predominant trends for bowhead whale sightings in 2012, and highlights importance of Barrow Canyon. "*In the northeastern Chukchi Sea, bowhead whales were scattered near shore in July and were not sighted in August, with the majority of sightings occurring in fall west of Barrow between 71°N and 72°N. Fall sighting rates (number of whales per km surveyed) of bowhead whales on transect in the western Beaufort Sea were comparable to sighting rates in recent years. The survey block with the highest overall sighting rate in the entire study area was block 14 in the northeastern Chukchi Sea. Sighting rate per depth zone between 140°W and 154°W in the western Beaufort Sea was highest in the 51–200 m depth zone in summer and the 21–50 m depth zone in fall. Sighting rates in summer and fall were highest in the ≤20 m depth zone in the Barrow Canyon area (154°W to 157°W) and in the 51–200 m North depth zone in the northeastern Chukchi Sea.*"
- The Bowhead Whale Feeding Ecology Study (BOWFEST) has documented the use of the Point Barrow region by bowheads (Ashjian et al. 2010, Moore et al. 2010).

    - Ashjian et al. (2010) in a study on the distribution of zooplankton and bowhead whales off Point Barrow concluded on page 192: "*Transport of euphausiids from the Pacific Ocean to Barrow in the large-scale circulation, coupled with local wind forcing, provides at least two mechanisms by which euphausiids are concentrated on the western Beaufort Sea shelf near Barrow, resulting in a predictable and abundant food supply for the bowhead whales during their migration. Because the development of this feeding region and the arrival of the whales appear to persist despite ongoing climate variability, the fall whale harvest by the Iñupiat community at Barrow should be relatively resilient to climate change. The whale harvest at Barrow could, however, be particularly vulnerable to anthropogenic activities such as ship traffic, oil development, or an oil spill.*"

- Bowhead whale reproduction Biologically Important Area (BIA)
  - A region stretching across the Beaufort Shelf and continuing on from Point Barrow through the southern portion of the broader Hanna Shoal Region has been delineated as a reproduction BIA in the U.S. Arctic Ocean (Clarke et al. 2015)
    - Page 95 and Figure 8.1(d) describe and show the location of a reproduction BIA during the spring migration. "*Bowhead whale reproductive BIAs for summer and fall (July–October) were based on locations of cow-calf sightings made during ASAMM surveys from 1982 to 2012 (Clarke et al., 1987, 2012, 2013a; Clarke & Ferguson, 2010a, 2010b). ASAMM surveys encompassed a large geographic area, with fairly consistent temporal coverage within and between years, and these data were considered the best representation of bowhead whale calf distribution in the western Beaufort Sea. Bowhead whales were recorded as calves when they were noticeably smaller, particularly in comparison to a nearby adult, with which they were usually in close association. Bowhead whale calves are often, though not always, light gray in color. Calves grow quickly in the first year, increasing in length from 3.6 to 5.5 m at birth to > 8 m by August (Koski et al., 1993). This rapid growth during the first year makes differentiating calves from yearlings difficult, particularly in September and October. The reproductive BIAs (Figure 8.1b, c & d; Table S8.1) encompass areas where the majority of bowhead whales identified as calves were observed each season (Clarke et al., 2013a). Bowhead whale cow-calf pairs were observed in the eastern Alaskan Beaufort Sea in summer (July through August) and in the western Beaufort Sea in fall (September and October). They were seen in the northeastern Chukchi Sea only in October.*"

1.2 Beluga Whale

Two populations of beluga whales (*Delphinapterus leucas*) use the Chukchi Sea Planning Area: the Eastern Chukchi Stock (ECS) of beluga whales, which is estimated to have a minimum of approximately 4,000 whales; and the Beaufort Sea Stock (BSS), which is estimated to have a minimum of approximately 40,000 whales (Allen and Angliss 2013). Beluga whales usually spend the winter in the Bering Sea pack ice (NOAA 1988, Frost and Lowry 1990). In spring they migrate to their summering grounds (NOAA 1988, Frost and Lowry 1990, Moore et al. 1993, Clarke et al. 2015), where the whales congregate in shallow waters in specific locations along the coast in late June to July (Frost and Lowry 1990, Frost et al. 1993, Huntington et al. 1999, Richard et al. 2001). These congregation areas are stock-specific (ABWC 2011;2013, Allen and Angliss 2013). The whales disperse from the congregation sites, apparently following one of two strategies. Some tagged whales have been found to head far offshore into the ice pack, while others spend time in areas closer to shore with more open water (NOAA 1988, Richard et al. 2001, Suydam et al. 2001, Suydam et al. 2005). In the fall the whales migrate back toward and into the Bering Sea (Richard et al. 2001, Suydam et al. 2005).

The mapped concentration areas for beluga whales are based on the following scientific source materials.

- **The spring migration corridor for the BSS**
    - The BSS of beluga whales migrates along the Chukchi coast in April and May.
    - Clarke et al. (2015) provide a recent synthesis of BIAs for cetaceans. On Page 100 and Figure 8.5 they describe and show the spring migration corridor BIA for beluga whales. *"The spring migration of some belugas from the Bering Sea is generally similar to that of bowhead whales in that they use nearshore leads in the sea ice (Ljungblad et al., 1985; Mocklin et al., 2012). Acoustic data from overwintered recorders in the northeastern Chukchi Sea indicated that belugas also migrate farther offshore (Delarue et al., 2011). Most belugas sighted during this time period are heading northeast in the Chukchi Sea and east in the western Beaufort Sea, suggesting these early migrants are likely the BS Stock (Ljungblad et al., 1985). Based on these data, a migratory BIA for BS belugas in April and May was defined in the Chukchi and Beaufort Seas (Figure 8.5; Table S8.6)."*
    - Aerial surveys were conducted along much of the northwest Alaskan coast in the spring during the years 1980–84. The surveys conducted in the early 1980s suggest that the BSS beluga whales migrate to the Beaufort Sea from the Bering Sea by following a path through the Bering Strait, following the coastal Chukchi Sea lead system along the Alaska coast, and turning east around a degree north of Point Barrow in offshore leads. (Moore et al. 1993).
    - Hunters and elders from Wainwright note that there are two migrations of beluga whales, one in spring and one in summer, that pass by their community (page 29, 2001). The first migration of beluga whales comes with the spring bowhead whale migration. The hunters observe these whales from the edge of the landfast sea ice, which provides additional evidence of the location of the migration.
    - NOAA (1988) atlas summarizes the movements of beluga whales along the Chukchi Sea lead system. "*Some [belugas] continue to the Beaufort Sea via eastern Chukchi flaw zone to Pt. Barrow and via offshore leads to Banks Island and Amundsen Gulf*".
    - Moore et al. (2000) summarize the BS beluga stock along the Chukchi Sea lead system. "*The BS beluga stock follows a migration cycle similar to bowheads. In spring, white whales are often seen along the same route as bowheads*".

- The Alaska Department of Fish and Game (ADFG) has conducted research on bowhead whales and documented their spring migration route, shared by beluga whales.
  - The summary of the spring bowhead whale migration from the Bering Sea to the Beaufort Sea is described in its entirety on Figures 21–23, and within the text found on pages 29–32 (Quakenbush et al. 2010b). On page 29 the description of the transit through the Chukchi Sea. "*On average, whales took 11 days to travel from St. Lawrence Island to Point Hope (sd=2.3, n=6), six days to travel from Point Hope to Wainwright (sd=0.4, n=5), and one day to travel from Wainwright to Barrow (sd=0.5, n=5). Bowhead whales traveled mostly parallel and within 40 km of the Alaskan coast during the spring migration. There was little use of Chukchi Sea Lease Sale Area 193 during spring migration with only one of the six tracks skirting the eastern boundary (Fig. 21). Six whales were tracked past Barrow, the earliest passing ~16 April and the latest was ~6 May*."
  - Alaska Department of Fish and Game (2010) illustrates the tagged bowhead whale tracks from 2006–2010.
- Figure 1 shows the bowhead whale and beluga whale spring migration route through the Chukchi Sea (Moore and Laidre 2006).

- **Timing of the ECS migration to the Chukchi Sea Planning Area**
  - Of the nearly 30 ECS beluga whales that have been satellite tagged, only one tag lasted through an entire year (see tag 22149). Information from that tag suggests the ECS of beluga whales may not enter the Chukchi Sea Planning Area until summer. These whales may remain in the Bering Sea or southern Chukchi Sea until June. The tagged beluga whale moved into the Chukchi Sea Planning Area in June and moved to the Kasegaluk Lagoon area in late June (NMFS 2013).
  - Prior work suggested that beluga whales in Kotzebue Sound in late May and early June were part of ECS (Frost and Lowry 1990). However, recent genetic-based research indicates that those beluga whales may actually be from a different stock (ABWC 2011;2013).
  - Documented knowledge from Point Lay beluga whale hunters describes that the ECS whales congregate south of Kaseagaluk Lagoon in late June or early July (Huntington et al. 1999).

- **ECS Kasegaluk Lagoon high concentration area**
  - Kasegaluk Lagoon and the Kuk River estuary "*are important seasonal summer habitats of beluga whales*" (Bureau of Land Management 2003). Belugas are sensitive to human disturbance; airborne and waterborne noise may influence their distribution (Frost and Lowry 1990) and drive them from important habitats. Subsistence hunters have reported concerns that if the first returning belugas are disturbed as they move along the coast in the spring, succeeding groups of whales may not come within hunting range (Huntington and Mymrin 1996, Bureau of Land Management 2003).
  - Although there are notes on the occurrence of belugas in the region from the 1950s and 1960s (Bee and Hall 1956, Childs 1969), studies in the area did not begin until 1978 "*when*

observations and conversations with residents indicated that at least several hundred belugas occurred in the area each year" (Frost and Lowry 1990).

- Huntington et al. (1999) describe the general patterns and variability in beluga use of the Kasegaluk Lagoon hotspot (see Figure 5). The whales come into the coastal region generally around Omalik Lagoon. After congregating there for a period of time, groups of whales move north along the coast.
- Aerial surveys of the region have occurred sporadically since the late 1970s, which have consistently documented the region as an important area for Beluga whales.
  - Surveys flown in the late 1970s and early 1980s with results displayed on Figure 6 on page 439 (Frost et al. 1983), and on Figure 8 on page 52 (Frost and Lowry 1990).
  - Surveys flown in 1981, with survey results documenting Kasegaluk lagoon as a concentration area in Appendix 3, on the first set of maps on page 384 (Moore et al. 1993).
  - Surveys flown in 1987 (and prior years) depict the importance of Kasegaluk Lagoon, in Figure 8 on page 52 (Frost and Lowry 1990).
  - Surveys flown in 1990 and 1991 document the importance of Kasegaluk Lagoon as a concentration area for beluga whales (Frost et al. 1993). Frost et al. (1993) is specific to the use of Kasegaluk Lagoon by the ECS.
  - A hotspot analysis of surveys from 2007 to 2012 indicated that the area off of Icy Cape is a biologically important pelagic area in summer (June 15 to August 31) (Kuletz et al. in press).
- Given the consistent high use of the Kasegaluk Lagoon area and the regular subsistence hunt that is conducted there, the area was chosen as the location to satellite tag beluga whales (Suydam et al. 2005). Hauser et al. (2014) identified the area around Kasegaluk Lagoon as a summer core area based on the 50% utilization distribution of 24 satellite-tagged whales between 1998 and 2007 (Fig. 1).
- NOAA bases their minimum population estimates for the beluga whale ECS on aerial survey data for the region (Allen and Angliss 2013), which indicates that at least most of the ECS is believed to congregate in this area. NOAA surveys may not accurately estimate beluga population size, but point to the importance of the region for this population.
- Clarke et al. (2015) provides a recent synthesis of BIAs for cetaceans. On Pages 99–100 and Figure 8.4 they describe and show their identified BIA for reproduction and feeding in and around Kasegaluk Lagoon. *"Belugas in the ECS Stock calve, feed, and molt in June and July near Kasegaluk Lagoon, between Cape Lisburne and Icy Cape, Alaska (Frost et al., 1993; Suydam et al., 2001). Feeding and molting were inferred from belugas sighted during aerial surveys that were milling without noticeable movement in any direction. Diet of the ECS beluga stock is known primarily from stomach contents obtained from subsistence harvests in Point Lay and Barrow, Alaska, between 1983 and 2010, and includes fish (especially saffron cod [Eleginus gracilis]), cephalopods, and shrimp (Quakenbush et al., in press). Fish move along the shore and into the inlets of Kasegaluk Lagoon when the tide is going out (Huntington et al., 1999). Based on ASAMM aerial survey and satellite-tag data (Suydam et*

al., 2001, 2005), the Kasegaluk Lagoon area was designated as a reproductive and feeding BIA for ECS belugas, with highest densities in June and July (Clarke et al., 2013a) (Figure 8.4; Table S8.5)."

- **Summer ECS concentration area**
  - After gathering at the Kasegaluk Lagoon hotspot, beluga whales from the ECS move northward along the northern Alaskan Chukchi Sea coastline (Huntington et al. 1999). During this time and through the rest of the summer the ECS is concentrated in Barrow Canyon and the shelf break off Point Barrow. The evidence for this concentration area is derived primarily from satellite tagging data (Fig. 1 in Hauser et al. 2014) as well as from aerial surveys.
  - Our analyses of ASAMM data (methods described above in the Bowhead whale section) indicate based on aerial survey data that Barrow Canyon is a core area for beluga whales in summer and fall.
  - Most (but not all) whales move northeastward from the Kasegaluk Lagoon hotspot in a band that stretches from the coast out 50–100 km offshore. The few tagged whales that do not follow this pattern moved further offshore into the middle of the Chukchi Sea (Suydam et al. 2005, Suydam 2009).
  - Aerial surveys have noted whales along the coast and out to the edge of the ice pack north of Kasegaluk Lagoon (see aerial survey references in ECS – Kasegaluk Lagoon hotspot section). Repeated sampling corroborates that the whales move from south to north along the coast (Frost et al. 1993, Clarke et al. 2011b, Clarke et al. 2012, Clarke et al. 2013).
  - While some whales continue into Barrow Canyon and keep going north into the central Arctic basin (Suydam et al. 2001, AFSC 2013), a large number of whales spend considerable time along the coast, in Barrow Canyon, and along the shelf break in the vicinity of Barrow Canyon (Suydam 2009). See Figures 1 and 2 in Suydam et al. (2001) and Figures 2–12 in NMFS (ND).
    - More recent beluga whale satellite tagging data corroborates these patterns (NMFS 2013).
- **BSS fall migration corridor**
  - In the fall, the beluga whale BSS crosses the Beaufort Sea and passes through the Chukchi Sea into to the Bering Sea to overwinter (NOAA 1988, Richard et al. 2001). Figure 6 in Richard et al. (2001) depicts this migration route.
  - Of the BSS satellite tagged beluga whales that were captured during the fall migration (Richard et al. 2001), all whales crossed the northern Chukchi Sea to the region around Wrangel Island (see Figure 6). However, just nine of the thirty tags originally deployed lasted long enough to show this trek. Based on large sightings of animals in the Wrangel Island area (NOAA 1988), the authors believe this migration represents a "*large segment of the population*" (page 232 in Richard et al. 2001). All tags that made it to Wrangel Island traveled above 72 degrees north latitude through the Chukchi Sea (see Figure 6 in Richard et al. 2001).

- A similar pattern is documented in Hauser et al. (2014). Figure 2 shows that between September and November the BSS migrates across the Beaufort into the Chukchi Sea toward Wrangel Island then south along the Chukotka coast toward the Bering Strait.
- From 1988 to 1991 a concerted effort was made to survey Chukchi Sea waters north of 72 degrees latitude, but even those aerial surveys did not extend beyond 73 degrees for the most part (Moore and Clarke 1991, Clarke et al. 1993). Figure 2 in Clarke et al. 1993 and Figure 4 in Moore and Clarke 1991 show this effort. In those surveys, a large number of beluga whales were found migrating above 72 degrees north latitude (Figures 2, 3 and 5 in Clarke et al. 1993; Figures 8 and 19 in Moore and Clarke 1991). Clarke et al. (1993) concluded in their abstract: "*There appears to be a nearshore migration route roughly following the axis of Barrow Canyon, and an offshore route north of 72 degrees in the northeastern Chukchi Sea.*" Given the information in these figures as well as in Richard et al. (2001), there appears to be a migration route across the northern part of the Chukchi Sea above 72 degrees north latitude. Aerial surveys suggest a fair number of beluga whales observed between 72 and 73 degrees north latitude, but satellite tracking data indicates it is a broader migration path.
- It is unclear what proportion of the beluga whale BSS travel farther north than are regularly surveyed, but the numbers may be substantial based on the proportion of whales from Figure 6 in Richard et al. (2001) that passed well north of 72 degrees north latitude. ASAMM surveys are rarely flown in this region and there is very little coverage, given the survey tracts for Chukchi Sea surveys (Clarke et al. 2011b, Clarke et al. 2012, Clarke et al. 2013). Only one flight track has been flown recently in the region above 72 degrees north latitude in the Chukchi Sea Planning Area, which was on Sept 3, 2012 with a sea state that was primarily poor for spotting animals (Beaufort Sea State Scale 6 to 8). Further, September 3 is early to catch the migration of belugas in the region (see Table 5 in Richard et al. (2001)).
- Aerial survey data covering September and October suggests two paths across the Chukchi Sea: a northern (highlighted above) and a southern; Figures 2, 3 and 5 in Clarke et al. (1993), and Figure 19 inMoore and Clarke (1991). It is unclear if the southern route is used by BSS or if those whales are from the ECS (see below).

- **ECS fall migration concentration area and migration corridor**
  - During early fall, many ECS satellite tagged beluga whales are still found in Barrow Canyon as well as the region along the shelf break in the vicinity of Barrow Canyon stretching along the Beaufort shelf break to the (Suydam et al. 2005, Suydam 2009, AFSC 2013). Figures 1–12 in Suydam et al. (2005) depict this aggregation.
  - More recent ECS satellite tagging data corroborates these patterns (AFSC 2013, NMFS 2013). Hauser et al. (2014) Figure 2 shows that in October and November the ECS migrates across the Chukchi Sea toward Wrangel Island then south along the Chukotka coast and through the Bering Strait.
  - In October and November, beluga whales move into the Barrow Canyon area (where it seems a large number of them spend time) and generally head southwest towards the central Chukchi Sea, and eventually to the southern Chukchi Sea (Suydam et al. 2005).

    - Figure 4 on page 39 shows the locations of whales tagged in July 2001 between July 3 and December 5. Note the high use in Barrow Canyon and relative lack of whales locations across and north of the Hanna Shoal region, which indicates that whales entering the Beaufort Sea and Arctic Ocean basin likely return to the southern Chukchi Sea through the Barrow Canyon region.
    - Figure 9 on page 44 shows the location of whales tagged in 1998 and 2001 during October through December.
    - Figure 10 on page 45 shows the location of whales tagged between 1998 and 2002 by age class.
- More recent tagging data corroborate these patterns, specifically individual whale movements in October and November (AFSC 2013, NMFS 2013).
- As the population of ECS is so much lower in numbers than that of the BSS, it is difficult to use aerial survey data to pinpoint ECS use areas when the two stocks may be mixed. However, aerial survey data corroborates the use of Barrow Canyon by beluga whales in the fall generally, which has been presented in several publications
    - On page 437 of Moore et al. (2000), Figure 6 shows autumn beluga whale sightings, which are concentrated in Barrow Canyon as well as the Beaufort Shelf (Moore et al. 2000).
    - On page 45 of Moore and Clarke (1991), Figure 19 shows cumulative beluga whale sightings in the Chukchi Sea during the fall with high numbers of sightings in the Barrow Canyon area (Moore and Clarke 1991).
    - On page 387, in the abstract from their paper on fall migration patterns of beluga whales, Clarke et al. (1993) observe that "[*t]here appears to be a nearshore migration route roughly following the axis of Barrow Canyon.*" Figure 2 on pages 389–390 of this paper shows survey effort and beluga sightings for each year between 1982 and 1991 with relatively high numbers of sightings in Barrow Canyon apparent in most years. Figure 3 on page 391 shows the data in terms of relative abundance, and Figure 5 on page 394 shows the swimming direction of Beluga whales with a direction that is parallel to Barrow Canyon in regions B and D, which contain the canyon (Clarke et al. 1993).
- Additional support for the fall migration route may be found in more recent aerial surveys that cover Barrow Canyon. Figure 27 on page 77 of Clarke et al. (2012) shows beluga whale sightings in 2011 as compared to other light ice years with surveys (Clarke et al. 2012). Figure 28 on page 87 of Clarke et al. (2013) shows beluga whale sightings in 2012 as compared to other light ice years with surveys (Clarke et al. 2013). Figure 13 on page 22 shows beluga whale sightings during October (as well as other months) for the years 2008–2010 in the Chukchi Sea (Clarke et al. 2011b).
- Our analyses of ASAMM data (methods described above in the Bowhead whale section) did not provide evidence of a clear migration corridor across the Chukchi Sea planning area. Although the use of Barrow Canyon remains evident during the fall.

1.3 Gray Whale

The gray whales (*Eschrichtius robustus*) found in the Chukchi Sea Planning Area are from the Eastern North Pacific Stock that winters in the waters of Baja, Mexico, where they calve. Gray whales begin their yearly northward migration from February through May to summer feeding grounds located in the northern and western Bering Sea and much of the Chukchi Sea (Allen and Angliss 2013). Gray whales usually travel singly or in small groups. Aggregations may occur on productive feeding grounds. Gray whales prey on benthic infauna – amphipods and mysiids – by filtering food through their baleen while traveling near the seafloor as they suck up sediment. As such they occupy shallow coastal areas. While most of the stock summers in the southern Chukchi and northern Bering Seas, there are important concentration areas in the northeast Chukchi Sea (Clarke et al. 1989, Clarke et al. 2015).

The mapped concentration areas for gray whales are based on our analyses and Clarke et al. (2015), and are supported by the following scientific source materials.

- **Concentrated gray whale feeding habitat in the Chukchi Sea Planning Area**
    - Our analyses of ASAMM data (methods described above in the Bowhead whale section) delineate core use areas off Peard Bay and Point Franklin. The sources below indicate these areas are important for feeding and rearing of calves.
    - Clarke et al. (2015) provide a recent synthesis of BIAs for cetaceans. On page 102 and Figure 8.6 they describe a reproduction BIA, which are based on sightings of calves in the ASAMM database. Although there are not many calf sightings each year, the distribution of rearing grounds can be inferred from the data. *"Gray whale calf distribution in the northeastern Chukchi Sea overlaps the distribution of the gray whale population in general, with the exception that calves are rarely found offshore (e.g., Hanna Shoal and west of Point Hope) (Moore et al., 1986; Clarke et al., 2012, 2013a). The nearshore, shallow habitat may provide some refuge from potential predators (e.g., killer whales), or it may represent habitat more suited to the faster respiratory rate of calves (Krupnik et al., 1983). Most (98%) calves observed during ASAMM aerial surveys were within the gray whale feeding area BIAs described below (Figure 8.6; Table S8.8). Calves were seen from June through September, with the greatest number reported during July, which is also the peak month for gray whale sightings overall (Clarke et al., 2013a). July calves also had the most widespread distribution, extending from slightly east of Point Barrow to south of Point Hope. No calves were seen in the southern Chukchi Sea; however, there has been far less aerial survey effort in that area (Moore et al., 1986, 2003)."*
    - Clarke et al. (2015) on pages 102–103 and in Figure 8.7 describe and show gray whale feeding BIAs:

      "Gray whales have been documented feeding in the northeastern Chukchi Sea from summer through fall with little variability in location within these seasons. Gray whale feeding is identified during ASAMM aerial surveys as whales associated with mud plumes that are produced when whales surface after feeding on benthic or epibenthic species (Nerini, 1984). Gray whales are generalist feeders, however, and are not limited to benthic or epibenthic

prey (e.g., Bluhm et al., 2007); therefore, mud plumes may not always accompany gray whale feeding events. Consequently, gray whale feeding activity is likely underreported, although to a lesser extent than with bowhead whales. Gray whale BIAs for feeding (Figure 8.7; Table S8.9) were derived primarily from data collected during aerial surveys (Clarke & Moore, 2002; Goetz et al., 2008, 2009, 2010, 2011; Clarke & Ferguson, 2010b; Clarke et al., 2011c, 2012, 2013a), augmented by information from oceanographic and benthic investigations (e.g., Moore et al., 2003; Bluhm et al., 2007).

Feeding BIAs for gray whales include areas where gray whales have been observed feeding consistently during summer and fall, and consist of three principal areas. In the northeastern Chukchi Sea, gray whales have been observed feeding between Point Barrow and Point Lay, within approximately 90 km of shore. Feeding gray whales have also been sighted nearshore from east of Cape Lisburne (Ledyard Bay) to south of Point Hope in most months from June to October. Finally, in the southern Chukchi Sea, gray whales have been documented feeding offshore from approximately 66.5° N to 68.5° N in most months from June to October (Clarke & Moore, 2002; Bluhm et al., 2007). This southernmost feeding area extends across the International Date Line and may be even more extensive along the Chukotka coast (Anonymous, 2010). Gray whales were consistently seen feeding in September and October near Hanna Shoal (72° N, 160° W) in the late 1980s and early 1990s (Clarke & Moore, 2002), but they have been seen there infrequently since aerial surveys recommenced in 2008. Therefore, Hanna Shoal was not included as a BIA for gray whale feeding (Clarke et al., 2013a)."

- Data sources from surveys conducted from 1982 through 2011.
    - Gray whale concentration areas in the northeastern Chukchi Sea have shifted from the 1982–1991 and 2008–2010 survey periods, with sightings concentrated closer to shore than the Hanna Shoal region (Clarke et al. 2012). The Hanna Shoal region was an important concentration area in surveys conducted during the 1980s (see below). However, gray whale sightings have been recently moving farther offshore as documented in the 2011 and 2012 surveys (Clarke et al. 2012, Clarke et al. 2013). These increased sightings offshore should be taken into account and the Hanna Shoal region should not be precluded from consideration as important gray whale habitat as whales may return to these foraging hotspots in the future.
    - The highest sighting rate by depth zone (51–200m) has not changed over time, as the highest sightings across years (1892 through 2012) has remained in the 51–200m depth zone (Clarke et al. 2012).
- COMIDA/ASAMM aerial surveys support the concentrated gray whale habitat in the nearshore Chukchi Sea.
    - The Kuletz et al. (in press) hotspot analysis of 2007–2012 aerial survey data identified the area from Wainwright to Barrow as a biologically important pelagic area in summer and fall for gray whales.

- COMIDA surveys have been conducted by MMS/BOEM and NOAA from 2008 through present day (now called Aerial Surveys of Arctic Marine Mammals (ASAMM)); prior to that, MMS surveyed the Chukchi Sea Planning Area from 1979 through 1991. COMIDA/ASAMM surveys are designed to document marine mammal distribution, relative density and behavior during the open water period, mid-June or early July through October.
- 2012 survey results are summarized on page vi. "*Gray whales were seen in all months of the study period in the northeastern Chukchi Sea and westernmost Alaskan Beaufort Sea. Gray whale aggregations were observed within ~40 km of the Alaskan coastline between Point Barrow and Wainwright and very nearshore (<5 km) from Icy Cape to Cape Lisburne, particularly in July. Few gray whales were seen on Hanna Shoal (~72°N, 162°W), but sightings were offshore (up to 100 km) between Point Franklin and Icy Cape. Gray whales were also seen in the Barrow Canyon area and very nearshore east of Barrow. Sighting rate per depth zone was highest in the ≤35 m depth zone in the northeastern Chukchi Sea; highest sighting rate per month occurred in July and decreased sharply in August, September and October. Most gray whales (57%) were feeding. Sixty-seven gray whale calves were seen, although some calf sightings may have been repeat sightings*" (Clarke et al. 2013).
- 2012 survey results, displayed and presented on page 66, noted increased sightings offshore: "*Some gray whales appeared to be distributed farther offshore between Point Franklin and Icy Cape in late summer and early fall; few gray whales were seen near Hanna Shoal and offshore west of Point Hope*."
- 2012 survey results are presented on page 67, Figure 20. Figure 20 shows ASAMM gray whale sightings plotted by month. In particular, note block 13. Gray whale sighting rate is described on page 72: "*In summer and fall 2012, gray whales were seen on transect from 68°N to 72°N and 154°W to 169°W. There were 132 gray whale sightings on transect, ranging from one whale per sighting (n = 70) to eight whales per sighting (n = 2). The greatest number of sightings on transect was in block 13 with 52 sightings, followed by block 17 with 44 sightings. The highest sighting rates per survey block for the entire study period were in block 13 (0.017 WPUE) and block 17 (0.014 WPUE) (Table 10). However, highest sighting rate was in block 12 in August (0.018 WPUE) and block 14 in September (0.006 WPUE), blocks that generally have not had high sighting rates since ASAMM aerial surveys commenced in 2008. The highest monthly sighting rate was in July (0.015 WPUE); monthly sighting rate decreased through August and September and was lowest in October (0.001 WPUE)*" (Clarke et al. 2013).
- 2011 surveys summarized on page vi. "*Similar to previous years, locations where gray whale aggregations were observed continued to be near the Alaska coastline between Point Barrow and Point Franklin. Scattered sightings were observed offshore (>100 km) and very nearshore (<5 km) between Cape Lisburne and Point*

Hope. Similar to 2008–2010, gray whales were not seen on Hanna Shoal (~72°N, 162°W), but sightings were farther offshore between Point Franklin and Icy Cape than were observed in 2008–2010" (Clarke et al. 2012).

    - 2011 surveys are summarized on page vi. "*Sighting rate per depth zone was highest in the 51–200 m depth zone, a trend noted since surveys in the Chukchi Sea recommenced in 2008; the highest sighting rate per month was in July, which is earlier than the peak in 2008–2010. Most gray whales (62%) were feeding.*"
    - 2011 survey results are presented and discussed on page 59. "*In summer and fall 2011, gray whales were seen from 68°N to 71.5°N and 156.5°W to 169°W. There were 131 gray whale sightings on transect, ranging from 1 whale per sighting (n = 92) to 5 whales per sighting (n = 2). The greatest number of sightings on transect was in Block 13 with 68 sightings, followed by block 17 with 41 sightings. The highest sighting rates per survey block were in block 13 (0.014 WPUE) and block 17 (0.012 WPUE) (Table 9). The highest monthly sighting rate was in July (0.012 WPUE) and the lowest was in October (0.003 WPUE)*" (Clarke et al. 2012).
  - Clarke and Ferguson (2010) conducted aerial surveys of large whales from 2008–2009 and compared these observations with data collected from 1982–1991.
    - Page 4 discusses the important areas based on sightings. "*Gray whale distribution in 2008–2009 remained primarily nearshore between Pt Lay and Pt Barrow, and underscores the continued importance of that area to gray whales in all months surveyed. Overall sighting rates were lowest in June, increased through August, then decreased through October, reflecting the migration timing of gray whales in Alaskan waters (Rugh et al., 2001). This temporal pattern in sighting rates was repeated in data collected from 1982–1991 and also observed during oil industry-sponsored surveys in 2006–2008 (Thomas et al.,2010).*"
    - The predominant behavior was feeding in 2008–2009.
    - The authors noted a lack of gray whales at Hanna Shoal, as they were observed regularly there engaging in feeding behavior during the 1980s.
    - Data collected from the early years (1982–1991) provide valuable insight for distribution and density patterns relative to sea ice presence/absence.

- **Highly concentrated gray whale habitat – Hanna Shoal Region**
  - Data sources from surveys 1982–1991.
    - Aerial surveys conducted between 1982 and 1987 showed concentrations of Gray whales in the Hanna Shoal region (as defined in the section on walrus). While gray whales were not consistently observed in this area in the surveys conducted between 2008 and 2010, it is important to note that the region was not systematically surveyed between 1991 and 2008. The Hanna Shoal region is not only a potentially important concentration area for gray whales, it is also shows where

gaps in the data reflect the need for further study to better understand the migratory patterns and concentrations of these animals.

- o Clarke et al. (1989) documents gray whale distribution and relative abundance from July through early September from 1982–1987. "*Feeding whales were seen most often within 40 km of the shore, but also occurred offshore. Thirty-six gray whale calves were seen. Calf abundance (number of calves/survey hour) was significantly higher ($p < 0.001$) in July, when 92% ($n = 33$) of all calves were seen, than in any other month. Most cow–calf pairs were seen nearshore between Point Hope and Point Barrow.*"
- o Moore (2000) analyzed 1982–1991 autumn sighting data for variability in cetacean distribution and habitat selection.
  - Habitat selection was evaluated by species for selected oceanographic parameters A chi-square analysis was used to calculate habitat selection ratios to investigate cetacean use of shoal and trough features.
  - There were 495 flights conducted between September and October over the period from 1982 to 1991. Sightings of gray whales were made during randomly derived transect legs.
  - Page 453: "*Gray whales were seen more often than expected in coastal/shoal habitat in all ice conditions in the northern Chukchi Sea (Table 4). Distribution during heavy ice conditions was sparse and generally confined to coastal waters near Wainwright, with only three sightings offshore near shoal areas (Fig. 2). Conversely, during light ice years, clusters of gray whale [transect sightings] occurred in coastal and offshore shoal habitat*."
  - Page 455: "*Gray whales were seen more often than expected in coastal/shoal habitat across all transport conditions in the northern Chukchi Sea (Fig. 2, Table 8). An exceptionally high selection ratio (B4 = 0.93) reflects the strong affinity of gray whales for coastal/shoal habitat in years of high transport (Table 9). Conversely, in years of moderate and low transport, gray whales were more strongly associated with shelf/trough waters (B2 = 0.68 – 0.69). Indeed, standardized ratios suggest that the latter habitat was selected at least twice as frequently as coastal/shoal waters during moderate and low-transport years. Notably, there were no gray whale [transect sightings] in shelf/trough habitat during high transport years*."
- o Moore and Clarke (1992) summarize distribution, abundance, migration timing and habitat relationships from surveys conducted in 1991.
  - Aerial surveys conducted in 1991 from 20 September through 7 November were subsequently compared to surveys flown from 1982–1990. 134 surveys were flown in 1991 with 79% effort in the Chukchi Sea.
  - Page xiii: "*There were 20 sightings for a total of 26 gray whales in the study area in 1991, from 22 September to 7 October. Gray whale distribution along the Chukchi*

coast was similar to, but not comprehensive of, past years. Although fewer in number, gray whales were seen offshore in the vicinity of Hanna Shoal (GEL 180 to 210 km northwest of Barrow) as in 1986–87 and 1989, and for the first time roughly 95 km northwest of Point Barrow."

- Page xiv: "*Over ten survey seasons (1982–91), there were 167 sightings for a total of 424 gray whales in the study area during September and October. Relative abundance was highest in nearshore blocks near Point Hope and Point Barrow. The majority of gray whales (84%, n= 358) seen were feeding, usually in coastal blocks 13, 17 and 24. Offshore, feeding gray whales were seen in blocks 14 and 14N in 1986–87, 1989 and 1991, near the boundary of Hanna Shoal. Gray whales were usually (93%, n =394) in open water (O–1 0% ice cover), although gray whales were seen in ice cover up to 90%.*" Note, Figure 2, found on page 7, shows the location of the blocks, and the line separating blocks 14 and 14N approximately bisects Hanna Shoal.
- Page 88: "*There were 167 sightings for a total of 424 gray whales over nine survey seasons*."
- Page 94: "*Gray whale distribution was limited to three areas in the latter half of September: nearshore between Point Barrow and Point Franklin (ca. 70" 55'N, 155" W); offshore northwest of Point Franklin from 71030' to 72.30'N between 160"30' and 1620 30'W (sic); and along the coast at Point Hope (Fig. 29). Gray whale distribution during the first half of October was more widespread. Whales were seen along the coast between Point Barrow south to Icy Cape, northwest of Point Franklin (as in late September) and west of Icy Cape, and along the coast at Point Hope and Cape Lisburne. During the latter half of October, gray whale distribution was limited to nearshore waters between Point Barrow and Point Franklin, and the south-central Chukchi Sea southwest of Point Hope. Waters south of Point Hope were surveyed only in late October and November 1989–91, and high sea states often curtailed surveys in this area. Gray whales were seen in the southernmost Chukchi Sea, and between the Bering Strait and St. Lawrence Island in the northern Bering Sea, in late October and November 1980 (Clarke and Moore in press) suggesting that whales continue to feed in this area even as the southbound migration is underway in the southeastern Bering Sea (Rugh 1984).*"
- Page 94: "*The overall pattern of gray whale distribution highlights the importance of nearshore waters between Point Barrow and Point Franklin and offshore areas in the north-central Chukchi Sea. Gray whale distribution in offshore areas appears related to prey availability near Hanna Shoal. As elsewhere, most of the gray whales seen in the north-central Chukchi Sea were associated with mud plumes, which indicate foraging on benthic invertebrates (Nerini 1984). Although Hanna Shoal has not been sampled for potential gray whale prey, the occurrence of feeding whales there and*

not elsewhere in the northern Chukchi Sea indicate that these waters represent a feeding area that the whales move into when receding ice cover permits."

- Moore et al. (2000) analyzed 1982–1991 aerial survey data for seasonal variability in summer cetacean habitat selection.
  - 634 flights were flown in total, with 139 flights flown between July and August and 495 flown between September and October.
  - Water depth and sea ice were the two environmental variables recorded on randomly derived transect legs. Determinations for depth and oceanographic conditions were made post-survey. Habitat selection was tested with chi-square analyses and calculation of habitat selection ratios.
  - Page 438: "*Gray whale summer distribution was concentrated in the northern Bering Sea, with 93% (462 of 496) of all [transect sightings] in the Chirikov Basin (Fig. 7).*"
  - Page 438: "*In the Chukchi Sea, gray whale sightings were clustered along the shore, mostly between Cape Lisburne and Point Barrow*."
  - Page 438: "*Gray whales were associated with ice only in the northern Chukchi Sea. During summer surveys, they were seen in ice conditions to 30% surface cover and, more often than expected, in 0 – 20% ice habitat ($\chi 2 = 12.5$; $p < 0.01$)*."
  - Page 439: "*In autumn, gray whale distribution in the Chukchi Sea was clustered near shore at Pt. Hope and between Icy Cape and Pt. Barrow, and in offshore waters northwest of Pt. Barrow (Hanna Shoal) and southwest of Pt. Hope (Fig. 7)*."
  - Page 442: "*Gray whale selection of shoal and coastal habitat was strongest in summer. In autumn, gray whales selected trough habitats in the northern Chukchi Sea, a shift possibly coupled with a transition from feeding to migratory behavior.*"

2. PINNIPEDS

2.1 Pacific Walrus

Pacific walrus (*Odobenus rosmarus divergens*) range in the shallow continental shelf waters of the Bering and Chukchi Seas (USFWS Marine Mammals Management 2014). Winter breeding sites are usually found by areas of open water historically that includes recurring polynyas near Nunivak Island, St. Lawrence Island, and the Gulf of Anadyr (Smith 2010, USFWS Marine Mammals Management 2014). During the summer months, walrus typically range widely across the continental shelf on ice floes from which they forage on benthic organisms in water depths up to 100 meters (Smith 2010, USFWS 2011, USFWS Marine Mammals Management 2014). The primary prey of walrus are benthic invertebrates (Fay 1982, Sheffield and Grebmeier 2009, USFWS 2011) however other taxa are occasionally consumed. Large concentrations of walrus are found near Hanna Shoal and Wrangell Island during the summer (USFWS Marine Mammals Management 2014). In recent years Hanna Shoal has been characterized as a "critical foraging area" (Department of the Interior 2013) for walrus in the summer and fall; in particular for female/calf pairs (Brueggeman et al. 1990, Brueggeman et al. 1991, Jay et al. 2012, MacCracken 2012). Historically, there have been land-based haul-out sites with scant walrus occupancy; however, the land-based haul-out use has increased in recent years likely due to diminishing sea ice cover over shallow continental shelf waters (Jay and Fischbach 2008, Clarke et al. 2011b, Garlich-Miller et al. 2011, Jay et al. 2011).

Walrus radio and satellite tagging studies suggest that most areas occupied by walrus are correlated with foraging habitat, and that the most concentrated foraging areas likely correspond with high benthic biomass (Jay et al. 2012). Recent boat-based surveys conducted on leased tracts within the Hanna Shoal complex also suggest that walrus distribution is dependent on habitat (Aerts et al. 2013). The exception to the correlation between walrus concentration areas and foraging habitat are the land-based haul out sites along the Chukchi Sea coast. In recent years, tracking studies have shown that walrus travel tens of kilometers to foraging sites offshore from land-based haul-out sites (Jay et al. 2012). Walrus are sensitive to disturbance and are vulnerable to injury and mortality when hauling out in large numbers on land (Huntington et al. 2012, USFWS Marine Mammals Management 2014). The use of land-based coastal haul-out sites may increase in coming decades with the predicted declines in sea ice extent (USFWS Marine Mammals Management 2014).

The mapped concentration areas for walrus are based on the following scientific source materials.

- **Summer foraging concentration areas**
  - Using satellite tagging data, Jay et al. (2012) have estimated walrus foraging and occupancy was in the northeastern Chukchi Sea
    - 251 animals were tagged from June to September in the years 2008–2011.
    - Walrus foraging and occupancy utilization distributions (UDs) were determined. UDs are the probability of animals using an area during the time specified. A UD of 50% was identified as core use area of most concentrated use.
    - Figure 4, page 8 shows UD estimates by month. Earlier in the season (June) walrus foraging occurred in low ice concentration areas along the Chukchi coast. In July the "*area of highest foraging concentration in the eastern Chukchi was restricted to the northeastern sector*," which included parts of Hanna Shoal and the area south of Hanna Shoal. In August, this area extended outward to cover more of Hanna Shoal and the region surrounding the shoal. In September, the foraging area was reduced and closer to shore-based haul-out sites, likely due to lack of sea ice present for animals to haul out and rest upon.
    - Page 10, September in Figure 4: "*Notably, in 2009 and 2010, tagged walruses used the nearshore area immediately surrounding the onshore haul-out, but, in 2011 about half of the tagged walruses made round trips of up to about 200km northward to an area just south of Hanna Shoal (USGS, Alaska Science Center, unpubl. Data; see also September in Fig. 4), an area with high infaunal biomass of bivalves that was used extensively by walruses prior to September*."
  - Our analyses of ASAMM data (methods described above in the Bowhead whale section) provide supporting evidence of the importance of the region south of Hanna Shoal for

walruses. Very high densities of walruses are regularly seen south of Hanna Shoal during aerial surveys in the summer and fall, which resulted in the core use areas we found during both seasons. In the fall our density analyses were dominated by the coastal haulout near Point Lay, and therefore to show marine core use areas, we removed coastal haulouts, leaving only at-sea locations used in the analysis. In the fall the region around the large coastal haulout becomes a core use area for walruses (as opposed to summer) as numerous animals are seen in the water during surveys of the area.

- Aerial survey data from COMIDA/ASAMM effort from the 2013 field surveys published in 2014 corroborate the areas identified in Jay et al. (2012) as containing important walrus habitat (Clarke et al. 2014).
  - COMIDA surveys were conducted by MMS/BOEM and NOAA from 2008 through present day (now called ASAMM); prior to that MMS surveyed the Chukchi Sea Planning Area from 1979 through 1991. ASAMM surveys document marine mammal distribution, relative density and behavior during the open water period, mid-June or early July through October.Walrus were observed in all months with the exception of October; however, survey effort was significantly reduced. The majority of the sightings were in the northeastern Chukchi Sea in the Hanna Shoal Region.
  - Figure 34 on pages 100–101 shows the sightings of walrus and include sightings plotted by month with transect, search, and circling effort for July, August, and September. Table 16 shows the number of sightings; excluding dead and repeat sightings there were 367 sightings totaling 20,892 animals.

- Aerial Survey data from ASAMM effort from 2012 field surveys published in 2013 corroborate the areas identified in Jay et al. (2012) as being important for walrus (Clarke et al. 2013).
  - Walrus were sighted in all months during the 2012 survey in the northeastern Chukchi Sea. Figure 35, found on pages 97–98, shows the ASAMM walrus sightings by month (June–July, August, September, and October) and include transect, search and circling effort. A total of 470 sightings of 12,892 walruses were recorded (Table 3).
  - Walrus were observed in the water and hauled out on ice, particularly near Hanna Shoal during the period from July through August. This was also the time period during which most walrus sightings occurred. Block 14 in the COMIDA/ASAMM surveys is the survey block commonly associated with the area defined as Hanna Shoal (see below for discussion on the delineation of Hanna Shoal).
  - ASAMM surveys were conducted on 3 September 2012 specifically to assess walrus use of sea ice habitats. Most sightings on this day occurred near Hanna Shoal, where there were 12 sightings of 50 walruses (Page 96).
  - As the sea ice recedes and less sea ice habitat is available for animals to haul out on, they migrate towards the coast closer to Pt. Lay (Figure 35 c/d). As use of land-based haulouts increases, walrus make foraging trips from land-based haulout sites

to offshore foraging locations in the Hanna Shoal region. As a result of these foraging trips, these corridors between resting sites and foraging sites should be protected to ensure connectivity.

  - Walrus haulout sites on land were not observed during the COMIDA/ASAMM surveys in 2012; however, in years when sea ice recedes to the northern Chukchi shelf (e.g. 2009, 2010, 2011, and 2013), extensive use of land-based haulout sites occurs (Clarke et al. 2011b, Clarke et al. 2012).

- COMIDA data published in 2012 from 2011 aerial surveys in the Chukchi Sea corroborate those areas identified in Jay et al. (2012) as being important for walrus (Clarke et al. 2012).
  - Page 84: "*Walruses observed offshore in August and September appeared to show a preference for Hanna Shoal (~72°N, 162°W), presumably using this area as a feeding ground*."
  - Figure 31, pages 85–87 shows the region of Hanna Shoal as being important for walrus.
  - Page 84: "*In June and July, when sea and shorefast ice were still present in the study area, walruses were either hauled out on ice or swimming in open water; group sizes ranged from single animals to 600, with larger groups hauled out on ice. In early August, when sea ice had receded north and the study area was virtually ice-free (Appendix A), walruses were observed only in open water and were starting to congregate nearshore. On 17 August, the first aggregation of walruses to haul out on the Alaskan coastline during the 2011 field season was observed (Figure 32)*."
- Department of the Interior (2013) delineated the Hanna Shoal region as being important for walrus.
  - Page 35,370: Significant summer concentrations include areas near Wrangel and Herald Islands in Russian waters and at Hanna Shoal (northwest of Point Barrow) in U.S. waters.
  - The Hanna Shoal Use Area was delineated on page 35,371 using Jay et al. (2012) walrus foraging and occupancy utilization distributions (UDs). Figure 2 on page 35,424 shows Hanna Shoal, as well as the combined 50% foraging and occupancy UDs from Jay et al. (2012), from June to September at Hanna Shoal that represents the core use area during the time of most concentrated use by walrus.
- A hotspot analysis of aerial survey data from 2007 to 2012 indicated that Hanna Shoal is a biologically important pelagic area in summer (June 15 to August 31) and fall (September 1 to November 20) (Kuletz et al. in press).
- Recent vocalization studies show the importance of the Hanna Shoal complex (Day et al. 2013, Hannay et al. 2013). There were higher densities of both bearded seals and walrus in the southern region of Hanna Shoal in the area outside of the withdrawal as indicated by recorded vocalizations. Calls from both bearded seals and walrus were high in the southern region, particularly as the sea ice receded; both walrus and bearded seals hauled out on land and foraged more heavily in the southern region. See Figure 22 and 23 on page 161.

- **Fall coastal land-based haul-out sites and associated habitat**.
  - In recent years, land-based walrus haul outs at Icy Cape and Point Lay have increased substantially—a trend that will likely continue as late summer sea ice recedes earlier and further north due to climate warming (USFWS Marine Mammals Management 2014). When hauled out, walruses are highly sensitive to human disturbance, including aircraft or boat traffic (Garlich-Miller et al. 2011, USFWS Marine Mammals Management 2014).
  - A buffer for walrus haul out areas, from Icy Cape to Point Franklin and around the coast of Peard Bay, was recommended by Joel Garlich-Miller of the USFWS (personal communication January 2011).
  - Traditional knowledge from Point Lay and Wainwright document recent and historical use of the land-based haulout sites for walrus along the Chukchi Coast (Huntington et al. 2012). Figure 1, page 3 shows the locations for historic sites as well as recent haulout sites near Point Lay. Walrus haulout sites have been seen from Cape Sabine all the way to Point Franklin with the largest sites located at Point Lay, just south of Icy Cape, and at Mitliktavik. In addition, many walrus have been observed in the nearshore waters in the fall months, and a concern identified by the traditional knowledge holders is increased disturbance due to offshore vessel traffic and offshore oil and gas activities during the open water period.
  - During the 2013 field season, ASAMM sightings of walrus were primarily associated with sea ice and shorefast ice (Clarke et al. 2014). When sea ice receded north, beyond the shallow continental shelf, walruses started to congregate on coastal, land-based haulout sites. The first aggregation of walruses on shore were observed on 12 September about 6 km northeast of Pt. Lay in a similar vicinity to the 2010 ASAMM surveys (Clarke et al. 2011a). The largest group observed during surveys was about 10,000 animals on September 27. Figure 34 on page 101 shows the vicinity of the land-based haulout site as well as walrus observed in the nearshore, likely foraging.
  - Figure 18 from Clarke et al. (2011a) illustrates the COMIDA walrus sightings from surveys flown July–October 2010, showing and delineating the concentration near Pt. Lay. The differences in numbers hauled out also corroborate the status review (Garlich-Miller et al. 2011) and draft Stock Assessment Report (USFWS Marine Mammals Management 2014) assessment of traveling walrus from coastal land-based haul-out sites to offshore benthic feeding areas.
  - Documentation for the Pt. Lay coastal haulout also can be found from COMIDA/ASAMM aerial surveys flown in 2011 (Clarke et al. 2012).
    - Page vi: "*Documentation of a walrus haulout near Point Lay, from mid-August to early October. Unlike the walrus haulout documented near Point Lay in 2010, the 2011 haulout was observed earlier and for a longer period of time. Group size estimates of the haulout throughout the field season ranged from 1,000 to 20,000 walruses.*"

        - Page 84: "*In early August, when sea ice had receded north and the study area was virtually ice-free (Appendix A), walruses were observed only in open water and were starting to congregate nearshore. On 17 August, the first aggregation of walruses to haul out on the Alaskan coastline during the 2011 field season was observed (Figure 32)*."
        - Page 84: "*The walrus haulout was located approximately 6 km northeast of Point Lay, Alaska, relatively close to where walrus haulouts were documented during 2010 aerial surveys (Clarke et al. 2011d). The aggregation was documented on nine subsequent surveys between mid-August and early October. Group size estimates of the haulout throughout the season ranged from 1,000 to 20,000 individuals (Table 14). The haulout was documented on every survey near Point Lay until it was last observed on 6 October. Additional survey effort near Point Lay was conducted in mid-October (17 October), and no haulouts were observed. Walrus aggregations on land were observed earlier and for a longer period of time in 2011 compared to those observed in 2009 and 2010 (Clarke et al. 2011d)*."
    - Robards et al. (2007) compiled a map for walrus haulout sites from traditional knowledge.
        - Data about coastal haulouts within the range of Pacific walrus were compiled from numerous sources, including community members and researchers. This effort identified several walrus haulout sites along the Chukchi coast.

- **Subsistence hunting areas**
    - While the majority of the walrus subsistence harvest occurs on St. Lawrence Island, walrus are an important subsistence resource for the communities of the North Slope along the Chukchi coast (Pedersen 1979a, Braund and Burnham 1984, MMS Alaska OCS Region 1987;1996, United States Army Corps of Engineers: Alaska District 1999, Kassam and Wainwright Traditional Council 2001, Alaska Eskimo Whaling Commission et al. 2003, Stephen R. Braund and Associates 2010, Huntington et al. 2012, Nelson c1982).
    - The U.S. Fish and Wildlife Service collected subsistence harvest information, that included timing of hunting, from 2007 through 2011 (Department of the Interior 2013). FWS found the following times for majority of harvests for the following Chukchi communities.
        - Barrow: June and July when land-fast ice breaks up; can range up to 60 miles from shore.
        - Wainwright: most harvests among North Slope communities; up to 40% of the communities' subsistence use; hunt from June through August as sea ice retreats; distances around 20 miles but can range up to 60 miles from shore (Braund 2012).
        - Point Hope: late May and early June and August through September; distances usually 5 miles

    - Point Lay: hunting timing peaks in June–July; travel usually up to 40 miles offshore; recently land-based haul out hunting only at the beginning and end of herd formation**.**

- **Defining the Hanna Shoal Region**
    - During a time of rapid change, Hanna and Herald shoals appear to be important sea ice areas over the long term. These shallow areas divert warm water masses flowing northward from the Bering Sea, holding colder water long into the summer season (Weingartner et al. 2005). As a result, sea ice persists there longer into the season as well (Martin and Drucker 1997). Recent warming has changed the structure of this persistent lobe of ice, and the minimum September sea ice extent has come that far south only once in the last decade (National Snow and Ice Data Center 2010). In comparison, Hanna Shoal was ice-covered seven out of ten years in the 1980s and four out of ten years in the 1990s. Nonetheless, Hanna and Herald shoals continue to be areas of persistent ice floes, which are very important for ice-associated wildlife. Although the pack ice is expected to further recede with climate change, the seafloor topography is likely to continue to divert warm waters. Hanna and Herald shoals have the potential to provide substantial lingering ice floes well into the future compared to other areas in the region (Spall 2007), and may become a last stronghold for some ice-associated species such as the walrus.
    - During the 2013 field season, ASAMM sightings of walrus were primarily associated with sea ice and shorefast ice (Clarke et al. 2014). When sea ice receded north, beyond the shallow continental shelf, walruses started to congregate on coastal, land-based haulout sites. Clarke et al. (2014) support Jay et al. (2012) in the importance of the connectivity between Hanna Shoal and the coastline. Figure 34 on page 100 shows walrus sightings in the area withdrawn as well as in the area to the north and south. The region between Hanna Shoal and the coastline was important in September as sea ice disappeared and walrus started hauling out on land to rest during foraging.
    - Foraging depth of walrus is an important delineator for Hanna Shoal. The FWS status review (Garlich-Miller et al. 2011), on page 6 provides support for walrus foraging depth. "*Although walruses are capable of diving to depths of more than 250 m (820 ft) (Born et al. 2005), they usually forage in waters of 80 m (262 ft) or less (Fay and Burns 1988; Born et al.2003; Kovacs and Lydersen 2008), presumably because of higher productivity of their benthic foods in shallow waters (Fay and Burns 1988; Carey 1991; Jay et al. 2001; Grebmeier et al. 2006 a,b)*."
    - Hanna Shoal Use Area (HSUA) as described in Incidental Take Letter of Authorization (LOA) by the Department of Interior U.S. Fish and Wildlife Service (Department of the Interior 2013) on page 35371: "*To delineate the HSWUA, we overlaid the 50 percent UDs for both foraging and occupancy in Jay et al. (2012) in the Hanna Shoal area, as defined bathymetrically by Smith (2011), for the months of June through September. The combined area of those 50 percent UDs produced two adjacent polygons, one on the north slope of the bathymetrically defined shoal and one on the south slope of the bathymetrically defined*

shoal. We recognize that animals using the areas delineated by those two polygons would be frequently crossing back and forth between those areas and, therefore, joined the two polygons at the closest point on the west and east ends. The final HSWUA totals approximately 24,600 km2 (9,500 mi2) (Figure 2; see Final Regulation Promulgation section)."

- o NOAA and BOEM have also recognized and identified the importance of Hanna Shoal (Department of the Interior 2013). "*For example, the Audubon Society (Smith 2011) defined Hanna Shoal based on bathymetry, delineating an area of approximately 5,700 km^2 (2,200 mi^2). The National Marine Fisheries Service (NMFS) (2013) defined Hanna Shoal as an area of high biological productivity and a feeding area for various marine mammals, including bearded seals (Erignathus barbatus) and ringed seals (Pusa hispida). Their maps delineate an area of approximately 7,876 km^2 (3,041 mi^2). The BOEM Environmental Studies Program reflects both a Hanna Shoal Regional Study Area and a Hanna Shoal Core Study Area of about 720,000 km^2 (278,000 mi^2) and 150,000 km^2 (58,000 mi^2), respectively (BOEM 2013)*."
- o On January 27, 2015 under 12(a) of the Outer Continental Shelf Lands Act, 43 U.S.C. 1341(a), the President of the United States withdrew a portion of the Hanna Shoal Region—specifically the area lying within the contours of the 40-meter isobath. This area was withdrawn because of its ecological importance, including importance for walrus. This area is a smaller subset of the USFWS Walrus Use Area.

2.2 Spotted Seal

Spotted seals (*Phoca largha*) in Alaska, including those that utilize the Chukchi Sea Planning Area, belong to the Bering Distinct Population Segment (DPS) (Allen and Angliss 2013). They are widely distributed along the Bering, Chukchi and Beaufort continental shelves. Their distribution is determined both by seasonal sea ice and life history events (Boveng et al. 2009). Pupping, breeding and molting usually occur in association with the movement of seasonal sea ice from late fall through spring, which is when seals are primarily in the Bering Sea. As the sea ice diminishes each year, spotted seals move north into Arctic Ocean waters and regularly use barrier islands and coastal haulout sites. During the open water period animals are hauling out on land, presumably closer to areas with dense aggregations of prey (Frost et al. 1983, Burns 2002) or as resting bouts in between long-distance foraging trips offshore (Lowry et al. 1998). These land-based haulout sites have been identified by the community of Pt. Lay in their traditional knowledge of the region and have also been incorporated into the naming of Kasegaluk Lagoon.

The Outer-Continental Shelf Environmental Assessment Program (OCSEAP) conducted large-scale aerial surveys of land-based haulout sites for pinnipeds in the Bering Sea and Arctic Ocean, including the Chukchi coastline during the late 1980s. These surveys determined that for spotted seals, one of the most utilized sites was Kasegaluk Lagoon (Frost et al. 1983). Of fourteen known spotted seal haulout sites in Western Alaska and Eastern Russia, four are located in the vicinity of Kasegaluk Lagoon (Lowry et al. 1998). Kasegaluk Lagoon haul outs are used from mid-July through early September, and over 1,000 spotted seals have been observed on many occasions (Frost et al. 1993). Kaseaguluk Lagoon is one of the few areas where over 1,000 seals may haul out regularly and is the most significant site in the Chukchi Sea. Other large haulout sites for spotted seals are located in the Bering Sea (Frost et al. 1993).

Spotted seals are considered among the most wary of seals, exhibiting high sensitivity to aircraft within 1.25 miles, and sensitivity to human disturbances at their haul-out sites (Quakenbush 1988, Johnson et al. 1992, Frost et al. 1993). Minimizing disturbance to seals at Kasegaluk Lagoon is a conservation priority. Furthermore, with increasing periods of late summer ice-free periods, the time seals spend hauled-out on land may be critical to animals molting later in the season, such as later molting males and maturing pups (Boveng et al. 2009). This need to minimize disturbance to important spotted seal habitat is identified in the Stock Assessment Reports for spotted seals, especially the need to minimize disturbance from OCS exploration and development in the form of "*disturbance form vessel traffic, seismic exploration noise, or the potential for oil spills*" (Allen and Angliss 2013).

Spotted seals are an important subsistence resource for communities along the coast from the Beaufort Sea to Bristol Bay. Animals that have been satellite tagged from haul-out sites at Kasegaluk Lagoon have spent significant time in Kotzebue Sound, the Bering Strait, and in the Yukon-Kuskokwim delta region (Lowry et al. 1998). Minimizing disturbance at important land-based haul-out site like Kasegaluk lagoon will help ensure that communities outside the Chukchi Sea program area, where spotted seal is an important subsistence resource, will have continued access to subsistence hunting of spotted seals.

The mapped concentration areas for spotted seals are based on the following scientific source materials.

- **Highly concentrated spotted seal haulout areas**
    - Information for the location of important land-based haulout sites during the open water season for spotted seals comes from surveys conducted in the 1980s and 1990s (Frost et al. 1993).
        - Aerial surveys were conducted in 1989, 1990 and 1991 to document distribution, abundance and habitat use of spotted seals during July, August, and September, with surveys extended in 1991 until November.
        - Spotted seals were observed hauled out near Utukok Pass, Akoliakatat Pass and Avak Inlet. See Figures 1 and 2 (pages 9 and 10, respectively) for place name locations.
        - In 1989, the highest count was approximately 1800 spotted seals on September 1st with equal numbers at Utukok and Akoliakatat passes (Table 1, page 11). In 1990 the highest count was approximately 2100 seals on July 28 with over 1,000 animals observed in late August and early September (Table 2, page 11). Utukok Pass had higher numbers of animals observed earlier and Akoliakatat Pass had higher numbers of animals observed later. In 1991, approximately 2200 seals were observed on 29 September with equal numbers of seals observed at Utukok and Akoliakatat passes (Table 3, page 11). In 1991 the highest counts at Utukok Pass occurred in late September and Akoliakatat occurred periodically from late July through late September.

    - Page 13: "*There was no obvious seasonal pattern in the total number of seals hauled out in Kasegaluk Lagoon during July–September (Fig. 3). During 1989–91, counts of over l000 seals occurred any time from late July through late September, and similar large counts have been reported as early as 10 July (Frost et al., 1983). Maximum yearly counts occurred on 1 September 1989, 28 July 1990, and 29 September 1991*."
- Satellite tracking provided context about spotted seal movement in the Chukchi Sea (Lowry et al. 1998).
    - Movement and behavior of 12 spotted seals (8 males and four females) captured from Kaseagaluk Lagoon were tracked using satellite tags from 1991–1993.
    - Open water season (August–November) movements: "*During August–November, satellite-tagged seals alternated haul-outs at coastal sites with trips to sea. Seals hauled out at four areas in Kasegaluk Lagoon and at ten other locations along the coast of northwestern Alaska and the Chukchi Peninsula (Fig. 1, Table 2). The most frequently used haul-out area was Akoliakatat Pass…*"
    - Table 2 on page 224 shows the number, characteristic and location of spotted seal haulouts on land in Beaufort, Chukchi and Bering Seas, August to October 1991–1993.
    - Figure 2 on page 225 shows a map of Bering, Chukchi, and Beaufort Seas showing average daily at-sea locations of satellite-tagged spotted seals, August to November 1991–1993. This figure shows the concentration area by Kasegaluk Lagoon to Icy Cape.
    - Page 224: "*When they were away from haul-outs, seals were located in both coastal and offshore areas (Fig. 2). The most heavily used region was the eastern Chukchi Sea within about 120 km of the Alaskan coast*."
- Concentration of spotted seals at Kasegaluk Lagoon from other studies.
    - Concentrations around Kasegaluk Lagoon identified in aerial surveys conducted from 1992–1993 (Rugh et al. 1997)
        - Page 12: "*The principal locations with seal concentrations were (ordered from south to north) Kuskokwim Bay, … Good Hope Bay, and Kasegaluk Lagoon.*"
    - A traditional knowledge study conducted on walrus in Point Lay and Wainwright noted the importance of Kasegaluk Lagoon and other rivers for feeding seals throughout the summer months (Huntington et al. 2012). Hunters in Point Lay identified the region north of Point Lay as being important haulout area for spotted seals. They also identified (Figure 1, page 3) spotted seal haulout sites on small islands on the north side of Utuqqaq Pass and at the entrance to Avvaq Bay. Traditional knowledge holders further discuss the productivity that supports

foraging habitat in the nearshore for marine mammals and fish about 10–15 miles offshore.

- o Environmental Sensitivity Index (NOAA: Office of Response and Restoration 2005)
  - ▪ The NOAA Environmental Sensitivity Index indicates a high level of concentration (greater than 1000) potentially present in Kasegaluk Lagoon during the months June through November. Areas of importance nearshore for spotted seal are included on Map 17 and Map 18. Map 17 indicates the following sites and corresponding locations as being specific concentration areas for spotted seals: #75, 78, and 80.

2.3 Bearded Seal

Bearded seals (*Erignathus barbatus nauticus*) are circumpolar in their distribution; in Alaska they inhabit the shallow continental shelves of the Bering, Chukchi, and Beaufort Seas in waters less than 200m where they feed primarily on benthic organisms (Boveng and Cameron 2013). The Beringia Distinct Population Segment (DPS) occupies these general areas and thus the Chukchi Planning Area. In general, bearded seals are closely associated with sea ice, in particular offshore pack ice between 70–90% coverage about 20–100 nautical miles offshore (Bengtson et al. 2005, Allen and Angliss 2013). Sea ice is important during critical life history events such as pupping and molting when hauling out of the water may be important for thermoregulation or resting. It is during these critical time periods that bearded seals are known to concentrate in specific areas (Boveng and Cameron 2013). As such, bearded seals follow the seasonal movements of the pack ice. The Bering and Chukchi Seas contain some of the most continuous habitat across their circumpolar range and it is here that the longest migrations occur (Cameron et al. 2010).

Bearded seals are an important subsistence resource for communities in the Yukon-Kuskokwim delta all the way to Beaufort Sea communities. Some bearded seals that use the Chukchi Sea Planning Area also use areas in the Bering Sea. As a result, decisions affecting bearded seals in the Chukchi Sea OCS Planning Area may impact communities in the Yukon-Kuskokwim and Bering Strait regions, where bearded seals are an important subsistence resource (Boveng and Cameron 2013).

The mapped concentration areas for bearded seals are based on the following scientific source materials:

- ➢ **Highly concentrated bearded seal habitat – spring**
  - o Bengtson et al. (2005) determined density and population estimates for bearded seals.
    - ▪ Aerial surveys were conducted primarily along the coastal zone (within 37 km of the shoreline) with a few surveys between 148 and 185 km from the shoreline from north of the Bering Strait to Pt. Barrow.
    - ▪ Detection probabilities were estimated for each observer based on recorded sighting data (versus proxy-density values). Bearded seals were not observed as frequently as ringed seals in this study to estimate separate detection probabilities for each ice type, so all observations were used to estimate a global detection

probability. Densities were based on sighting recorded for all observers. Bearded sighting densities were not adjusted due to insufficient information about haulout patterns. Abundance of seals in each stratum were calculated as sum of abundance estimates for each line multiplied by ratio of stratum area to survey effort within the stratum. Density of seals in each stratum was the abundance estimate divided by the stratum area. Uncorrected densities for bearded seals likely underestimated the actual densities of bearded seals as those animals in the water were not accounted for. Traditional knowledge from hunters in the region indicates that during this time period there may be many animals present in the water.

    - The highest density of bearded seals in May–June was located in offshore pack ice with high benthic productivity, and thus a preferred food source. Figure 4b on page 839.

    - Figure 6 on page 841 illustrates for the Chukchi coastline, the estimated densities of bearded seals from May–June. The actual densities of bearded seals along this region may be under-represented as they are presented with unadjusted survey timing and seal haulout behavior for both 1999 and 2000. Additionally, the open lead was excluded from density calculation further underestimating density of bearded seals (which is likely an area of high use – see next section).

- **Highly concentrated bearded seal habitat – spring and summer**
  - Movement and behavior methodology to identify marine habitats of importance to bearded seals using movement and dive data (Boveng and Cameron 2013).
    - Boveng and Cameron (2013) identified seasonal movements and dive behavior of bearded seals as determined by satellite and time-depth transmitters.
    - To identify specific marine habitats in the Chukchi Sea Planning Area they fit movement and diving data to multi-state random walk model that allows for transitions between states of movement behavior for: foraging, transit and resting. Figure 5, page 20 depicts the model.
    - Bearded seals in this study utilized the Chukchi Sea Planning Area in all behavioral categories.
      - Page 64: "*All seven of the bearded seals tracked in this study moved through the Chukchi Sea Planning Area (CSPA) and two of the seven also used the Beaufort Sea Planning Area (BSPA) (Figure 8). The tagged bearded seals' use of the habitat within the planning areas was a mix of transit, foraging, and resting, as determined by the multi-state movement and behavior modeling (see next section).*"
      - Figure 11 on page 68 shows the modeled tracks of bearded seals for the summer period (June–September), fall (October–December) and winter (January–April) periods.

        - Two tagged bearded seals traveled offshore into the Chukchi planning area and engaged in foraging behavior, (see Figure 11, page 68).
    - The Chukchi nearshore corridor is an important area for bearded seals.
        - Seals captured in Kotzebue Sound traveled north in spring and were usually located within 50 km of the shoreline.
        - Page 64: "*The majority of the locations in the planning areas were in a corridor relatively near the Alaska coast (Figure 9). Of all the locations obtained from bearded seals in the CSPA, 70.8% were within 50 km of the coast.*"
    - There are some limitations as to the extent that bearded seal tracking results can be extrapolated from the Bering Sea DPS, as the sample size is limited to five subadult and two adult bearded seals.
- Boat-based surveys are also yielding new information about important habitat associations for species like bearded seals(Aerts et al. 2013). Both walrus and bearded seal distribution in the northeastern Chukchi Sea is heavily dependent upon habitat (and thusly forage) location (Aerts et al. 2013). The area north of the withdrawal is also important, particularly as sea ice recedes; this is among the lingering sea ice with easy access to the shallow floor before it drops to the Arctic Ocean shelf break and has particularly heavy use in August.
- Recent vocalization studies show the importance of the Hanna Shoal complex (Day et al. 2013, Hannay et al. 2013). There were higher densities of both bearded seals and walrus in the southern region of Hanna Shoal in the area outside of the January 27th withdrawal as indicated by recorded vocalizations. Calls from both bearded seals and walrus were high in the southern region, particularly as the sea ice receded; both walrus and bearded seals hauled out on land and foraged more heavily in the southern region. See Figure 22 and 23 on page 161.
- A traditional knowledge study conducted on walrus in Point Lay and Wainwright noted that there were abundant bearded and ringed seals basking, visible from shore (Huntington et al. 2012). Traditional knowledge holders further discuss the productivity that supports foraging habitat in the nearshore for marine mammals and fish about 10–15 miles offshore.
- NOAA: Office of Response and Restoration (2005) documents highly concentrated bearded seal habitat for spring and summer.
    - Chukchi Sea waters were included as being important for bearded seals from Barrow to Point Hope, offshore. Bearded seals were identified specifically in waters for maps 13–24 to the extent of the Chukchi waters represented by the maps.
- NOAA (1988) documents highly concentrated bearded seal habitat for spring and summer.

- In the map included in Section 3.74, the NOAA atlas (1988) identifies much of the Chukchi coastal lead system area as a “Major Adult Area” for the months of March and April.

2.4 Ringed Seal

Ringed seals (*Phoca hispida*) have a circumpolar distribution, and in the U.S. are found in the Bering, Chukchi and Beaufort Seas (Allen and Angliss 2013). In Alaska, they are considered one stock, and regional migratory patterns and movements are not well-known. Ringed seals are closely associated with sea ice and adapted to both pack ice and shorefast ice (Kelly 1988). In the Beaufort and Chukchi Seas, as the pack ice retreats, they generally follow the ice edge; however, some animals may remain near their fast ice habitats during the open water period (Kelly et al. 2010b). In the winter months, ringed seals in the Beaufort and Chukchi Seas remain in Arctic waters near landfast ice as well as leads and areas of open waters. Relative to other pinnipeds, they are among the most well-adapted to shorefast ice; they return to nearshore habitats prior to freeze-up and their densities tend to be the highest in fast ice regions (Frost et al. 2004). As water freezes, they maintain breathing holes in the ice, and as snow accumulates they excavate snow caves and maintain lairs for resting and pupping (Kelly et al. 2010b). As spring warms and melts snow accumulated over breathing holes, seals begin their annual molting cycle and will bask on top of ice for longer periods of time. Molting in adults may extend into July in the U.S. Arctic (Kelly et al. 2010b). Increasingly, there are concerns about the impacts as a result of climate change on ringed seals. In particular, the loss of sea ice and changes in snow cover may impact the timing and quality of lairs (Kelly et al. 2010b).

The mapped concentration areas for ringed seals are based on the following scientific source materials.

- **Highly concentrated ringed seal fast ice habitat**
  - Density and population estimates of ringed seals in the Chukchi Sea (Bengtson et al. 2005).
    - Aerial surveys were conducted primarily along the coastal zone (within 37 km of the shoreline) with a few surveys between 148 and 185 km from the shoreline from north of the Bering Strait to Pt. Barrow.
    - Density and population estimates were derived from aerial surveys and a correction factor to account for those seals not visible that may be in the water. The correction factor was determined using a model of the proportion of time out of the water for seals caught in Kotzebue Sound and Prudhoe Bay.
    - Average density of ringed seals was estimated as: 1.91 seals/km^2 and 1.62 seals/km^2, respectively for 1999 and 2000. Estimated densities of ringed seals in the eastern Chukchi May–June in 1999 and 2000 found are depicted in Figure 3 on page 838. Note that the open water lead was excluded from surveys and from density estimates as the surveys were counting those animals hauled out on ice.
    - The greatest density of ringed seals occurred south of Kivalina. However, there was still a relatively high density of ringed seals in the nearshore Chukchi in 1999 (again, refer to Figure 3 on page 838).

- Page 842: "*Ringed seals were four to ten times more abundant in nearshore fast and pack ice environments than in offshore pack ice. This distribution is consistent with the pattern reported by other authors such as Smith (1973), who reported that densities of ringed seals were much lower beyond 29 km from shore. The higher densities of ringed seals in the coastal areas was not surprising, given the importance of shorefast ice for ringed seal lairs and breeding habitat (Burns 1970; Smith and Stirling 1975; Smith and Hammill 1981; Lydersen and Gjertz 1986; Hammill and Smith 1989; Lydersen et al. 1990; Lydersen and Ryg 1991; Smith et al. 1991; Furgal et al. 1996).*"

o Information about key environmental correlates to determine density of ringed seals (Frost et al. 2004). Both water depth and location relative to fast ice edge are both factors that could be applied in identifying areas in the Chukchi as being important habitat for ringed seals.

  - Aerial surveys were conducted in the Beaufort Sea from late May through early June 1996–1999 using strip-transect methodology. They examined the effects of habitat, weather, and time of day on observed seal densities using univariate chi-square goodness-of-fit tests, and a multivariate generalized linear model to estimate the relationship between seal counts and covariates.
  - Observed densities ranged from 0.81 seals/km^2 in 1996 to 1.17 seals/km^2 in 1999. Water depth and location relative to fast ice edge and ice deformation were important determinants for higher densities.
  - Highest densities occurred at depths between 5–35m. Densities were also high in relatively flat ice and near fast ice edge, declining both shoreward and seaward.
  - Seals may return to shorefast regions before freeze-up as food resources in those regions may be plentiful and in the case of males, may start defending home ranges (Kelly et al. 2010a).

o A traditional knowledge study conducted on walrus in Point Lay and Wainwright noted that there were abundant bearded and ringed seals basking visible from shore (Huntington et al. 2012). Traditional knowledge holders also discuss the productivity that supports foraging habitat in the nearshore for marine mammals and fish about 10–15 miles offshore. They further note that while the other species of seals regularly haul out onto land, ringed seals never haul out onto land.

o NOAA (1988) documents highly concentrated ringed seal fast ice habitat.

  - In Section 3.72 with regards to ringed seal movements it states "Seals wintering in Bering Sea apparently move to Chukchi in May–June, return October–November. Others non-migratory, except for inshore-offshore movements. Fast ice mainly inhabited by adults in winter-spring; immatures reside offshore, moving too fast and remnant ice for molt, late spring-early summer" with emphasis added. In addition, the associated map identifies the region of shorefast ice as a "Major Adult Area" for the months of February to June.

- NOAA: Office of Response and Restoration (2005)documents highly concentrated ringed seal fast ice habitat.
  - The NOAA Environmental Sensitivity Index indicates that ringed seals are present in concentrations throughout the Chukchi in coastal waters and shorefast ice from October through July, engaging in pupping from March to May and molting from March to July. Maps 19–24 indicate particularly high concentration areas for ringed seals.
- Harwood (2012) identified seasonal movements and dive behavior of seven ringed seals (one adult female, three subadult males, two subadult females and one male pup) instrumented with satellite-linked (SLTDR-16) transmitters, and released at Cape Parry, Northwest Territories, Canada in 2001 and 2002.
  - Figure 1 on page 36 shows the tracks of ringed seals during the fall migration period with some deployments lasting into the winter (January-April) period.
  - All ringed seals tracked in this study migrated westward across the Beaufort Sea Planning Area into areas in the Chukchi Sea with one seal moving south into the Bering Sea at the end of the tracking period.
    - Page 42: "*The tracks and timing of westward fall migrant seals in this study revealed a routing through three political jurisdictions and included present-day oil and gas industry lease areas in all three. This fact points to the importance of cooperation between the United States, Canada, and Russia in the management of this species."*
  - While traveling through the Chukchi Sea planning area seals followed divergent tracks westward to the Russian coast off the Chukotka Peninsula, where the last locations we received were transmitted from five of the seven seals.
- To identify ringed seal use of specific marine habitats in the Beaufort and Chukchi Seas the data from Harwood (2012) were fit to a Bayesian Switching State-Space movement model that classified location and behavioral data into 12-hour time steps with an associated behavioral state estimation defined as either traveling or resident/foraging (Harwood et al. in press). Figure 26 in Appendix A shows the results of the model.
  - The tagged ringed seals' use of the habitat within the Beaufort Sea planning area as determined by the state-space model was a combination of traveling through the central Beaufort Sea migratory corridor and concentrated use of areas for resting/foraging at the eastern and western ends of the planning area (Figure 26).
  - Areas of resting/foraging identified by the state-space model corresponded with pinniped concentration areas identified by an ASAMM data analysis for pinnipeds (not presented in our map package due to data quality concerns) in the Barrow

Canyon Complex and the Eastern U.S. Beaufort that likely represent important marine mammal habitat use areas.

- There are some limitations as to the extent that ringed seal tracking results can be extrapolated from the Beaufort/Chukchi Sea analysis, as the sample size is limited to one adult ringed seal, five subadults and one pup.

3. POLAR BEAR

Polar bears (*Ursus maritimus*) occur throughout the Arctic in close association with the seasonal ice pack. The worldwide population of polar bears is estimated to be approximately 20,000–25,000 individuals distributed among 19 subpopulations (Schliebe et al. 2008). Within the United States portion of the range, polar bears most commonly occur at low densities over shallow continental shelf waters (<300 meters) within 180 miles of the Alaskan coast (USFWS 2013a). Polar bears from two separate sub-populations or stocks occur in Alaska: (1) the Chukchi-Bering Seas stock (CS); and (2) the Southern Beaufort Sea stock (SBS) (USFWS 2013b). The SBS population is estimated to have approximately 1,500 polar bears that range between Icy Cape on the Northwest coast of Alaska and Pearce Point in Canada. The distribution of the CS stock extends westward into the eastern portion of the Eastern Siberian Sea, Russia Federation, east past Point Barrow, Alaska, and southward into the Bering Sea, where the southern boundary is determined by the extent of annual ice. The size of the CS population is estimated at approximately 2000 individuals and may be declining, however there is a low level of confidence in the current population estimate (Evans et al. 2003).

Polar bears utilize sea ice habitat for foraging, and are most often concentrated near the ice edge, leads, or polynas over shallow continental shelf waters (Durner et al. 2004). The primary prey of polar bears in most areas of the arctic are ringed seals (*Pusa hispida*), and bearded seals (*Erignathus barbatus*) are also a common prey. Pacific walrus (*Odobenus rosmarus divergens*) calves are taken occasionally and polar bears will also scavenge walrus and bowhead whale (*Balaena mysticetus*) carcasses. Changes in the concentration and distribution of arctic sea ice that reduce access to prey may have a negative effect on polar bear growth and survival (Schliebe et al. 2008). Sea ice is also important for pregnant females to access denning sites. Pregnant females enter maternity dens by late November, and give birth in late December or early January. Changing sea ice patterns may negatively impact polar bear reproductive success and may also reduce foraging opportunities for females and cubs after they emerge from maternal dens. Based on recent satellite tracking studies, denning of pregnant females from the Chukchi Sea population occurs primarily on Wrangel and Herald Islands, and on the Chukotka coast in the Russian Federation (USFWS 2010a). Denning on the northwest coast of Alaska has decreased in recent decades, likely due to reduced sea ice connectivity with the Chukchi coastline during the late-fall (Fischbach et al. 2007, USFWS 2010a).

The polar bear was listed as a threatened species under the Endangered Species Act (ESA) on May 15, 2008 and is listed as vulnerable in the IUCN Red List of Threatened Species (Schliebe et al. 2008). The USFWS designated critical habitat for polar bear populations in the United States effective January 6, 2011 (USFWS 2010a). In the Federal Register listing, USFWS designated three separate units as components of polar bear critical habitat: (1) Sea-ice Habitat; (2) Terrestrial Denning Habitat; and (3)

Barrier Island Habitat. The designation of critical habitat was challenged in Federal Court by several parties, including the State of Alaska and the Alaska Oil and Gas Association. On January 11, 2013, the District Court for the District of Alaska, issued an order vacating and remanding to the Service specific sections of this rule (United States District Court For the District of Alaska 2013). As a result there is no legally designated critical habitat for the polar bear at this time.

The primary threat to the survival of threatened polar bear populations is the loss of sea-ice habitat throughout the species range (Durner et al. 2009, USFWS 2010a). If current trends of sea-ice loss due to climate change continue, polar bears may decrease by 30–50% in the next 50 years and may become extirpated from most of their range within 100 years (Schliebe et al. 2008). Other anthropogenic threats including oil and gas exploration and development, shipping, over-harvesting and the effects of toxic contaminants may also impact recruitment and survival (Schliebe et al. 2008). The potential effects of human activities are much greater in areas where there is a high concentration of dens (USFWS 2010a). Low-level negative impacts on polar bears due to oil and gas exploration and development include disturbance due to noise and human interaction and toxic effects from chronic releases of contaminants. The greatest threat to polar bears and their habitat from future oil and gas development is the potential effect of an oil spill or discharges into the marine environment (USFWS 2010a). (Amstrup et al. 2006) estimated that "*the numbers of bears potentially oiled by a hypothetical 5912 barrel spill (the largest spill thought probable from a pipeline breach) ranged from 0 to 27 polar bears for September open water conditions, and from 0 to 74 polar bears in October mixed ice conditions.*" If a spill of the magnitude of the Deepwater Horizon in the Gulf of Mexico were to occur, the effects could be catastrophic, especially if oil persisted in the marine environment over the winter and entered the coastal sea-ice lead systems where polar bears, the ice seals they prey upon, and other marine life would be severely impacted.

The mapped concentration areas for polar bears in this package are based on the best available scientific source materials. As stated in the Federal Register notice designating critical sea-ice habitat (USFWS 2010a), the main problem in identifying important areas for polar bears lies in identifying specific areas that are spatially and temporally consistent given the variability in sea ice extent and seasonal location within and between years. A recent habitat modeling study of Chukchi polar bears by Wilson et al. (2014) exemplified this, but also identified an area offshore of Ledyard Bay and the Lisburne Peninsula with consistently high use probability (>80%) for a longer period of time relative to other portions of the Chukchi Program Area. These areas are significant when ice is present in winter, spring and early summer. We note that there is an extensive history of radio and satellite tracking of polar bears and habitat utilization information and data layers exist from previous studies (e.g. Amstrup et al. 2006, Durner et al. 2009). USFWS and USGS are conducting new satellite tracking studies on bears from the Chukchi Sea population (USFWS 2010a)[1].

The map showing polar bear denning and feeding areas displays the following:

- **Polar Bear high use area**

[1] See also http://alaska.usgs.gov/science/biology/polar_bears/tracking.html)

- In late 2013 the US Fish and Wildlife Service conducted a resource selection function analysis for polar bears in the Chukchi Sea (Wilson et al. 2014). Results of that model were summarized in the Service's comments on the Call for Information and Nominations for Proposed Oil and Gas Lease Sale 237 in the Chukchi Sea Planning Area (US DOI Fish and Wildlife Service 2013). They found that "important habitat for polar bears in the Chukchi Sea extends from the shoreline to approximately 50–70 miles offshore from Point Hope north to Icy Cape. These areas have been identified as having a consistent high probability of use by polar bears." They further explain that the area is important because of polynyas with high densities of ringed seals and that the area is a movement corridor as sea ice recedes.

- **Major denning area**
    - The 1988 NOAA Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment Data Atlas delineated the boundaries within which major polar bear denning areas are located. Within the Chukchi Program Area the major denning area is coincident with the western extent of the area that was designated as ESA critical habitat. Within the Chukchi Sea Program Area these boundaries are consistent with recent studies of maternal denning habitat in Alaska (e.g. Fischbach et al. 2007).

- **Lower density denning area**
    - Key references that we used for lower density denning for polar bear included: (NOAA 1988, USFWS 1995, Fischbach et al. 2007). This map layer is derived from the 1988 NOAA Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment Data Atlas in combination with the USFWS Habitat conservation strategy for polar bears in Alaska (USFWS 1995). Use of the area west of Point Barrow by polar bears for denning has historically been lower than the Southern Beaufort Sea coast and may be decreasing due to the loss of late-fall sea ice connectivity. Conversely however, the importance of terrestrial denning habitat may be increasing due to the decline in multi-year sea ice. Radio and satellite telemetry studies elsewhere indicate that denning can occur in multi-year pack ice and on land. Recent studies of the SBS indicate that the proportion of dens on pack ice have declined from approximately 62% in 1985–1994 to 37% in 1998–2004 (Fischbach et al. 2007).
    - In the 2010 Final Rule designating polar bear critical habitat (CH) the USFWS noted that denning habitat west of Pt. Barrow lacks the required primary constituent element (PCE) of "*sea ice in proximity of terrestrial denning habitat prior to the onset of denning during the fall to provide access to terrestrial den sites.*" The USFWS cites radio tracking data indicating that historically, few bears denned in this region and that it is not accessible to pregnant females from the Chukchi/Bering Sea population in the fall. This view is also consistent with the data and findings presented in (Fischbach et al. 2007).

The map showing polar bear sea ice habitat selection by season is based on resource selection models published in Durner et al. (2009).

- On the advice of George Durner at USGS, our team mapped polar bear sea ice habitat selection by applying seasonal resource selection coefficients presented in Durner et al. (2009) to the last five years of available sea ice data. Average sea ice concentration data were acquired as 25-km monthly grids from the National Snow and Ice Data Center (2014) for each month from October 2008 through September 2013. Durner et al. presented four seasonal models. We assigned months to season based on the most common assignment in their analysis: winter—December through May, spring—June through July, summer—August through September, and autumn—October through November. The models were run for each of the 60 months, then monthly results were grouped by season and averaged into a four final seasonal layers representing mean habitat selection value over the most recent five-year period.

4. MARINE BIRDS

The Chukchi Sea is an important region for marine birds migrating, nesting, foraging, and staging through spring, summer, and fall. Multiple Important Bird Areas (IBAs) line the Chukchi Sea coast stretching into the offshore waters out to about 40 miles. One area of high abundance reaches 100 miles offshore off the Lisburne Peninsula where nearly 250,000 colonial nesting seabirds forage during the breeding season.

The maps for marine birds are based on the following scientific source materials.

- **Seabird Colonies**
  - The World Seabird Union, on behalf of the U.S. Fish and Wildlife Service and other entities, manages the North Pacific Seabird Data Portal, formerly the Beringian Seabird Colony Catalog. This extensive dataset includes ~1700 nesting colonies in Alaska (World Seabird Union 2011).
    - The abundance of each species present at each colony was recorded by surveyors counting the number of individuals, nests, or pairs over the last few decades. The database reports the best estimate made for that colony based on one or more site visits.
    - We eliminated records that were more than four decades old (pre-1971), rated as a poor quality estimate, or were otherwise questionable (Smith et al. 2012).
    - Based on this information, there are 30 nesting colonies on the Chukchi coast adjacent to the program area, which are home to 10 breeding species. The largest colony, Cape Lisburne, has an estimated 216,000 nesting birds in summer. There are approximately one quarter million seabirds nesting in coastal areas adjacent to the program area. These seabirds forage in the offshore waters of the Chukchi Sea.

Table 4-1. Estimate of breeding birds present at nesting colonies near the Chukchi Sea Program Area[1].

Location	ARTE	BLGU	BLKI	COEI	COMU	GLGU	HOPU	PECO	TBMU	TUPU	Total
Lisburne Peninsula											
Cape Dyer						48	24	26		4	**102**
Cape Lewis		28	3,000		7,500	50	300	58	17,500	4	**28,440**
Cape Lisburne		170	15,000		70,000	20	1,450	78	130,000	20	**216,738**
Corwin Creek								33		3	**36**
Kilikralik Pass						50	60	40			**150**
Kowtuk Point			100					30			**130**
Noyalik Peak							35	4		12	**51**
Sapumik Ridge		9									**9**
Subtotal		**207**	**18,100**		**77,500**	**168**	**1,869**	**269**	**147,500**	**43**	**245,656**
Kasegaluk Lagoon											
E. Akoliakatat Pass	42			442		10					**49**
Icy Cape Spit	6			62		2					**470**
Kasegaluk Lagoon 1				2		6					**8**
Kasegaluk Lagoon 2	4			2		4					**10**
Kasegaluk Lagoon 3				6		36					**42**
Kasegaluk Lagoon 4	2			18		14					**34**
Kasegaluk Lagoon 5				12		12					**24**
Kasegaluk Lagoon 6				6		14					**20**
Kasegaluk Lagoon 7				46		36					**82**
Kasegaluk Lagoon 8				50							**50**
Kasegaluk Lagoon 9				34		36					**70**
Kasegaluk Lagoon 10	2			102		8					**112**
Kasegaluk Lagoon 11	8			20		12					**40**
Kasegaluk Lagoon 12	4			8		10					**22**
Omalik Spit	10										**10**
Point Lay Barrier Is.				4		4					**8**
S. Kasegaluk Spit	2			6							**8**
S. Utukok Pass Is.				56		2					**58**
Sikok Point Barrier Is.	4			4							**8**
Solivik Island	36			538		40					**614**
Subtotal	**120**			**1,418**		**246**					**1,739**
Barrow Area											
Deadman's Island		30									**30**
Point Barrow Spit		14									**14**
Seahorse Island	24										**24**
Subtotal	**24**	**44**									**68**
Total	**144**	**281**	**18,100**	**1,418**	**77,500**	**414**	**1,869**	**269**	**147,500**	**43**	**247,508**

[1]ARTE = Arctic tern; BLGU = black guillemot; BLKI = black-legged kittiwake; COEI = common eider; COMU = common murre; GLGU = glaucous gull; HOPU = horned puffin; PECO = pelagic cormorant; TBMU = thick-billed murre; TUPU = tufted puffin.

- **Seabird marine hotspots**
  - A hotspot analysis of surveys from 2007 to 2012 indicated multiple biologically important pelagic areas for seabirds in summer (June 15 to August 31) and fall (September 1 to November 20) (Kuletz et al. in press).

        - Using a Getis-Ord Gi analysis, the analysis identified seabird hotspots in the Chukchi Corridor from Icy Cape to Wainwright, along Barrow Canyon near Point Barrow, and adjacent to Hanna Shoal in the summer. Fall hotspots in the Chukchi Sea Planning Area were near Cape Lisburne.
        - Surface-feeding seabirds concentrated in summer near Cape Lisburne, Wainwright, and Hanna Shoal; and in fall offshore between Icy Cape and the Hanna Shoal region.
        - Subsurface-feeding seabirds concentrated in summer near Cape Lisburne, Wainwright, and Barrow Canyon.
        - Benthic-feeding seabirds concentrated in summer near Cape Lisburne and Wainwright; and in fall near Icy Cape, Barrow Canyon near Point Barrow, and between Icy Cape and the Hanna Shoal region.
        - The Chukchi Corridor was particularly important for shearwaters, black-legged kittiwakes, thick-billed murres, crested auklets, and parakeet auklets in summer and fall; and ancient murrelets, Kittlitz's murrelets, and phalaropes in fall.
        - The Chukchi Barrow Canyon was particularly important for shearwaters in summer and fall, black-legged kittiwakes in summer, and Kittlitz's murrelets in fall.
        - The Hanna Shoal Region was particularly important for thick-billed murres, least auklets, and parakeet auklets in summer; crested auklets in summer and fall; and Kittlitz's murrelets in fall.
    - Audubon Alaska (2014) and Smith et al. (2014) analyzed globally significant coastal and marine IBAs through spatial analysis of at-sea survey data and aerial survey data.
        - The analysis was based on Drew and Piatt (2013) version 2 of the North Pacific Pelagic Seabird Database (NPPSD), a compilation of at-sea survey transect data that documents seabird densities in the Arctic Ocean and the North Pacific; as well as the Alaska Waterbird Database (AWD) version 1 which is a compilation of aerial survey data across the state of Alaska (Walker and Smith 2014).
        - The IBAs are based on BirdLife International's A4 criteria: places that regularly hold more than 1% of the North American population of a congregatory waterbird species (A4i), or more than 1% of the global population of a congregatory seabird species (A4ii) (National Audubon Society 2012).
        - Smith et al. (2014) developed a standardized and data-driven spatial method for identifying globally significant marine IBAs using six primary steps: accounting for unequal survey effort, filtering input data for persistence, producing maps representing a gradient from low to high abundance, drawing core area boundaries around major concentrations, validating the results, and combining overlapping boundaries into important areas for multiple species.
        - The authors "*tried to minimize uncertainty and leaned toward decisions that could potentially increase Type II error (false negatives, or failure to identify an area that is truly important) but decrease Type I error (false positives, or identifying an area as important that truly is not). This approach, along with*

survey coverage gaps in the available data, likely means that important areas exist in places not identified. Therefore, failure to identify an IBA did not necessarily mean that a particular area was unimportant (Rocchini et al. 2011)."

- Using data generated for the IBA analysis, Audubon Alaska (2015) analyzed a new product: the integrated globally significant proportion of birds, which provides a measure of importance by looking at a combination of both species abundance and species rarity, integrated over multiple species.
  - The data indicates relative importance using abundance normalized by population size, integrated for multiple species. It is the % of IBA threshold achieved, summed for all regularly occurring species.
  - The IBA threshold is 1% of the population, based on global population numbers for seabirds or on continental population numbers for waterbirds (BirdLife International 2012).

Table 4-2 Globally significant IBAs overlapping the Chukchi Program Area (Audubon Alaska 2014).

IBA Name	Global Trigger Species[1,2]	Continental Trigger Species	State Trigger Species	Estimated Abundance for Assessed Species	Species Richness
Barrow Canyon & Smith Bay	ARTE; BLKI; GLGU; KIEI; LTDU; POJA; REPH; RTLO; SAGU	BRAN; COEI	PALO	725,467	38
Chukchi Sea Nearshore	ARTE; BLKI; GLGU; LTDU; POJA; REPH; SAGU		COEI; RTLO	698,091	33
Icy Cape Marine	BLKI; GLGU; POJA			185,449	32
Kasegaluk Lagoon[3]	BRAN; SPEI		ALTE	>40,100	unknown
Ledyard Bay[3]	SPEI; BLKI; COMU	COMU	BLKI	>143,000	unknown
Lisburne Peninsula Marine	BLKI		GLGU; PALO	104,504	33
Point Lay Marine	LTDU		GLGU	32,088	24

[1]ALTE = Aleutian tern; ARTE = Arctic tern; BLKI = black-legged kittiwake; BRAN = brant; COEI = common eider; COMU = common murre; GLGU = glaucous gull; KIEI = king eider; LTDU = long-tailed duck; POJA = pomerine jaeger; PALO = Pacific loon; REPH = red phalarope; RTLO = red-throated loon; SAGU = Sabine's gull; SPEI = spectacled eider.

[2]Trigger species are those that met the global criteria, for which the IBA was recognized.

[3]Ledyard Bay and Kasegaluk Lagoon IBAs were based on different methods (satellite telemetry and expert assessment); abundance was estimated for the trigger species only and total species richness was not assessed.

5. LOWER TROPHIC LEVELS AND PHYSICAL FEATURES

Productivity and production at lower trophic levels can shape Arctic ecosystems, especially considering the relatively short food chains that occur in the Arctic (Grebmeier et al. 2006a, Grebmeier 2012). Primary production is ultimately the foundation of any ecosystem. In the northern Bering and Chukchi sea ecosystems, a greater proportion of primary productivity moves through the benthic portion of the food web compared to more southern regions, such as the southern Bering Sea (Hunt et al. 2002, Grebmeier et al. 2006b). This makes productivity of seafloor communities particularly important. Seafloor communities are an important prey resource in the Arctic for species at higher trophic levels, such as walrus, gray whales, bearded seals, and diving sea ducks (Bogoslovskaya et al. 1981, Suydam 2000, Moore et al. 2003, Petersen and Douglas 2004, Cameron et al. 2010, Jay et al. 2012, Boveng and Cameron 2013).

Complete data are not available on primary production or movement of production through the food web. However, there are good data sets on the distribution of patterns of water column algae during the open water period, as well as patterns of benthic biomass across the region—specifically the review put together by Grebmeier et al. (2006a). These are proxies that can be used to delineate areas that may be productive spots at lower trophic levels that are important to the productivity and structure of the Chukchi Sea ecosystem. The synthesis compiled by Grebmeier et al. (2006a) will soon be updated by the PacMARS project, but those data have not been made readily available to the public yet. The areas that generally have high concentrations of water column algae or benthic biomass, are likely important to the health of Arctic ecosystems.

Grebmeier et al. (2006a) generously shared their synthesis data sets for water column algae and benthic biomass with us. Specific methods they used to produce these data sets are described in their methods.

5.1 Primary Productivity

Areas that tend to have high concentrations of water column algae are Barrow Canyon, parts of Hanna Shoal, and the waters south of Hanna Shoal. To produce the map of primary productivity (integrated water column algae) in Appendix A we interpolated data values from Dunton et al. (2005), Grebmeier et al. (2014). For the analysis we:

- Established a 25×25km grid over the Beaufort Sea Planning Area;
- Calculated the average value for each grid cell;
- Smoothed grid cell values by first converting the grid cell values into point data with one point per grid cell at the centroid, and then running a simple kriging function with ESRI's Geostatistical Analyst extension.

Integrated water column algae are likely the best proxy available for the region. The open water season is an important time for production, as sea ice cover does not limit light penetration into the water column. While algal growth at the ice edge, in polynyas, in and under the ice, and in melt ponds may be significant, accurate measurements are not available for the Chukchi Sea area (Krembs et al. 2000, Hill and Cota 2005, Arrigo et al. 2012, Frey et al. 2012, Boetius et al. 2013). While there are satellite data available for the region, these data may not reflect biomass accurately because of subsurface plumes of phytoplankton; and satellite measurements need to be calibrated to account for sediments in coastal waters, which is ongoing (Lee Cooper personal communication with C. Krenz).

5.2 Benthic Biomass

The Chukchi Sea has high levels of benthic biomass compared to the Beaufort Sea. Areas with especially high levels of benthic biomass include the head of Barrow Canyon and the region South of Hanna Shoal. Hanna Shoal also has relatively high levels of benthic biomass, too. To develop the map in Appendix A, we used the same methods as used for primary productivity data.

While some of the data are relatively old—and sparse in some areas of the areas of the Chukchi Sea Planning Area—the patterns are at least a gross reflection of the distribution of hot spots of benthic biomass. The more recent information being synthesized as a part of the PacMARS project will undoubtedly clarify the patterns. Once available, that information should be used to delineate high benthic biomass areas.

5.3 Sea Ice

Sea ice is a defining ecosystem characteristic which consists of multiple types of features that influence the distribution of marine productivity and wildlife, such as pack ice, ice floes, leads, polynyas, landfast ice, river overflood, and under-ice freshwater pooling. In the Arctic, ice reaches it maximum extent in March, reaching in some years nearly to the Aleutian Islands in the eastern Bering Sea. In September each year, sea ice reaches its minimum extent, receding past the U.S. Exclusive Economic Zone, more than 200 miles offshore, north of 75° N latitude. This constantly changing, essential feature is a key to why the Arctic marine environment is so dynamic. Although the minimum sea ice extent varies significantly from year to year, the trend is an annually receding ice edge in all months of the year (Comiso 2002, Comiso et al. 2008). It is not known exactly how these dynamic sea ice features will change in a warming climate. Predictions of future sea ice conditions include earlier melting, later freeze-up, an increase in open water, retraction of sea ice from the productive continental shelf, declining multi-year ice, and less stability in landfast ice (USFWS 2010b). Wang and Overland (2009) predict a nearly sea ice-free Arctic summer in approximately 20 years, and more recent papers acknowledge that state could occur considerably sooner (Maslowski et al. 2012, Overland and Wang 2013).

Polynyas (recurrent, predictable open water areas in the sea ice) and open leads are important congregation and feeding areas for mammals and birds (Stringer and Groves 1991, Stirling 1997). Polynyas are continually changing in size and shifting position, which can make them difficult to map (Eicken et al. 2005). However, these openings are found consistently in some areas that are adjacent to land or grounded pack ice where the ice is blown offshore by the prevailing wind or pulled away by currents. Although summer ice pack has changed dramatically over the last four decades, winter ice openings have stayed fairly consistent (Eicken et al. 2005), indicating that areas important now and in the past are likely to persist into the future. In the Chukchi and Bering seas, there are two distinct classes of polynyas: persistent open areas off south-facing coasts and less frequently occurring wind-driven openings that occur off north-facing coasts (Stringer and Groves 1991).

Another important sea ice feature is landfast ice, which is stable ice that is fastened to the shore and remains much of the year. This feature provides an important platform for wildlife and subsistence hunters. In the Alaskan Beaufort Sea, landfast ice "*first forms in October and is anchored to the coast. It then rapidly extends some 20–40 km offshore to eventually cover ~25% of the shelf area and remains in place through June*" (Gradinger 2008). Landfast ice in this area has not changed in extent, although formation and breakup are occurring later and earlier compared to data from the 1970s; the ice is also less stable, with impacts on local hunting (Gradinger 2008).

Variation in ice cover is the dominant factor in the spatial pattern of primary productivity from phytoplankton (Wang et al. 2005). Many of the phytoplankton blooms and much of the wildlife activity occurring in the Arctic environment is concentrated at the ice edge. The sea ice is very important to primary productivity as a platform for large algal blooms happening on the bottom of the sea ice in spring and summer (Homer and Schrader 1982, Gradinger 2008, Laidre et al. 2008). Production associated with the sea ice is the base of an ice-associated food web that includes amphipods, Arctic cod, seabirds, and seals. "*It remains unresolved how changes in the diversity and productivity of the ice related biota combined with changes of the timing and regions of ice melt and formation will impact the ice itself and the tight sea ice-pelagic-benthic couplings in the arctic shelf seas*" (Gradinger 2008). Complicated by climate warming, baseline biophysical processes are difficult to measure. Nonetheless, an effort should be made to better understand sea ice dynamics in relation to climate change, which has the potential to significantly change the Arctic marine ecosystem as we currently know it.

The sea ice maps are based on the following scientific source materials:

- **Sea ice concentration**
    - National Snow and Ice Data Center (2013) distributes daily sea ice extent data, which is a product of the National Ice Center. Derived from satellite imagery, these data are the most current and complete resource for examining sea ice patterns in the Northern Hemisphere.
        - The National Environmental Satellite, Data, and Information Service (NESDIS), part of NOAA, has an extensive history of monitoring snow and ice coverage. Accurate monitoring of global snow and ice cover is a key component in the study of climate and global change as well as daily weather forecasting. By inspecting environmental satellite imagery, analysts from the Satellite Analysis Branch (SAB) at the Office of Satellite Data Processing and Distribution (OSDPD), Satellite Services Division (SSD), created a Northern Hemisphere snow and ice map from November 1966 until the National Ice Center (NIC) took over production in 2008.
        - Beginning in February 2004, further improvements in computer speed and imagery resolution allowed for the production of a higher resolution daily product with a nominal resolution of 4 km. NSIDC distributes the 24-km and the 4-km IMS product for February 2004 to present. In 2006, NSIDC started distributing 4-km GeoTIFF files for use with GIS applications.

- Audubon Alaska (2013) collected five years of daily sea ice extent data, using spatial analysis to derive grids of the percent of days with sea ice by month for the Northern Hemisphere from 2008 through 2012.
    - Daily sea ice extent data for the circumpolar north were collected for five years from January 1, 2008 to December 31, 2012 at a 4 km resolution (National Snow and Ice Data Center 2013). These data define sea ice presence as areas with greater than 15% ice concentration.
    - The data layers were summed by month then divided by the total number of days of data available for that month (occasionally a daily grid was unavailable from NSIDC due to processing error). The resulting statistic represented the percent of days with sea ice for each of 60 months (12 months over 5 years). Next, five grids for each month (2008 to 2012) were averaged, resulting in one grid each for the months of January through December representing the average percent of days with sea ice. Finally, months were combined into seasons by averaging three months together, as shown on the map.

6. SUBSISTENCE

Subsistence use area data have been collected on the North Slope since at least the 1970s (Pedersen 1979a;b). Until recently, these data have been based primarily on recall interviews, in which hunters are asked after the fact where they have traveled and hunted. Some studies document lifetime use areas (e.g., Pedersen (1979a;b), whereas others have looked at specific years (e.g. Stephen R. Braund and Associates and Institute of Social and Economic Research 1993a). While such data have been repeatedly shown to be reliable in providing a broad picture of subsistence patterns, there has always been a degree of uncertainty associated with the maximum extent, especially offshore where there are no landmarks by which hunters can connect their memories with a map. Widespread use of GPS by hunters has provided a much higher degree of certainty for hunting routes and harvest locations, whether by hunters noting where they are and reporting that information in interviews, or by hunters providing GPS data to researchers (e.g., the results of the Braund study that are being reviewed by BOEM at present). The combination of GPS, taking uncertainty out of navigation, and larger boats with more powerful engines has given hunters the ability to travel farther offshore. Recent studies (e.g., as reported in Stephen R. Braund and Associates 2010) document subsistence activities farther offshore than have been documented previously. The areas recorded in previous studies are thus confirmed as still being used, with the addition of more distant areas, up to 90 miles offshore in some cases.

More recent studies have also differentiated use areas by season. Not surprisingly, the greatest extent of offshore use is during summer, when hunters can travel by boat. Typically, such trips are in search of pack ice where hunters can find walrus and bearded seals. If animals can be found close to the community, hunters will not travel far. But with the rapid retreat of sea ice in recent summers, hunters often have to travel great distances, especially as the period between break up of shorefast ice (allowing boat launch and travel) and the disappearance of pack ice within boating range (ending the opportunity to get ice-associated animals) appears to be getting shorter.

Harvest areas can vary considerably from one year to the next, depending on environmental conditions and also the degree to which subsistence needs have been filled already. In years with poor spring bowhead whale harvests, for example, hunters may have greater incentive to find walrus and bearded seals in summer. In years with ice staying near shore, hunters may not have to travel far to find bearded seals needed for, among other things, making covers for skin boats (*umiaq*s) used the following spring during whaling.

Thus, studies that document harvest areas in a given year cannot be interpreted as representing the full use area over the course of many years. Even lifetime subsistence use areas, which in principle reflect the degree of spatial flexibility required for a hunter to continue to provide for his family and community over a long period, cannot be taken as indications of what will be required in future. Use areas can grow (e.g., as implied in Stephen R. Braund and Associates 2010) for offshore areas, assuming the areas farther offshore are in fact new use areas rather than areas that were inaccurately documented before), and they can also shrink due to environmental, social, and technological changes (e.g. Fienup-Riordan et al. 2013 for seal hunting in Emmonak). The essential feature is flexibility, so that hunters can adjust and adapt as needed, without unnecessary constraints. For example, the ability of bowhead whale hunters in Savoonga to hunt in fall (from the north side of St. Lawrence Island) as well as in spring (when they hunt from the south side of the island) was the result of changing ice conditions together with the lack of a restricted hunting season and the lack of any impediments or conflicting uses in what is now the fall whaling use area (Noongwook et al. 2007).

Recent subsistence use area studies have also estimated intensity of use (e.g. as shown in Stephen R. Braund and Associates 2010) in addition to aggregate spatial extent. Intensity can be a useful indicator of areas where conflicting uses would cause maximum disruption, but should not be over-interpreted to mean that areas of less intense use are unimportant or that activities in those areas would have minimal impact on harvests and food security. First, intensity of use can vary extensively from year to year, as noted earlier for annual use areas as a whole. Second, intensity of use for a community may not match intensity of use for individuals or households, some of whom may use different areas from the majority. Third, areas of lower use intensity may still be important at certain times or for procuring a full harvest. Thus, maps of intensity of harvest effort may be valuable for deciding the locations or routes of transitory phenomena (e.g., a barge bringing supplies to a village), but long-term facilities or impacts anywhere within the subsistence use area should be treated with great caution.

Finally, it is important to note that hunting areas are only one of the spatial aspects of successful hunting. The animals, too, need to thrive throughout their range in order to arrive in the hunting area healthy and in sufficient numbers to support an adequate harvest to meet local needs. Thus, protecting only the subsistence use area is unlikely to be adequate to protect food security of Chukchi coast villages. Disturbances within hunting areas are of most concern, because such disturbances can reduce the local availability of otherwise abundant animals or force hunters to travel farther, with greater risk, to have a successful hunt. Disturbances outside the hunting areas may not have as rapid or direct an effect on hunting success, unless they cause major changes in migratory routes, but they can affect the health and abundance of a population and thus lead to long-term impacts on subsistence harvests. A range of geographic characterizations of subsistence use areas, up to the “calorie-shed” (area from which one’s food comes) are described in Huntington et al. (2013), emphasizing that long-term activities need to be evaluated at the largest spatial scales.

Table 6-1 Summary of subsistence studies in the U.S. Chukchi Sea

Study	Period	Village(s)	Recall/Real time	Species specific?	Seasonal/ annual	GPS?
Pedersen (1979a)	Lifetime	Point Hope	Recall	Yes	Annual	No
Pedersen (1979b)	Lifetime	All North Slope	Recall	Yes	Annual	No
Nelson (c1982)	Lifetime	Wainwright	Recall	Yes	Annual	No
Braund and Burnham (1984)	1979–1983	Barrow, Point Hope, Point Lay, Wainwright	Recall	Yes	Annual	No
Impact Assessment Inc. (1989)	Lifetime	Point Lay	Recall	Yes	Annual	No
Stephen R. Braund and Associates and Institute of Social and Economic Research (1993b)	1988–1989	Wainwright	Real time	Yes	Seasonal	No
Stephen R. Braund and Associates and Institute of Social and Economic Research (1993a)	1987–89	Barrow	Real time	Yes	Seasonal	No
Kassam and Wainwright Traditional Council (2001)	Not specified	Wainwright	Recall	Yes	Annual	No
Stephen R. Braund and Associates (2010)	1997–2006, 2006	Barrow, Kaktovik, Nuiqsut	Recall	Yes	Annual	No

7. IEAs

Identification of Important Ecological Areas (IEAs) provides a way to prioritize spatial conservation, response, and restoration efforts. We define Important Ecological Areas as geographically delineated areas which by themselves or in a network have distinguishing ecological characteristics, are important for maintaining habitat heterogeneity or the viability of a species, or contribute disproportionately to an ecosystem’s health, including its productivity, biodiversity, functioning, structure, or resilience. For example, IEAs may encompass migration routes, subsistence areas, sensitive seafloor habitats, breeding and spawning areas, foraging areas, or areas of high primary productivity. As an exercise in valuation, determining “relative importance” requires a process for establishing and comparing values of individual or multiple ecological features on a similar scale. This can be accomplished using standard deviates, as described below.

The results we incorporate in our comments were based on an analysis in a 400,000 square kilometer area in the Beaufort and Chukchi seas off the north slope of Alaska. Ecological features used in the analysis were primary productivity, benthic biomass, sea ice, seabirds, marine mammals, and subsistence for which datasets were available or could be compiled. The study region was divided into a 10×10 km grid of study units. Spatial data for each ecological feature were overlaid on the grid and values for each study unit calculated. This created a distribution of study unit values for an ecological feature and values were then converted to standard deviates. Positive standard deviates from the different ecological features were added to provide a landscape of relative importance. Variability in the relative importance of planning units was found across the study region with Barrow Canyon, coastal areas, and the greater Hanna Shoal region (including areas to the south of the shoal) having high relative importance values.

Descriptions of the data layers used and the methods used to combine information are provided in a draft Atlas of Important Ecological Areas submitted during prior comment periods. That draft is available at: http://www.regulations.gov/#!documentDetail;D=NOAA-NMFS-2013-0054-0070.

8. References Cited

ABWC. 2011. Alaska Beluga Whale Committee Report to the 2011 Open Water Meeting. http://www.nmfs.noaa.gov/pr/pdfs/permits/openwater/day1_abwc.pdf.

_____. 2013. Alaska Beluga Whale Committee Report to the 2013 Open Water Meeting. http://www.nmfs.noaa.gov/pr/pdfs/permits/openwater/abwc.pdf.

Aerts, L. A. M., A. E. McFarland, B. H. Watts, K. S. Lomac-MacNair, P. E. Seiser, S. S. Wisdom, A. V. Kirk, and C. A. Schudel. 2013. Marine mammal distribution and abundance in an offshore sub-region of the northeastern Chukchi Sea during the open-water season. *Continental Shelf Research* 67:116-126.

AFSC, 2013. Movement of tagged beluga whales at Point Lay, Alaska 1998-2002. Accessed online 18 November at https://alaskafisheries.noaa.gov/protectedresources/whales/beluga/plmaps/summary98_02.pdf.

Alaska Department of Fish and Game, 2010. Bowhead Movements May 2006-July 2010. Alaska Department of Fish and Game, Juneau, AK. Accessed online October 2013 at http://www.adfg.alaska.gov/index.cfm?adfg=marinemammalprogram.bowheadmovements.

Alaska Eskimo Whaling Commission, U.S. National Science Foundation, North Slope Borough Department of Wildlife Management, North Slope Borough Planning and Community Services GIS Division, and Barrow Arctic Science Consortium. 2003. Bowhead Whale Subsistence Sensitivity Map. Alaska Eskimo Whaling Commission, Barrow, AK.

Allen, B. M., and R. P. Angliss. 2013. Alaska Marine Mammal Stock Assessments, 2012.

Amstrup, S. C., D. G.M., M. T.L., and J. W.R. 2006. Estimating Potential Effects of Hypothetical Oil Spills on Polar Bears. US Geological Survey Alaska Science Center, Anchorage, Alaska.

Arrigo, K. R., D. K. Perovich, R. S. Pickart, Z. W. Brown, G. L. van Dijken, K. E. Lowry, M. M. Mills, M. A. Palmer, W. M. Balch, and F. Bahr. 2012. Massive phytoplankton blooms under Arctic sea ice. *Science* 336:1408-1408.

Ashjian, C. J., S. R. Braund, R. G. Campbell, J. George, J. Kruse, W. Maslowski, S. E. Moore, C. R. Nicolson, S. R. Okkonen, and B. F. Sherr. 2010. Climate variability, oceanography, Bowhead Whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. *Arctic* 63:179-194.

Audubon Alaska, 2013. Monthly Percent of Days with Sea Ice for the Northern Hemisphere, 2008-2012. Audubon Alaska, Anchorage, AK.

_____, 2014. Important Bird Areas of Alaska, v3. Audubon Alaska, Anchorage, AK. Accessed online at http://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9.

_____, 2015. Integrated Globally Significant Proportion. Anchorage, AK. Accessed online at

Bee, J. W., and E. R. Hall. 1956. *Mammals of northern Alaska on the Arctic Slope*. Museum of Natural History, University of Kansas.

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.

BirdLife International, 2012. Important Bird Areas (IBAs). BirdLife International, Cambridge, UK. Accessed online August 28 2012 at http://www.birdlife.org/action/science/sites.

Boetius, A., S. Albrecht, K. Bakker, C. Bienhold, J. Felden, M. Fernández-Méndez, S. Hendricks, C. Katlein, C. Lalande, and T. Krumpen. 2013. Export of algal biomass from the melting Arctic sea ice. *Science*.

Bogoslovskaya, L. S., V. M. Votrogov, and T. N. Semenova. 1981. Feeding Habits of Gray Whale off Chukotka. International Whaling Commission,

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. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-200, Seattle, WA.

Boveng, P. L., and M. F. Cameron. 2013. Pinniped Movements and Foraging: Seasonal Movements, Habitat Selection, Foraging and Haul-out Behavior of Adult Bearded Seals in the Chukchi Sea. Anchorage, Alaska, USA.

Braund, S. R. 2012. Summary of marine subsistence uses: Barrow and Wainwright, Alaska. Prepared for The Pew Charitable Trusts U.S. Arctic Program.

Braund, S. R., and D. Burnham. 1984. Subsistence Economics and Marine Resource Use Patterns. *in Barrow Arch Environment and Possible Consequences of Planned Offshore Oil and Gas Development*. Prepared by LGL Ecological Research Associates, Inc. Prepared for U.S. Department of Interior, Minerals Management Service and Department of Commerce, NOAA., Anchorage, AK.

Brueggeman, J. J., C. I. Malmoe, R. A. Grotefendt, D. P. Volsen, J. J. Burns, D. G. Chapman, D. K. Ljungblad, and G. A. Green. 1990. 1989 Walrus Monitoring Program: The Klondike, Burger, and Popcorn prospects in the Chukchi Sea. Report from Ebasco Environmental, Bellevue, WA., for Shell Western E&P, Incl. Houston, TX.

Brueggeman, J. J., D. P. Volsen, R. A. Grotefendt, G. A. Green, J. J. Burns, and D. K. Ljungblad. 1991. Final report Shell Western E&P Inc. 1990 Walrus Monitoring Program: The Popcorn, Burger, and Crackerjack Prospects in the Chukchi Sea. Report from Ebasco Environmental, Bellevue, WA for Shell Western E&P, Inc. Houston, TX.

Bureau of Land Management. 2003. Northwest NPR-A Final Integrated Activity Plan and Environmental Impact Statement. BLM Alaska State Office, Anchorage, AK.

Burns, J. J. 2002. Harbor seal and spotted seal, *Phoca vitulina* and *P. largha*. Pages 552-560 *in* eds W. F. Perrin, B. Wursig, andJ. G. M. Thewissen *Encyclopedia of Marine Mammals*. Academic Press, San Diego, CA.

Cameron, M. F., J. L. Bengtson, P. L. Boveng, J. Jansen, B. P. Kelly, S. Dahle, E. Logerwell, J. Overland, C. Sabine, and G. Waring. 2010. Status Review of the Bearded Seal (*Erignathus barbatus*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-211. 246 p,

Childs, H. E. 1969. Birds and Mammals of the Pitmegea River Region, Cape Sabine, Northwestern Alaska. DTIC Document,

Citta, J. J., L. T. Quakenbush, S. Okkonen, J. George, R. J. Small, M. P. Heide-Jorgensen, L. A. Harwood, and H. Brower. 2015. Inter-annual variability in the fall movements of bowhead whales in the Chukchi Sea, *in Alaska Marine Science Symposium*. Anchorage, AK.

Citta, J. J., L. T. Quakenbush, S. R. Okkonen, M. L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J. C. George, H. Brower, R. J. Small, and C. J. Ashjian. 2014. Ecological characteristics of core-use areas used by Bering–Chukchi–Beaufort (BCB) bowhead whales, 2006–2012. *Progress in Oceanography*.

Clarke, J. T., A. A. Brower, C. L. Christman, and M. C. Ferguson. 2014. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2013. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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. Annual Report, OCS Study BOEM 2012-009. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J. T., C. L. Christman, M. C. Ferguson, and S. L. Grassia. 2011a. Aerial surveys of Endangered Whales in the Beaufort Sea, Fall 2006-2008. Final Report, OCS Study BOEMRE 2010-042. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J. T., and M. C. Ferguson. Aerial Surveys of Large Whales in the Northeastern Chukchi Sea, 2008-2009, with Review of 1982-1991 Data. Paper SC/62/BRG13 presented at the International Whaling Commission Scientific Committee Meetings, Morocco, 2010.

Clarke, J. T., M. C. Ferguson, C. L. Christman, S. L. Grassia, A. A. Brower, and L. J. Morse. 2011b. Chukchi Offshore Monitoring in Drilling Area (COMIDA) Distribution and Relative Abundance of Marine Mammals: Aerial Surveys. Final Report, OCS Study BOEMRE 2011-06. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J. T., M. C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Arctic Region. *Aquatic Mammals*:94-103.

Clarke, J. T., S. E. Moore, and M. M. Johnson. 1993. Observations on beluga fall migration in the Alaskan Beaufort Sea, 1982-87, and northeastern Chukchi Sea, 1982-91. *Report of the International Whaling Commission* 0:387-396.

Clarke, J. T., S. E. Moore, and D. K. Ljungblad. 1989. Observations on gray whale (*Eschrichtius robustus*) utilization patterns in the northeastern Chukchi Sea, July-October 1982-1987. *Canadian Journal of Zoology* 67:2646-2654.

Comiso, J. C. 2002. A rapidly declining perennial sea ice cover in the Arctic. *Geophysical Research Letters* 29.

Comiso, J. C., C. L. Parkinson, R. Gersten, and L. Stock. 2008. Accelerated decline in the Arctic sea ice cover. *Geophysical Research Letters* 35.

Day, R. H., T. J. Weingartner, R. R. Hopcroft, L. A. M. Aerts, A. L. Blanchard, A. E. Gall, B. J. Gallaway, D. E. Hannay, B. A. Holladay, J. T. Mathis, B. L. Norcross, J. M. Questel, and S. S. Wisdom. 2013. The offshore northeastern Chukchi Sea, Alaska: A complex high-latitutde system. *Continental Shelf Research* 67:147-165.

Department of the Interior. 2013. Marine Mammals; Incidental Take During Specific Activities; Final Rule.

Drew, G. F., and J. Piatt, 2013. North Pacific Pelagic Seabird Database (NPPSD) v2. US Geological Survey Alaska Science Center & US Fish and Wildlife Service, Anchorage, AK.

Dunton, K. H., J. L. Goodall, S. V. Schonberg, J. M. Grebmeier, and D. R. Maidment. 2005. Multi-decadal synthesis of benthic-pelagic coupling in the western arctic: role of cross-shelf advective processes. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3462-3477.

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.

Durner, G. M., D. C. Douglas, R. M. Nielson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. C. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. *Ecological Monographs* 79:107-120.

Eicken, H., L. H. Shapiro, A. G. Gaylord, A. Mahoney, and P. W. Cotter. 2005. Mapping and Characterization of Recurring Spring Leads and Landfast Ice in the Beaufort and Chukchi Seas. US Department of the Interior, Minerals Management Service, Alaska OCS Region, Anchorage, AK.

Evans, T. J., A. Fischbach, S. Schliebe, B. Manly, S. Kalxdorff, and G. York. 2003. Polar bear aerial survey in the eastern Chukchi sea: A pilot study. *Arctic* 56:359-366.

Fay, F. H. 1982. Ecology and biology of the Pacific walrus, *Odobenus rosmarus divergens* Illiger. *North American Fauna* 74:279 p.

Fienup-Riordan, A., C. Brown, and N. M. Braem. 2013. The value of ethnography in times of change: the story of Emmonak. *Deep Sea Research Part II* 94.

Fischbach, A., 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.

Frey, K. E., K. R. Arrigo, and W. J. Williams 2012. Arctic Ocean Primary Productivity and Nutrient Distributions. *in Arctic Report Card 2012*. http://www.arctic.noaa.gov/reportcard.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. In Advances in Research on the Beluga Whale. *Canadian Bulletin of Fisheries and Aquatic Sciences* 224:39-57.

Frost, K. J., L. F. Lowry, and J. Burns. 1983. Distribution of Marine Mammals in the Coastal Zone of the Eastern Chukchi Sea During Summer and Autumn. Outer Continental Shelf Environmental Assessment Program, Anchorage, AK.

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. 2004. Factors affecting the observed densities of ringed seals, *Phoca hispida*, in the Alaskan Beaufort Sea, 1996-99. *Arctic* 57:115-128.

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*). *USFWS, Anchorage AK. 163pp*.

Gradinger, R. 2008. Sea ice. *in* eds R. Hopcroft, B. Bluhm, andR. Gradinger *Arctic Ocean Synthesis: Analysis of Climate Change Impacts in the Chukchi and Beaufort Seas with Strategies for Future Research*. University of Alaska, Fairbanks, Institute of Marine Science, Fairbanks, AK.

Grebmeier, J. M. 2012. Shifting Patterns of Life in the Pacific Arctic and Sub-Arctic Seas. *Annual Review of Marine Science* 4:63-78.

Grebmeier, J. M., L. W. Cooper, H. M. Feder, and B. I. Sirenko. 2006a. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

_____. 2014. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

Grebmeier, J. M., J. E. Overland, S. E. Moore, E. V. Farley, E. C. Carmack, L. W. Cooper, K. E. Frey, J. H. Helle, F. A. McLaughlin, and S. L. McNutt. 2006b. A major ecosystem shift in the northern Bering Sea. *Science* 311:1461-1464.

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.

Harwood, L. A. 2012. Fall Migration of Ringed Seals (Phoca hispida) through the Beaufort and Chukchi Seas, 2001 - 02. Arctic.

Harwood, L. A., T. G. Smith, J. C. George, S. J. Sandstrom, W. Wojciech, and G. J. Divoky. in press. Changes in the Beaufort Sea ecosystem: diverging trends in the body condition of marine mammals, seabirds and anadromous char revealed through long-term monitoring. *Progress in Oceanography. Special Issue, Synthesis of Arctic Research (SOAR)*.

Hauser, D. D., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). *Polar Biology*:1-13.

Hill, V., and G. Cota. 2005. Spatial patterns of primary production on the shelf, slope and basin of the Western Arctic in 2002. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3344-3354.

Homer, R., and G. C. Schrader. 1982. Relative contributions of ice algae, phytoplankton, and benthic microalgae to primary production in nearshore regions of the Beaufort Sea. *Arctic* 35:485-503.

Hunt, G. L., P. Stabeno, G. Walters, E. Sinclair, R. D. Brodeur, J. M. Napp, and N. A. Bond. 2002. Climate change and control of the southeastern Bering Sea pelagic ecosystem. *Deep Sea Research Part II: Topical Studies in Oceanography* 49:5821-5853.

Huntington, H. 2013. Traditional Knowledge Regarding Bowhead Whales and Camden Bay, Beaufort Sea, Alaska. Eagle River, AK.

Huntington, H., and N. I. Mymrin. 1996. Traditional Ecological Knowledge of Beluga Whales: An Indigenous Knowledge Pilot Project in the Chukchi and Northern Bering Seas. Final Report. Inuit Circumpolar Conference, Anchorage, AK.

Huntington, H. P., M. Nelson, and L. T. Quakenbush. 2012. Traditional knowledge regarding walrus near Point Lay and Wainwright, Alaska.

Huntington, H. P., I. Ortiz, G. Noongwook, M. Fidel, L. Alessa, A. Kliskey, D. Childers, M. Morse, and J. Beaty. 2013. Mapping human interaction with the Bering Sea ecosystem: comparing seasonal use areas, lifetime use areas, and "calorie-sheds". *Deep Sea Research Part II* 94:292-300.

Huntington, H. P., and L. T. Quakenbush. 2009. Traditional knowledge of bowhead whale migratory patterns near Kaktovik and Barrow, Alaska. Report to the Alaska Eskimo Whaling Commission and the Barrow and Kaktovik Whaling Captains. in Quakenbush, L.T., J.J. Citta, R.J. Small. 2010. Satellite Tracking of Western Arctic Bowhead Whales, Final Report. OCS Study BOEMRE 2010-033. Department of the Interior; Bureau of Ocean Energy Management, Regulation and Enforcement.

Huntington, H. P., The Communties of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the eastern Chukchi and northern Bering Seas, Alaska. *Arctic* 52:49-61.

Impact Assessment Inc. 1989. Point Lay Case Study. Alaska OCS Social and Economic Studies Program, Technical Report No. 139. US Department of the Interior, Minerals Management Service, Anchorage, AK.

Jay, C. V., and A. S. Fischbach. 2008. Pacific Walrus Response to Arctic Sea Ice Losses. U.S. Department of the Interior, U.S. Geological Survey, Alaska Science Center, Anchorage, 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.

Jay, C. V., B. G. Marcot, and D. C. Douglas. 2011. Projected status of the Pacific walrus (*Odobenus rosmarus divergens*) in the twenty-first century. *Polar Biology* 34:1065-1084.

Johnson, S. R., K. J. Frost, L. F. Lowry, D. A. Wiggins, and P. F. Wainwright. 1992. Use of Kasegaluk Lagoon, Chukchi Sea, Alaska, by marine birds and mammals. LGL Alaska Research Associates and AK Department of Fish and Game,

Kassam, K.-A. S., and Wainwright Traditional Council. 2001. *Passing on the knowledge : mapping human ecology in Wainwright, Alaska*. Arctic Institute of North America, Calgary.

Kelly, B. P. 1988. Ringed seal, *Phoca hispida*. Pages 57-75 *in* ed. J. W. Lentfer *Selected Marine Mammals of Alaska. Species Accounts with Research and Management Recommendations*. The Marine Mammal Commission, Washington, D.C.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, J. R. Moran, M. Martinez-Bakker, D. Wartzok, and P. Boveng. 2010a. Seasonal home ranges and fidelity to breeding sites among ringed seals. *Polar Biology* 33:1095-1109.

Kelly, B. P., J. Bengtson, P. Boveng, M. Cameron, S. Dahle, J. Jansen, E. Logerwell, J. Overland, C. Sabine, and G. Waring. 2010b. Status Review of the Ringed Seal (*Phoca hispida)*.

Krembs, C., R. Gradinger, and M. Spindler. 2000. Implications of brine channel geometry and surface area for the interaction of sympagic organisms in Arctic sea ice. *Journal of Experimental Marine Biology and Ecology* 243:55-80.

Kuletz, K. J., M. C. Ferguson, B. Hurley, A. E. Gall, E. A. Labunski, and T. C. Morgan. in press. Seasonal spatial patterns in seabird and marine mammal distribution in the Pacific Arctic: identifying biologically important pelagic areas. *Progress in Oceanography* 00:000-000.

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:S97-S125.

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.

MacCracken, J. G. 2012. Pacific Walrus and climate change: observations and predictions. *Ecology and evolution* 2:2072-2090.

Martin, S., and R. Drucker. 1997. The effect of possible Taylor columns on the summer ice retreat in the Chukchi Sea. *Journal of Geophysical Research* 102:10473-10482.

Maslowski, W., J. Clement Kinney, M. Higgins, and A. Roberts. 2012. The Future of Arctic Sea Ice. *Annual Review of Earth & Planetary Sciences* 40:625-654.

MMS Alaska OCS Region. 1987. Beaufort Sea Sale 97. Final Environmental Impact Statement. Volume I.MMS 87-0069. Minerals Mamagement Service (MMS), Alaska OCS Region,

_____. 1996. Beaufort Sea Planning Area Oil and Gas Lease Sale 144. Final Environmental Impact Statement. MMS 96-0012. Minerals Management Service, Alaska OCS Region.

Moore, S. E. 2000. Variability of Cetacean distribution and habitat selection in the Alaskan Arctic, autumn 1982-91. *Arctic* 53:448-460.

Moore, S. E., and J. T. Clarke. 1991. Aerial Surveys of Endangered Whales in the Alaskan Chukchi and Western Beaufort Seas, 1990. OCS Study MMS 91-0017, Final Field Report prepared for the U.S. Minerals Management Service, Alaska OCS Region, prepared by Science Applications International Corporation (SAIC), Maritime Services Division, 96p.

_____. 1992. Distribution, Abundance and Behavior of Endangered Whales in the Alaskan Chukchi and Western Beaufofl seas, 1991: With a Review 1982-91. OCS Study MMS-92-0029, Final Report prepared for the US. Minerals Management Service, Alaska OCS Region, prepared by SAIC, Maritime Services Division, 237 p.

Moore, S. E., J. T. Clarke, and M. M. Johnson. 1993. Beluga Distribution and Movements Offshore Northern Alaska in Spring and Summer, 1980-84. Report of the International Whaling Commission.

Moore, S. E., D. P. DeMaster, and P. K. Dayton. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. *Arctic* 53:432-447.

Moore, S. E., J. C. George, G. Sheffield, J. Bacon, and C. J. Ashjian. 2010. Bowhead whale distribution and feeding near Barrow, Alaska, in late summer 2005–06. *Arctic*:195-205.

Moore, S. E., J. M. Grebmeier, and J. R. Davies. 2003. Gray whale distribution relative to forage habitat in the northern Bering Sea: current conditions and retrospective summary. *Canadian Journal of Zoology-Revue Canadienne De Zoologie* 81:734-742.

Moore, S. E., and K. L. Laidre. 2006. Trends in sea ice cover within habitats used by bowhead whales in the western Arctic. *Ecological Applications* 16:932-944.

National Audubon Society, 2012. Important Bird Areas Criteria Overview. National Audubon Society, New York, NY. Accessed online January 2012 at http://web4.audubon.org/bird/iba/criteria.html.

National Snow and Ice Data Center, 2010. Monthly Sea Ice Extent.

______, 2013. IMS Daily Northern Hemisphere Snow and Ice Analysis at 4 km and 24 km Resolution. NSIDC, Boulder, CO. Accessed online at http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html#acq_proc):.

______, 2014. Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I Passive Microwave Data. NSIDC, Boulder, CO. Accessed online at http://nsidc.org/data/nsidc-0051.

Nelson, R. K., c1982. Harvest of the Sea: Coastal Subsistence in Modern Wainwright. North Slope Borough's Coastal Management Program, Barrow, AK.

NMFS, 2013. Point Lay Beluga Whales. National Marine Fisheries Service, Juneau, AK. Accessed online 6/25/13 2013 at http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/ptlay.htm#2012.

NOAA. 1988. Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas. Rockville, MD.

NOAA: Office of Response and Restoration, 2005. Environmental sensitivity index, version 3.0. Seattle, WA. Accessed online at http://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html#Alaska.

Noongwook, G., The Native Village of Savoonga, The Native Village of Gambell, H. P. Huntington, and J. C. George. 2007. Traditional knowledge of the bowhead whale (*Balaena mysticetus*) around St. Lawrence Island, Alaska. *Arctic* 60:47-54.

Overland, J. E., and M. Wang. 2013. When will the summer Arctic be nearly sea ice free? *Geophysical Research Letters* 40:2097-2101.

Pedersen, S. 1979a. Point Hope synopsis. *in Native Livelihood and Dependence: A Study of Land Use Values through Time*. U.S. Department of the Interior, Anchorage, AK.

______. 1979b. Regional Subsistence Land Use, North Slope Borough, Alaska. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska., Fairbanks, AK.

Person, B. T., A. K. Prichard, G. M. Carroll, D. A. Yokel, R. S. Suydam, and J. C. George. 2007. Distribution and Movements of the Teshekpuk Caribou Herd 1990–2005: Prior to Oil and Gas Development. *Arctic* 60 (3):238-250.

Petersen, M. R., and D. C. Douglas. 2004. Winter ecology of spectacled eiders: Environmental characteristics and population change. *The Condor* 106:79-94.

Quakenbush, L., J. Citta, J. C. George, M. P. Heide-Jorgensen, R. Small, H. Brower, L. Harwood, B. Adams, L. Brower, G. Tagarook, C. Pokiak, and J. Pokiak. 2012. Seasonal Movements of the Bering-Chukchi-Beaufort Stock of Bowhead Whales: 2006-2011 Satellite Telemetry Results.

Quakenbush, L. T. 1988. *Phoca largha*. *in* ed. J. Lentfer *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations*. Marine Mammal Commission, Washington, DC.

Quakenbush, L. T., J. J. Citta, J. C. George, R. J. Small, and M. P. Heide-Jørgensen. 2010a. Fall and winter movements of bowhead whales (*Balaena mysticetus*) in the Chukchi Sea and within a potential petroleum development area. *Arctic* 63:289-307.

Quakenbush, L. T., and H. P. Huntington. 2010. Traditional Knowledge Regarding Bowhead Whales in the Chukchi Sea near Wainwright, Alaska. OCS Study MMS 2009-063. U.S. Department of the Interior, Minerals Management Service,

Quakenbush, L. T., R. J. Small, and J. J. Citta. 2010b. Satellite tracking of western Arctic bowhead whales, final report. OCS Study BOEMRE 2010-033. Department of Interior, Bureau of Ocean Energy Management, Regulation and Enforcement,

Quakenbush, L. T., R. J. Small, and J. J. Citta. 2013. Satellite Tracking of Bowhead Whales: Movements and Analysis from 2006 to 2012. OCS Study BOEM 2013-01110, Anchorage, AK.

Richard, 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.

Robards, M., A. Kochnev, and S. Deming. 2007. Sharing Knowledge About Pacific Walrus (published map).

Rocchini, D., J. Hortal, S. Lengyel, J. M. Lobo, A. Jiménez-Valverde, C. Ricotta, G. Bacaro, and A. Chiarucci. 2011. Accounting for uncertainty when mapping species distributions: the need for maps of ignorance. *Progress in Physical Geography* 35:211–226.

Rugh, D. J., K. E. Sheldon, and D. E. Withrow. 1997. Spotted Seals, Phoca largha, in Alaska. *Marine Fisheries Review* 59:1-18.

Schliebe, S., Ø. Wiig, A. Derocher, and N. Lunn, 2008. *Ursus maritimus*. IUCN Red List of Threatened Species. Version 2012.2. IUCN, Accessed online 6/27/13 2013 at www.iucnredlist.org.

Sexson, M. G., M. R. Petersen, and A. N. Powell. 2012. Spatiotemporal distribution of Spectacled Eiders throughout the annual cycle, *in 15th Alaska Bird Conference*. Anchorage, AK.

Sheffield, G., and J. M. Grebmeier. 2009. Pacific walrus (*Odobenus rosmarus divergens*): differential prey digestion and diet. *Marine Mammal Science* 25:761-777.

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.

Smith, M. A. 2010. *Arctic Marine Synthesis: Atlas of the Chukchi and Beaufort Seas*. Audubon Alaska and Oceana, Anchorage.

Smith, M. A., N. J. Walker, C. M. Free, M. J. Kirchhoff, G. S. Drew, N. Warnock, and I. J. Stenhouse. 2014. Identifying marine Important Bird Areas using at-sea survey data. *Biological Conservation* 172:180-189.

Spall, M. A. 2007. Circulation and water mass transformation in a model of the Chukchi Sea. *Journal of Geophysical Research: Oceans (1978–2012)* 112.

Stephen R. Braund and Associates. 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Bureau of Ocean Energy Management, MMS OCS Study No. 2009-003. Anchorage, Alaska.

Stephen R. Braund and Associates, and Institute of Social and Economic Research. 1993a. North Slope Subsistence Study: Barrow, 1987, 1988, and 1989. Technical Report No. 149. U.S. Department of Interior, Minerals Management Service, Alaska OCS Region, Social and Economic Studies, Anchorage, AK.

_____. 1993b. North Slope Subsistence Study: Wainwright, 1988 and 1989. Technical Report No.147. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Social and Economic Studies, Anchorage, AK.

Stirling, I. 1997. The importance of polynyas, ice edges, and leads to marine mammals and birds. *Journal of Marine Systems* 10:9-21.

Stringer, W. J., and J. Groves. 1991. Location and areal extent of polynyas in the Bering and Chukchi Seas. *Arctic*:164-171.

Suydam, R. 2000. King Eider (*Somateria spectabilis*). *in* eds A. Poole, andF. Gill *The Birds of North America*. The Birds of North America, Inc., Philadelphia, PA.

Suydam, R., 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. Coastal Marine Institute and US Department of the Interior, Minerals Management Service, Alaska OCS Region.

Suydam, R. S. 2009. *Age, growth, reproduction, and movements of beluga whales (Delphinapterus leucas) from the eastern Chukchi Sea*. Ph.D. Dissertation, University of Washington.

Suydam, R. S., L. F. Lowry, K. J. Frost, G. M. O'Corry-Crowe, and D. Pikok. 2001. Satellite tracking of eastern Chukchi Sea beluga whales into the Arctic Ocean. *Arctic* 54:237-243.

United States Army Corps of Engineers: Alaska District, 1999. Final Environmental Impact Statement: Beaufort Sea and Oil and Gas Development/Northstar Project. North Slope.

United States District Court For the District of Alaska. 2013.

US DOI Fish and Wildlife Service. 2013. Comments on the Call for Information and Nominations for Proposed Oil and Gas Lease Sale 237 in the Chukchi Sea Planning Area. US DOI FWS, Anchorage, AK.

USFWS. 1995. Habitat Conservation Strategy for Polar Bears in Alaska.

_____. 2010a. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. Federal Register.

_____. 2010b. Polar Bear (*Ursus maritimus*). *in Stock Assessment Reports*. USFWS, Marine Mammals Management, Alaska Region, Anchorage, AK.

_____. 2011. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List the Pacific Walrus as Endangered or Threatened. U.S. Fish and Wildlife Service, Federal Register.

_____. 2013a. Environmental Assessment: Endangered Species Act 4(d) Regulations for Threatened Polar Bears. Marine Mammals Management, Anchorage, Alaska.

_____, 2013b. Polar Bear: U.S.-Russia Bilateral Agreement. U.S. Fish and Wildlife Service, Marine Mammals Management, Alaska Region, Accessed online 6/25/13 2013 at http://alaska.fws.gov/fisheries/mmm/polarbear/bilateral.htm.

USFWS Marine Mammals Management. 2014. Pacific Walrus (*Odobenus rosmarus divergens*): Alaska Stock. *in Alaska Stock Assessment Report*. Anchorage, AK.

Walker, N. J., and M. A. Smith, 2014. Alaska Waterbird Database v1. Audubon Alaska, Anchorage, AK.

Wang, J., G. F. Cota, and J. C. Comiso. 2005. Phytoplankton in the Beaufort and Chukchi Seas: distribution, dynamics, and environmental forcing. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3355-3368.

Wang, M., and J. E. Overland. 2009. A sea ice free summer Arctic within 30 years? *Geophysical Research Letters* 36:L07502.

Weingartner, T. J., K. Aagaard, R. Woodgate, S. Danielson, Y. Sasaki, and D. Cavalieri. 2005. Circulation on the north central Chukchi Sea shelf. *Deep Sea Research Part II* 52:3150-3174.

Western Arctic Caribou Herd Working Group. 2011. Western Arctic Caribou Herd Cooperative Management Plan. Western Arctic Caribou Herd Working Group, Nome, AK.

Wilson, R. R., J. S. Horne, K. D. Rode, E. V. Regehr, and G. M. Durner. 2014. Identifying polar bear resource selection patterns to inform offshore development in a dynamic and changing Arctic. *Ecosphere* 5:art136.

World Seabird Union, 2011. Seabird Information Network: North Pacific Seabird Data Portal. World Seabird Union, www.seabirds.net. Accessed online at http://axiom.seabirds.net/portal.php.

APPENDIX C

MAPS OF THE BEAUFORT SEA PROGRAM AREA

List of Figures

Fig 13. Marine Mammal Aerial Survey Fall Transects (September - October, 2000 - 2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)

Fig 14. Beluga Whale Aerial Survey Fall Observations (September - October, 2000 - 2013)
Fig 15. Beluga Whale Fall Relative Density (September - October, 2000 - 2013)
Fig 16. Beluga Fall Migration Corridor (September - October, 2000 - 2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)

Fig 17. Bowhead and Beluga Spring and Summer Migration Corridors and Concentration Areas

1. Hauser et al. (2014)
2. Clarke et al. (2015)

Fig 18. Bowhead Whale Aerial Survey Fall Observations (September - October, 2000 - 2013)
Fig 19. Bowhead Whale Fall Relative Density (September - October, 2000 - 2013)
Fig 20. Bowhead Fall Migration Corridor (September - October, 2000 - 2013)

1. Oceana and Audubon Alaska (2015), based on:
    a. NOAA Fisheries (2014)
2. Huntington et al. (2013)

Fig 21. Pinniped Aerial Survey Fall Observations (September - October, 2000 - 2013)

1. NOAA Fisheries (2014)

Fig 22. Ringed Seal Winter/Spring Higher Quality Breeding Habitat and Spotted Seal Summer Haulouts

1. NOAA (1988)
2. NOAA: Office of Response and Restoration (2005)

Fig 23. Polar Bear Denning Areas

1. Schliebe et al. (2008)
2. USFWS (2010)
3. NOAA (1988)
4. Alaska Department of Fish and Game Habitat and Restoration Division (2001)
5. USFWS (1995)

Fig 24. Predicted Polar Bear Habitat Use, By Season

1. Audubon Alaska (2014d), using resource selection models from:
    a. Durner et al. (2009)

Fig 25. Marine Bird Summer Nesting Colonies

1. World Seabird Union (2011)

Fig 26. Shorebird Coastal Aerial Fall Observations (2006-2007)

1. Taylor et al. (2010)

Fig 27. Bird Aerial Survey Observations, All Species (1974-2012)

1. Drew and Piatt (2013)
2. Walker and Smith (2014)
3. USFWS (2014)

Fig 28. Bird Observations (1974-2012): Survey Effort

1. Audubon Alaska (2014a), based on:
    a. Drew and Piatt (2013)
    b. Walker and Smith (2014)
    c. USFWS (2014)

Fig 29. Watchlist Bird Relative Density (1979-2010)

1. Audubon Alaska (2014c), based on:
    a. Drew and Piatt (2013)
    b. Walker and Smith (2014)
    c. Smith et al. (2014b)

Fig 30. Marine Birds: Relative Importance

1. Audubon Alaska (2015b), based on:
    a. Drew and Piatt (2013)
    b. Walker and Smith (2014)
    c. Smith et al. (2014b)

Fig 31. Recognized Globally Important Bird Areas

1. Audubon Alaska (2014b), based on:
   a. Drew and Piatt (2013)
   b. Walker and Smith (2014)
   c. Smith et al. (2014a) and Smith et al. (2014b)

Fig 32. Seabird and Marine Mammal Hotspots

1. Kuletz et al. (in press)

Fig 33. Important Ecological Area – Ecosystem Analysis

1. Oceana (2013)

Figure References

Alaska Center for the Environment, Alaska Department of Natural Resources, Bureau of Land Management, and Bureau of Ocean Energy Management, 2013. Active Leases. Alaska Center for the Environment, Anchorage, AK.

Alaska Department of Fish and Game Habitat and Restoration Division. 2001. Oil Spill Contingency Planning: Most Environmentally Sensitive Areas (MESA) Along the Coast of Alaska, Volume I. Report. ADFG, Anchorage, AK.

Alaska Department of Natural Resources: Division of Oil and Gas, 2014. Alaska Statewide Active Lease Boundaries. Accessed online at http://dog.dnr.alaska.gov/GIS/GISDataFiles.htm.

Alaska Department of Natural Resources: Information Resource Management, 1995. Trans-Alaska Pipeline. ASGDC, Accessed online at http://dnr.alaska.gov/mdfiles/trans_alaska_pipeline.html.

Alaska Department of Transportation: Division of Program Development: Highway Data and GIS/Mapping Sections, 2007. Alaska Department of Transportation Centerline Inventory - Routes. ASGDC, Accessed online at http://dnr.alaska.gov/mdfiles/dot_centerline_route.html.

Alaska Eskimo Whaling Commission, U.S. National Science Foundation, North Slope Borough Department of Wildlife Management, North Slope Borough Planning and Community Services GIS Division, and Barrow Arctic Science Consortium. 2003. Bowhead Whale Subsistence Sensitivity Map. Report. Alaska Eskimo Whaling Commission, Barrow, AK.

Alaska Oil and Gas Conservation Commission, 2013. Oil and Gas Information System. Accessed online at http://doa.alaska.gov/ogc/publicdb.html.

Audubon Alaska, 2013. Monthly Percent of Days with Sea Ice for the Northern Hemisphere, 2008-2012. Audubon Alaska, Anchorage, AK.

______, 2014a. Analysis of Survey Effort for Marine Mammals, 1979-2012. Audubon Alaska, Anchorage, AK.

______, 2014b. Important Bird Areas of Alaska, v3. Audubon Alaska, Anchorage, AK. Accessed online at http://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9.

______, 2014c. Marine Bird Species Core Area Analysis. Anchorage, AK.

______, 2014d. Predicted Polar Bear Habitat Use, By Season. Audubon Alaska, Anchorage, AK.

______, 2015a. Bathymetric Contours of the Arctic Ocean. Anchorage, AK.

______, 2015b. Integrated Globally Significant Proportion. Anchorage, AK. Accessed online at

BLM, 2014. 2014 NPR-A Lease Sale Shape Files for Download. Accessed online at http://www.blm.gov/ak/st/en/prog/energy/oil_gas/npra/npr-a_lease_sales-maps.html.

BOEM. 2012. Chukchi Area Analytical Considerations Map *in* Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017. Report. Department of the Interior, Bureau of Ocean Energy Management, Anchorage, AK.

BPXA, 2011a. Gravel Road Centerline.

______, 2011b. Pipeline Corridor.

Bureau of Ocean Energy Management: Alaska Region, 2012. Alaska Federal Oil and Gas Historical Leases. Accessed online at http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Alaska.aspx.

Bureau of Ocean Energy Management: Mapping and Boundary Branch, 2013. Alaska Active Federal Oil and Gas Leases. Accessed online at http://www.boem.gov/Oil-and-Gas-Energy-Program/Mapping-and-Data/Alaska.aspx.

Clarke, J. T., M. C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Arctic Region. Aquatic Mammals:94-103.

Drew, G. F., and J. Piatt, 2013. North Pacific Pelagic Seabird Database (NPPSD). US Geological Survey Alaska Science Center & US Fish and Wildlife Service, Anchorage, AK. v2.

Dunton, K. H., J. L. Goodall, S. V. Schonberg, J. M. Grebmeier, and D. R. Maidment. 2005. Multi-decadal synthesis of benthic-pelagic coupling in the western arctic: role of cross-shelf advective processes. Deep-Sea Research Part Ii-Topical Studies in Oceanography 52:3462-3477.

Durner, G. M., D. C. Douglas, R. M. Nielson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. C. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. Ecological Monographs 79:107-120.

Galginaitis, M. 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). Report. U.S. Department of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, Alaska.

Grebmeier, J. M., L. W. Cooper, H. M. Feder, and B. I. Sirenko. 2006. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. Progress in Oceanography 71:331-361.

_____. 2014. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. Progress in Oceanography 71:331-361.

Hauser, D. D., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). Polar Biology:1-13.

Huntington, H. 2013. Traditional Knowledge Regarding Bowhead Whales and Camden Bay, Beaufort Sea, Alaska. Report. Eagle River, AK.

Huntington, H. P., I. Ortiz, G. Noongwook, M. Fidel, L. Alessa, A. Kliskey, D. Childers, M. Morse, and J. Beaty. 2013. Mapping human interaction with the Bering Sea ecosystem: comparing seasonal use areas, lifetime use areas, and "calorie-sheds". Deep Sea Research Part II 94:292-300.

Jakobsson, M., L. Mayer, B. Coakley, J. A. Dowdeswell, S. Forbes, B. Fridman, H. Hodnesdal, R. Noormets, R. Pedersen, and M. Rebesco. 2012. The international bathymetric chart of the Arctic Ocean (IBCAO) version 3.0. Geophysical Research Letters 39.

Kuletz, K. J., M. C. Ferguson, B. Hurley, A. E. Gall, E. A. Labunski, and T. C. Morgan. in press. Seasonal spatial patterns in seabird and marine mammal distribution in the Pacific Arctic: identifying biologically important pelagic areas. Progress in Oceanography 00:000-000.

National Snow and Ice Data Center, 2013. IMS Daily Northern Hemisphere Snow and Ice Analysis at 4 km and 24 km Resolution. NSIDC, Boulder, CO. Accessed online at http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html#acq_proc):.

NOAA. 1988. Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas. Rockville, MD.

NOAA Fisheries, 2014. Aerial Survey of Arctic Marine Mammals, 1979-2013 (ASAMM; including the Historical BWASP and COMIDA Databases). NOAA Fisheries, Alaska Fisheries Science Center, National Marine Mammal Labratory, Anchorage, AK. Accessed online December 2014 at http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php.

NOAA: Office of Response and Restoration, 2005. Environmental sensitivity index, version 3.0. Seattle, WA. Accessed online at http://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html#Alaska.

Oceana. 2013. Oceana Comments on Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement, 78 FR 21347. Report. Oceana, Juneau, AK.

Oceana, and Audubon Alaska, 2014a. Interpolated Benthic Biomass. Audubon Alaska, Anchorage, AK.

_____, 2014b. Interpolated Primary Productivity. Juneau, AK.

_____, 2015. Marine Mammal Species Core Area Analysis. Juneau and Anchorage, AK.

Pedersen, S. 1979. Regional Subsistence Land Use, North Slope Borough, Alaska. Report. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska., Fairbanks, AK.

Schliebe, S., K. D. Rode, J. S. Gleason, J. M. 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.

Smith, M., N. J. Walker, I. J. Stenhouse, C. M. Free, M. Kirchhoff, O. Romanenko, S. Senner, N. Warnock, and V. Mendenhall. A new map of Important Bird Areas in Alaska, *in* Alaska Bird Conference. A. Alaska.

Smith, M. A., N. J. Walker, C. M. Free, M. J. Kirchhoff, G. S. Drew, N. Warnock, and I. J. Stenhouse. 2014b. Identifying marine Important Bird Areas using at-sea survey data. Biological Conservation 172:180-189.

Stephen R. Braund and Associates, 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Anchorage, AK.

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:451-467.

United States Coast Guard. 2012. Federal Register. Government Printing Office.

USFWS. 1995. Endangered and Threatened Wildlife and Plants; Final Rule to Reclassify the Bald Eagle from Endangered to Threatened in all of the Lower 48 States. Federal Register.

_____. 2010. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. Pages 760086 *in*, Federal Register.

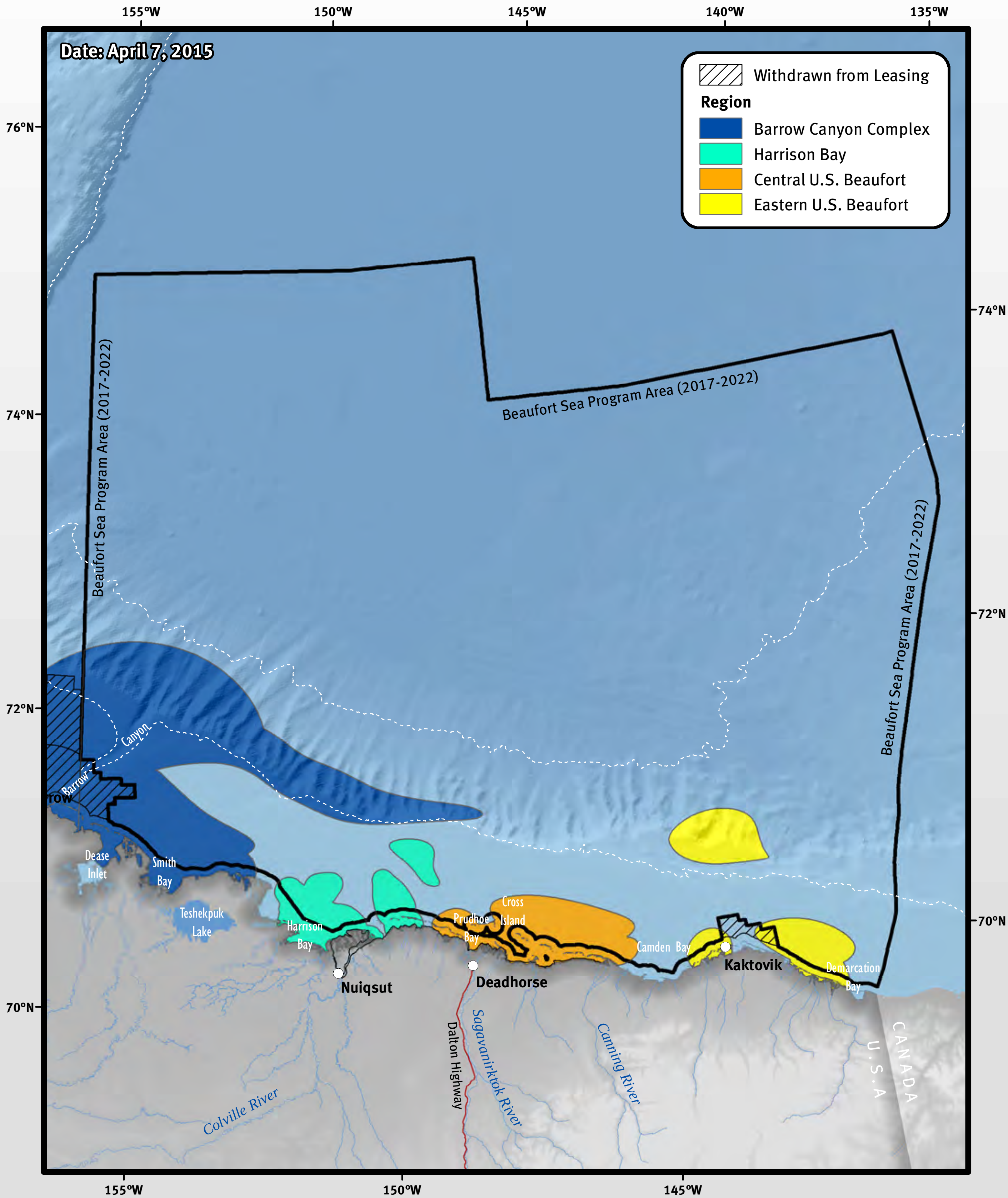
_____, 2014. At-Sea Surveys of Seabirds from Ships of Opportunity. USFWS, Anchorage, AK.

Walker, N. J., and M. A. Smith, 2014. Alaska Waterbird Database. Audubon Alaska, Anchorage, AK. v1.

World Seabird Union, 2011. Seabird Information Network: North Pacific Seabird Data Portal. World Seabird Union, www.seabirds.net. Accessed online at http://axiom.seabirds.net/portal.php.

Figure 1.

Important Areas of the U.S. Beaufort Sea

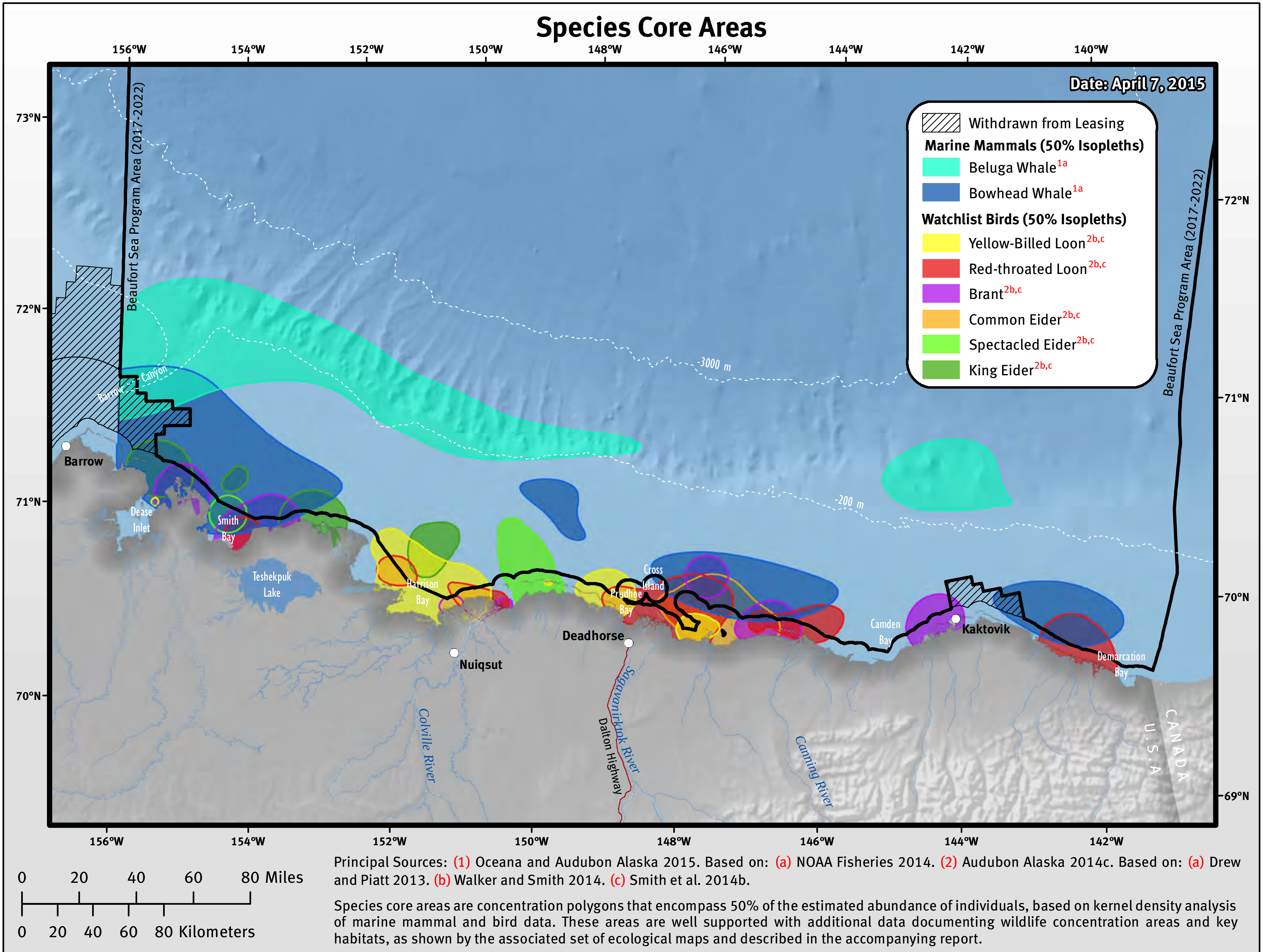


0 25 50 75 100 Miles

0 25 50 75 100 Kilometers

These important areas were drawn using the following wildlife and habitat areas:
Bowhead and beluga whale fall core areas: (1) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.
Beluga whale summer core area (Barrow Canyon): (2) Hauser et al. 2014.
Marine bird Watchlist species breeding season core areas: (3) Audubon Alaska 2014b. Based on: (a) Drew and Piatt 2013. (b) Smith et al. 2014b. (c) Walker and Smith 2014.

Figure 2.

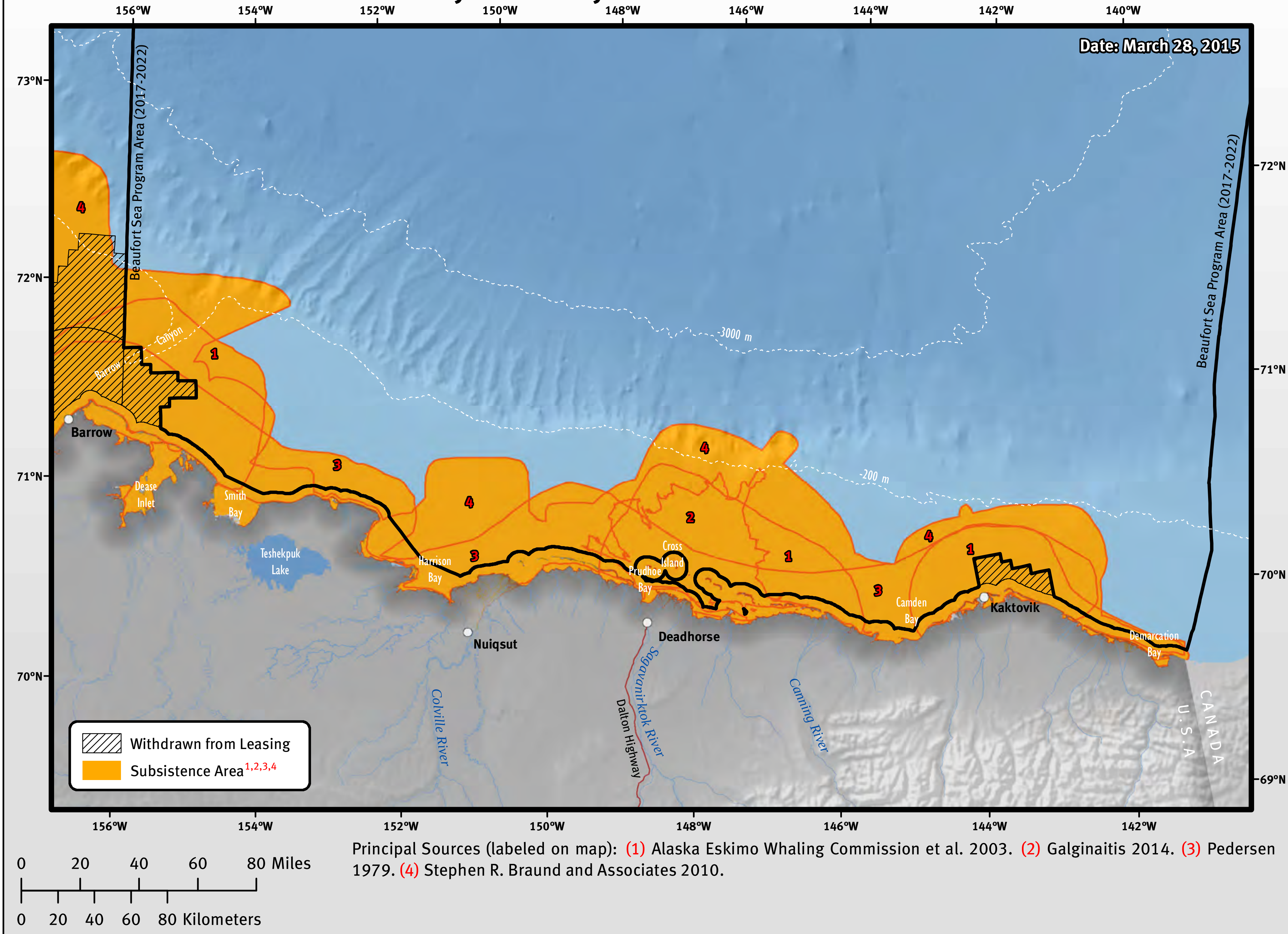


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014. (2) Audubon Alaska 2014c. Based on: (a) Drew and Piatt 2013. (b) Walker and Smith 2014. (c) Smith et al. 2014b.

Species core areas are concentration polygons that encompass 50% of the estimated abundance of individuals, based on kernel density analysis of marine mammal and bird data. These areas are well supported with additional data documenting wildlife concentration areas and key habitats, as shown by the associated set of ecological maps and described in the accompanying report.

Figure 3.

Summary of Publicly Available Subsistence Studies



Principal Sources (labeled on map): (1) Alaska Eskimo Whaling Commission et al. 2003. (2) Galginaitis 2014. (3) Pedersen 1979. (4) Stephen R. Braund and Associates 2010.

Figure 4.

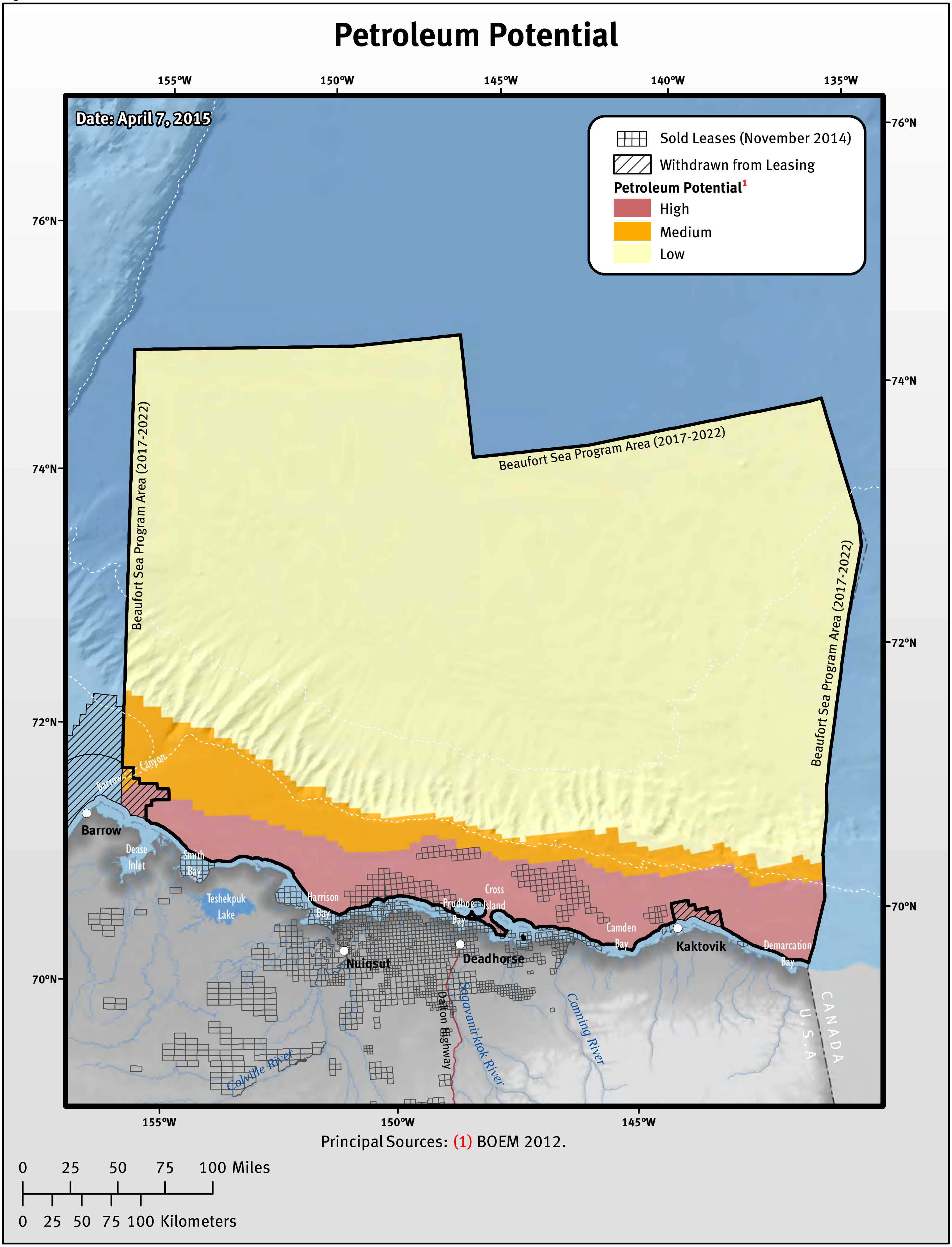
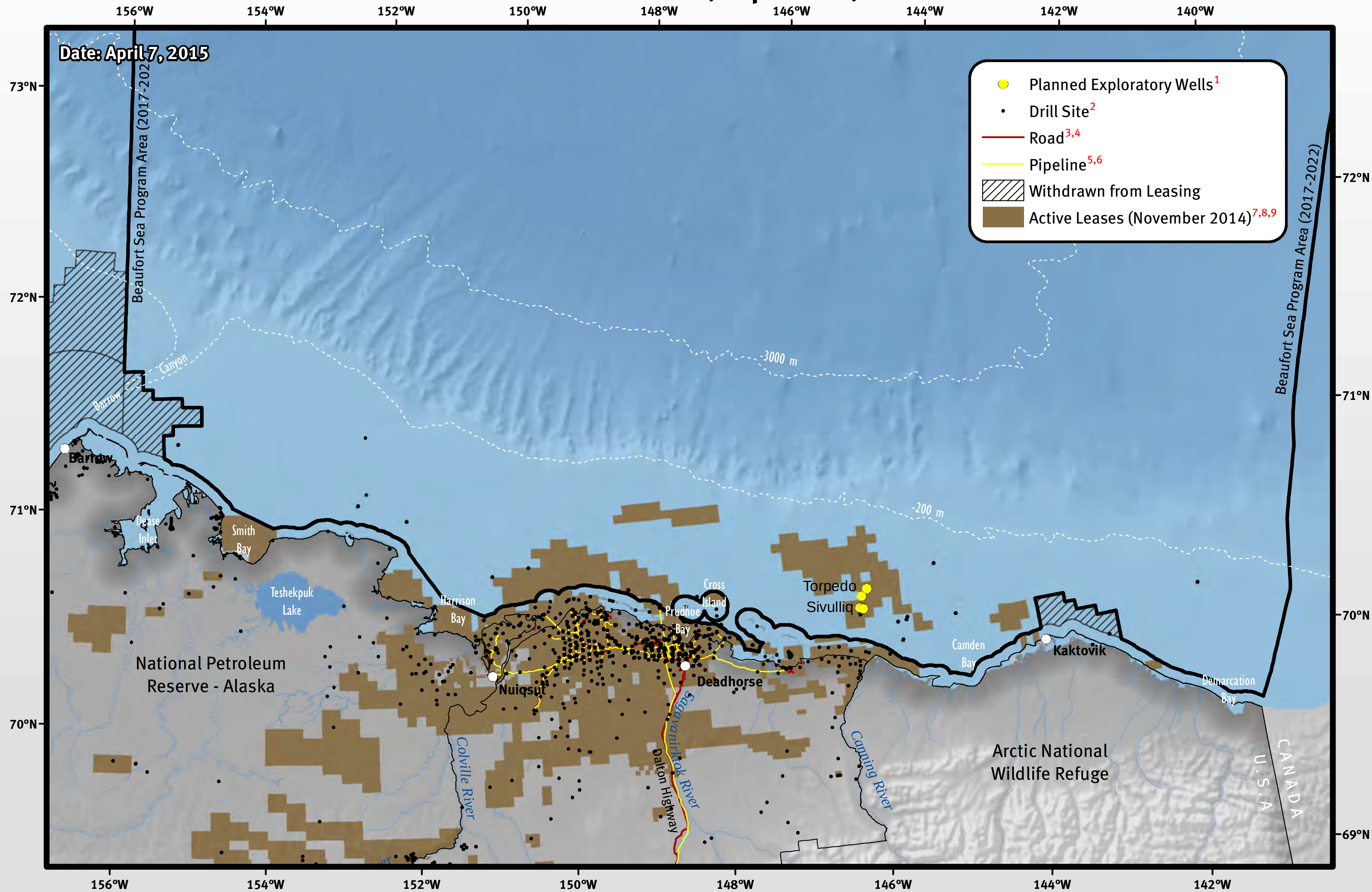

Petroleum Potential
155°W
150°W
145°W
140°W
135°W
76°N
74°N
72°N
70°N
Date: April 7, 2015
Sold Leases (November 2014)
Withdrawn from Leasing
Petroleum Potential1
High
Medium
Low
Beaufort Sea Program Area (2017-2022)
Beaufort Sea Program Area (2017-2022)
Beaufort Sea Program Area (2017-2022)
Barrow Canyon
Barrow
Dease Inlet
Smith Bay
Teshekpuk Lake
Harrison Bay
Prudhoe Bay
Cross Island
Camden Bay
Kaktovik
Demarcation Bay
Nuiqsut
Deadhorse
Dalton Highway
Sagavanirktok River
Canning River
Colville River
CANADA
U.S.A
Principal Sources: (1) BOEM 2012.
0 25 50 75 100 Miles
0 25 50 75 100 Kilometers

Figure 5.

Infrastructure: Roads, Pipelines, and Wells

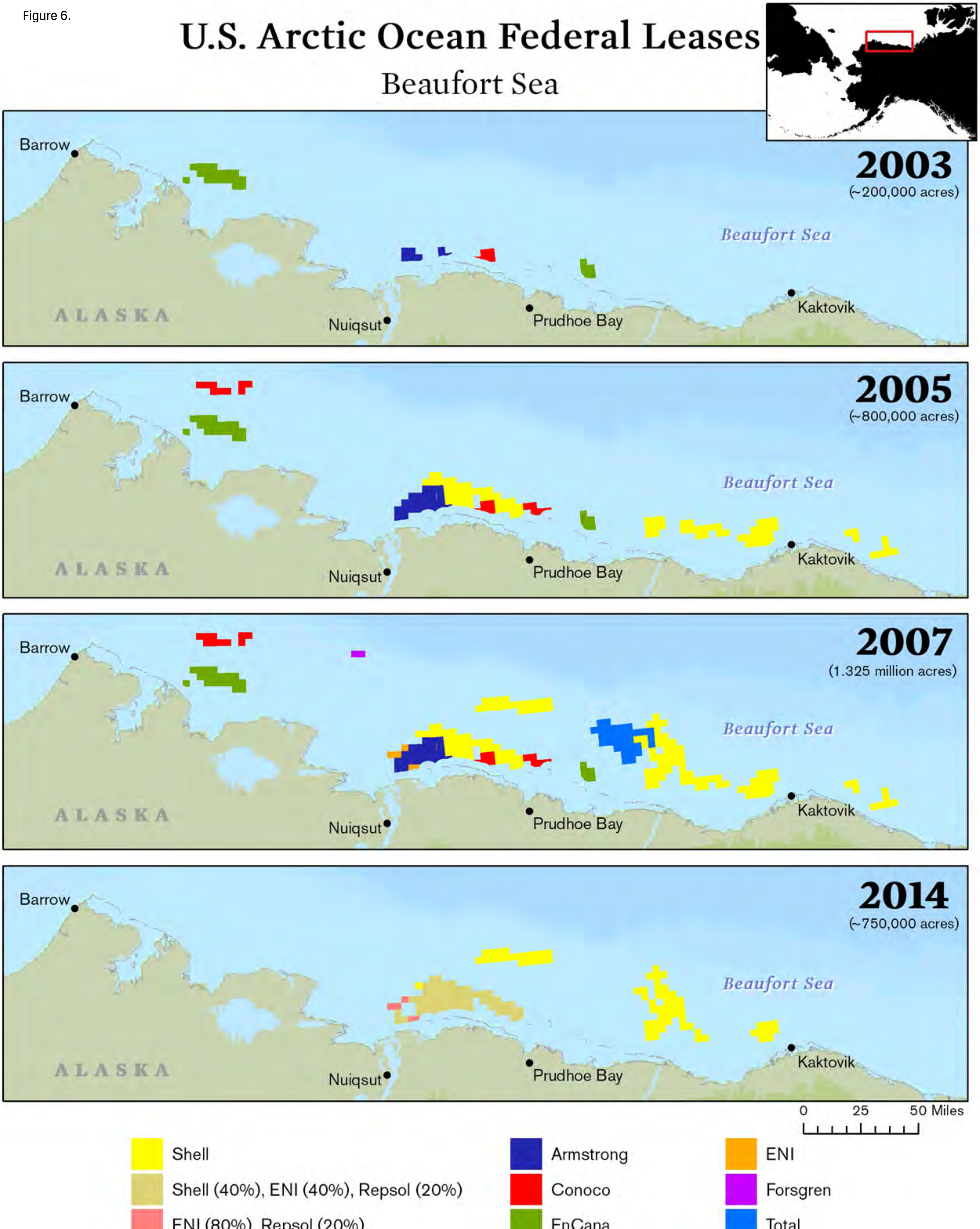


0 20 40 60 80 Miles

0 20 40 60 80 Kilometers

Sources: (1) United States Coast Guard 2012. (2) Alaska Oil and Gas Conservation Commission 2013. (3) Alaska Department of Transportation and Public Facilities 2007. (4) BPXA 2011a. (5) Alaska Department of Natural Resources: Information Resource Management 1995. (6) BPXA 2011b. (7) Alaska Department of Natural Resources 2014. (8) Alaska Center for the Environment et al. 2013. (9) BLM 2014.

Figure 6.

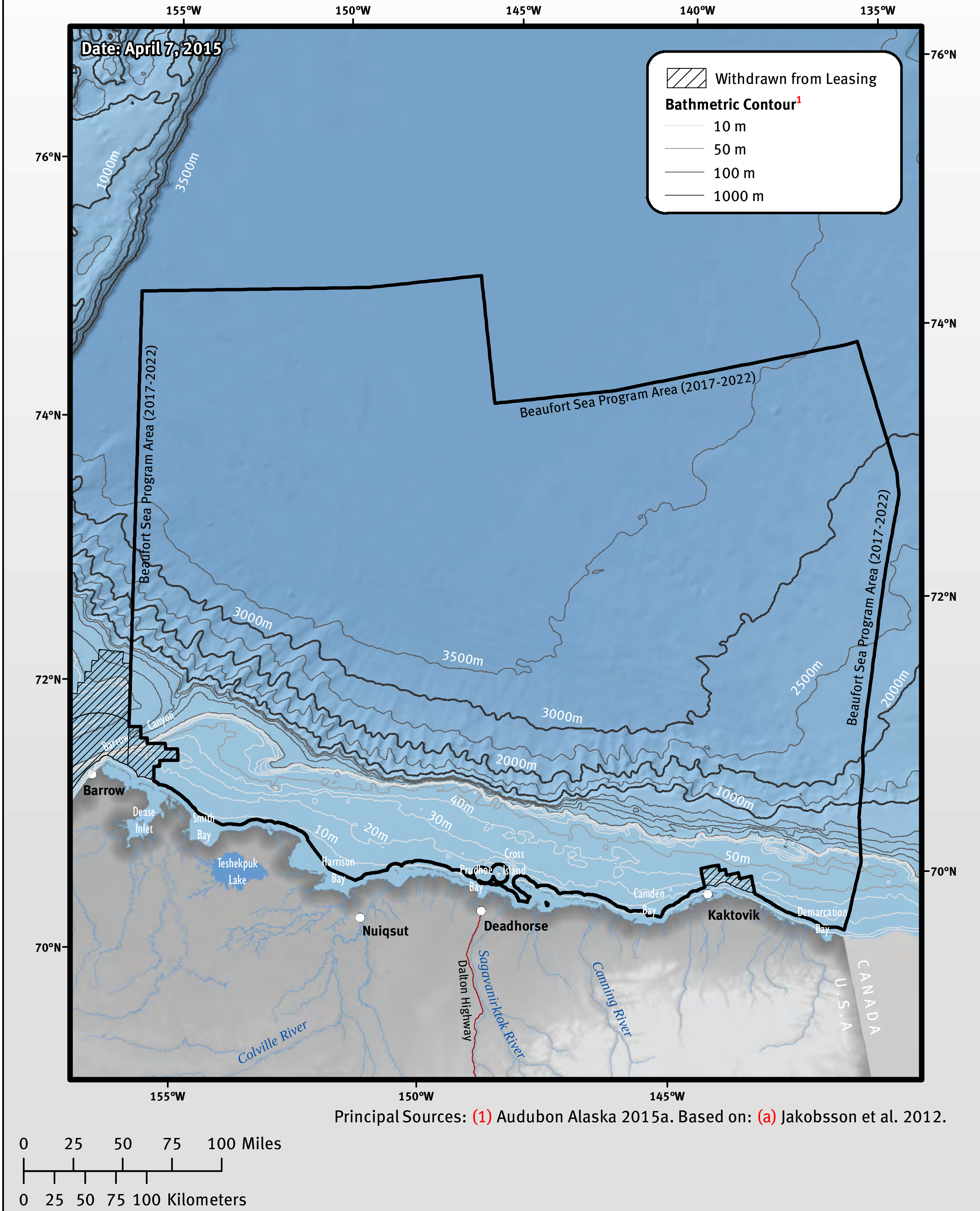


*Leases owned by BP and Murphy near the Liberty/Northstar project just offshore of Prudhoe Bay that were purchased prior to 2000 are excluded from these maps.

Source: Bureau of Ocean Energy Management.

Figure 7.

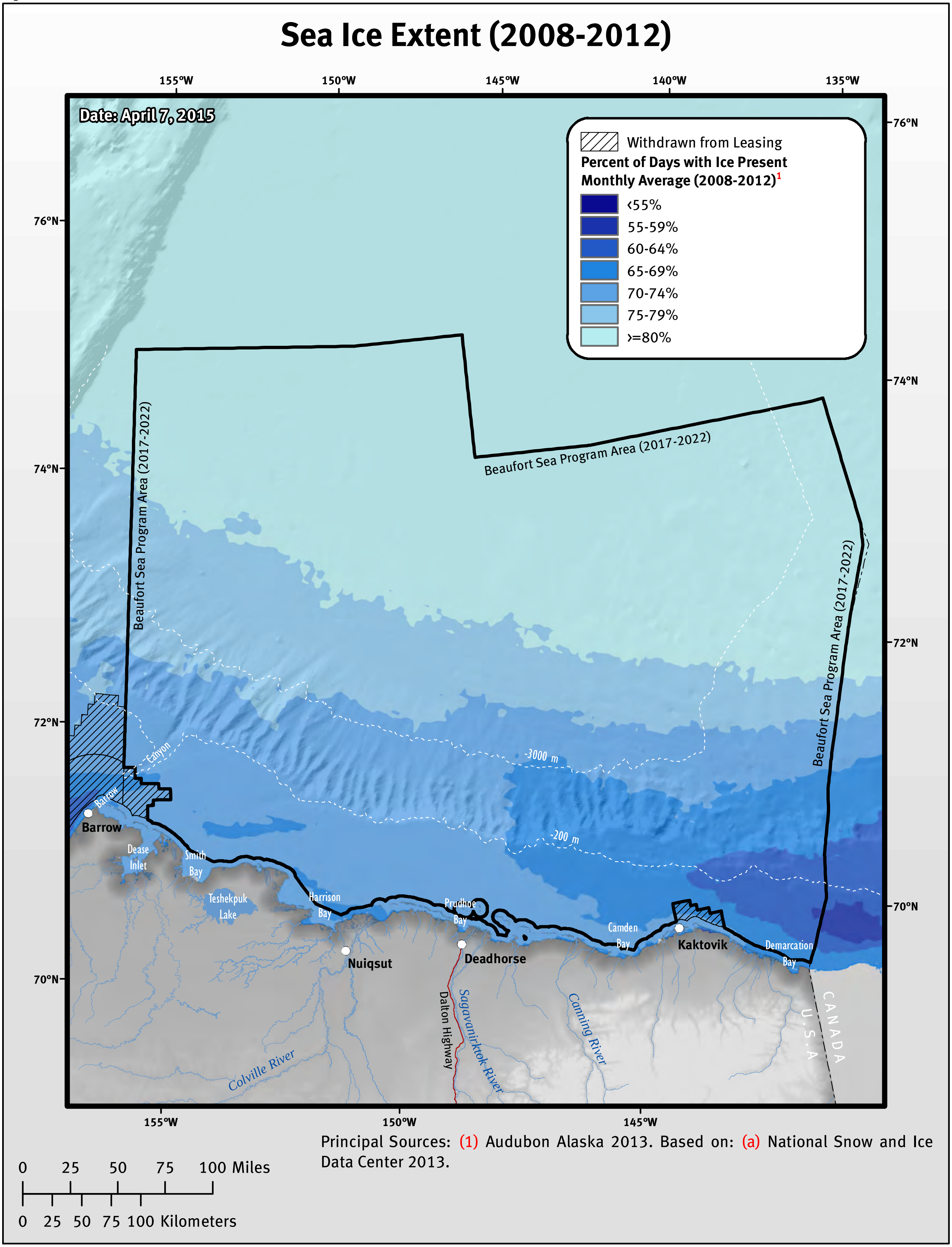
Seafloor Depth



Principal Sources: (1) Audubon Alaska 2015a. Based on: (a) Jakobsson et al. 2012.

Figure 8.

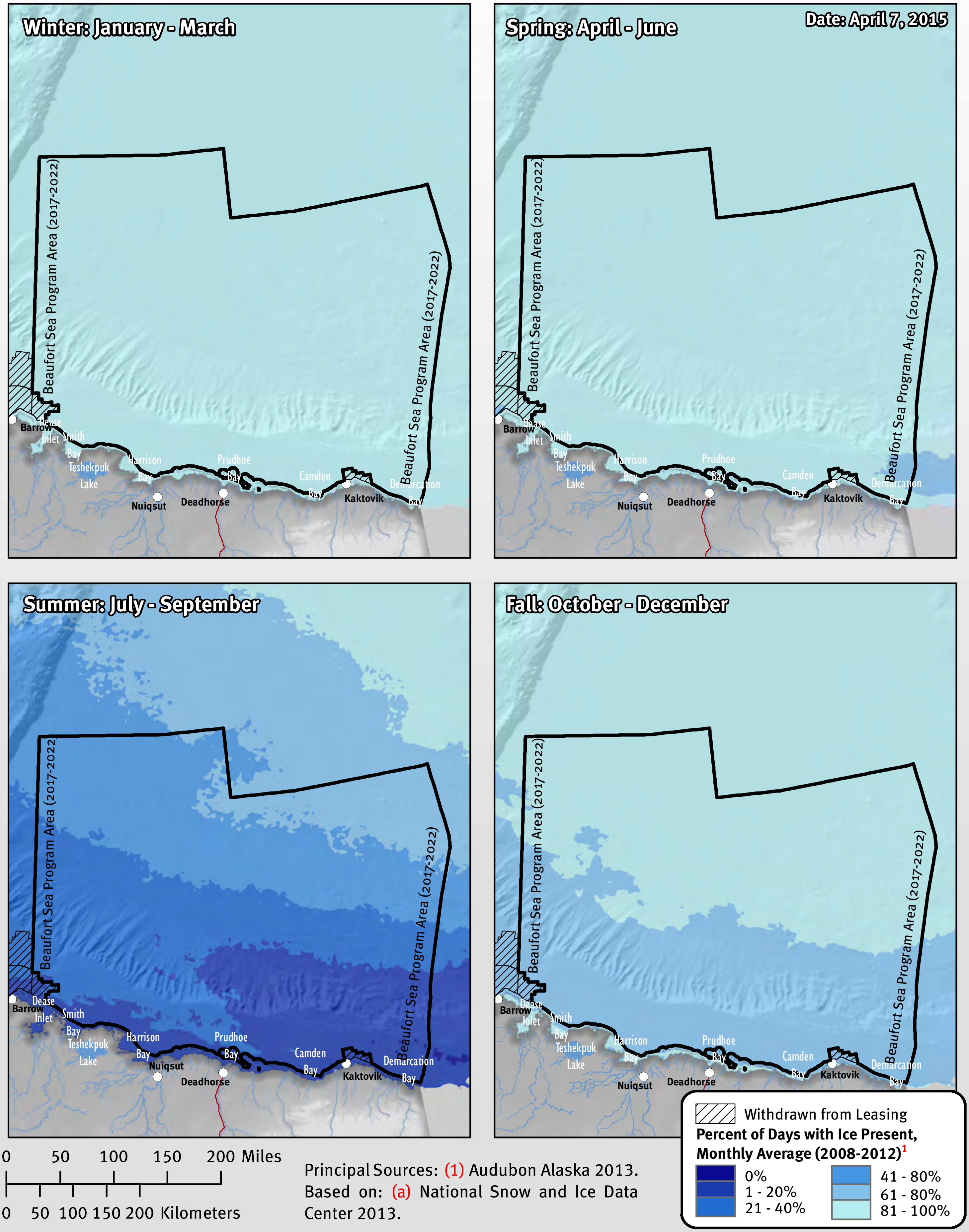
Sea Ice Extent (2008-2012)



Principal Sources: (1) Audubon Alaska 2013. Based on: (a) National Snow and Ice Data Center 2013.

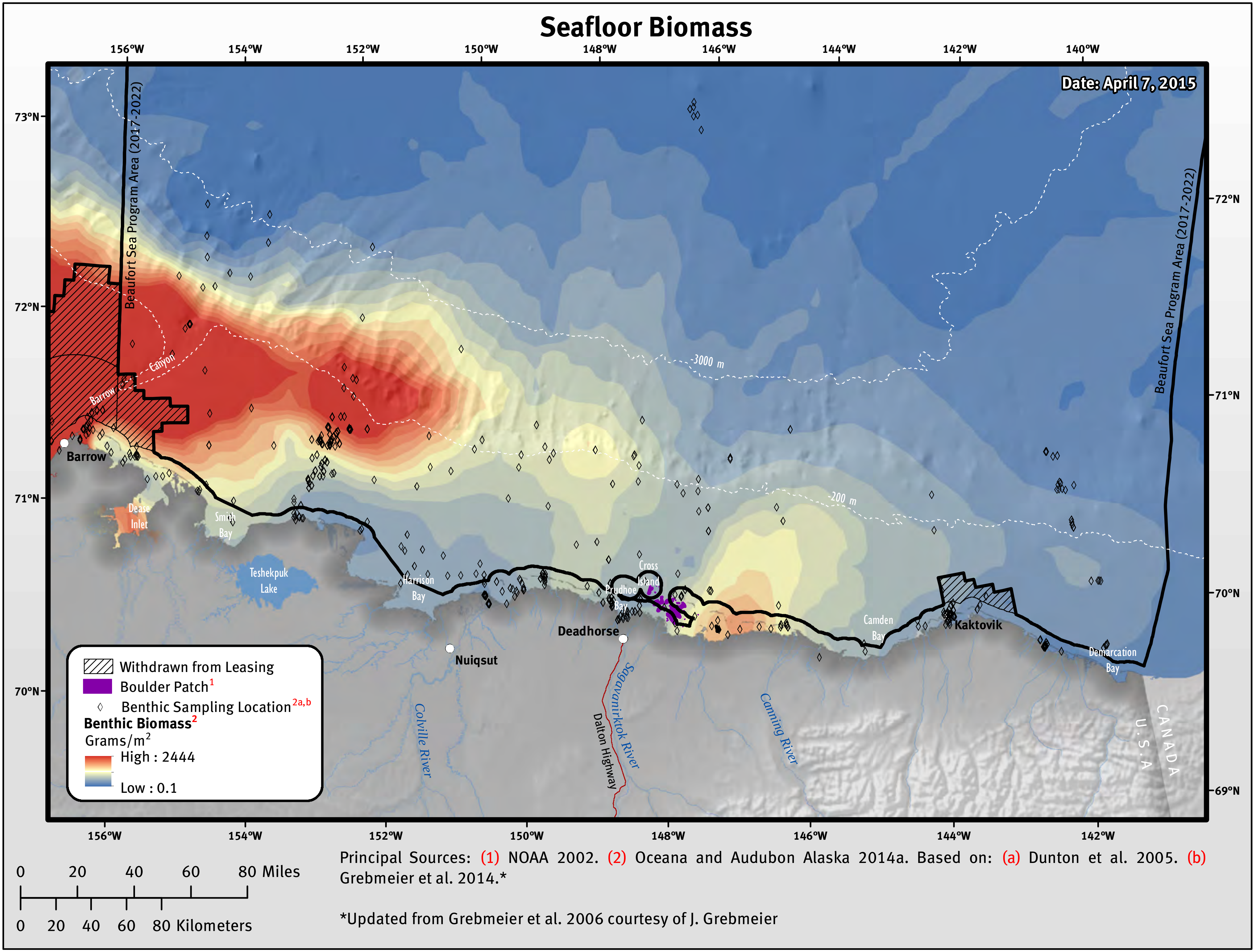
Figure 9.

Sea Ice Extent, By Season (2008-2012)



Principal Sources: (1) Audubon Alaska 2013. Based on: (a) National Snow and Ice Data Center 2013.

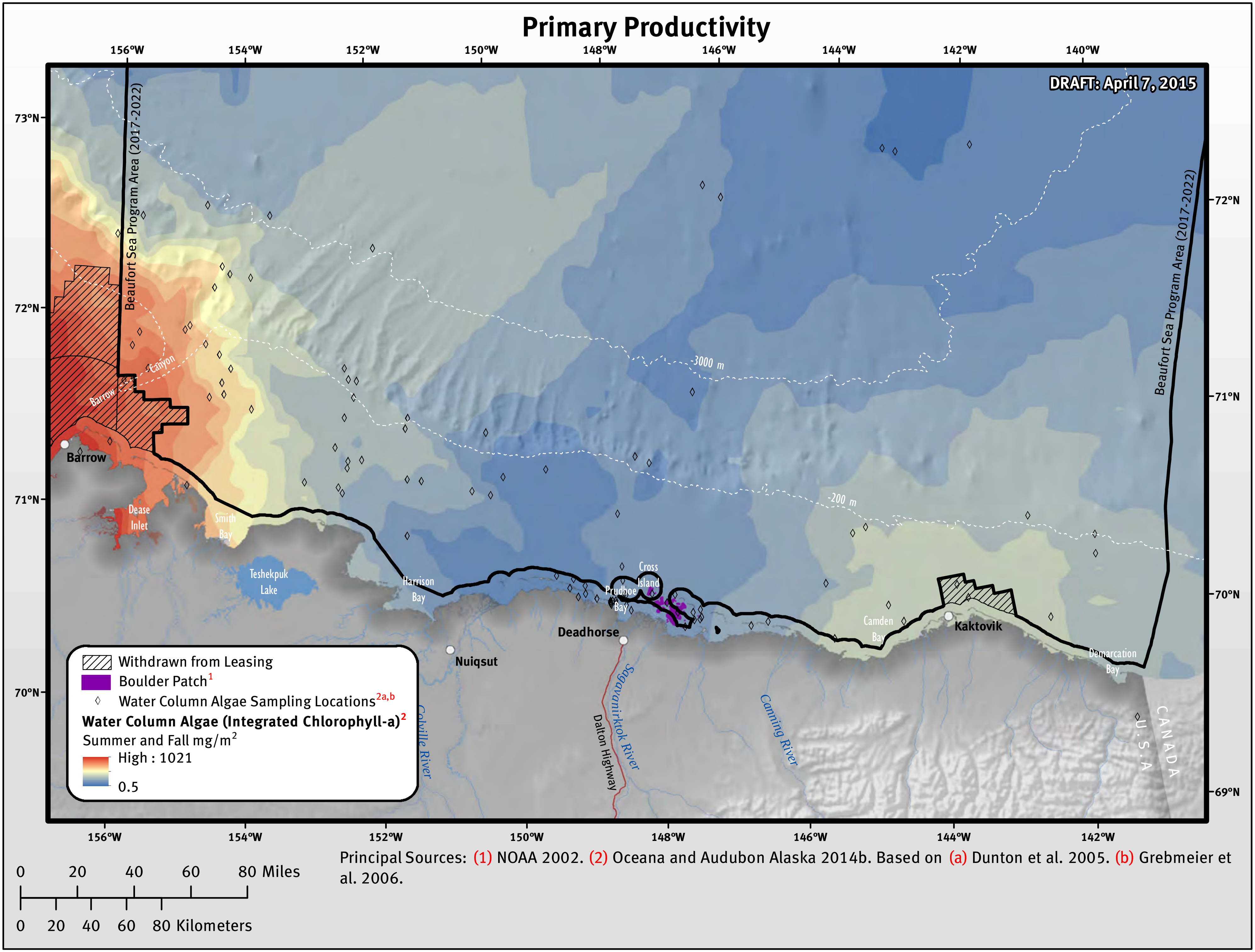
Figure 10.



Principal Sources: (1) NOAA 2002. (2) Oceana and Audubon Alaska 2014a. Based on: (a) Dunton et al. 2005. (b) Grebmeier et al. 2014.*

*Updated from Grebmeier et al. 2006 courtesy of J. Grebmeier

Figure 11.



Principal Sources: (1) NOAA 2002. (2) Oceana and Audubon Alaska 2014b. Based on (a) Dunton et al. 2005. (b) Grebmeier et al. 2006.

Figure 12.

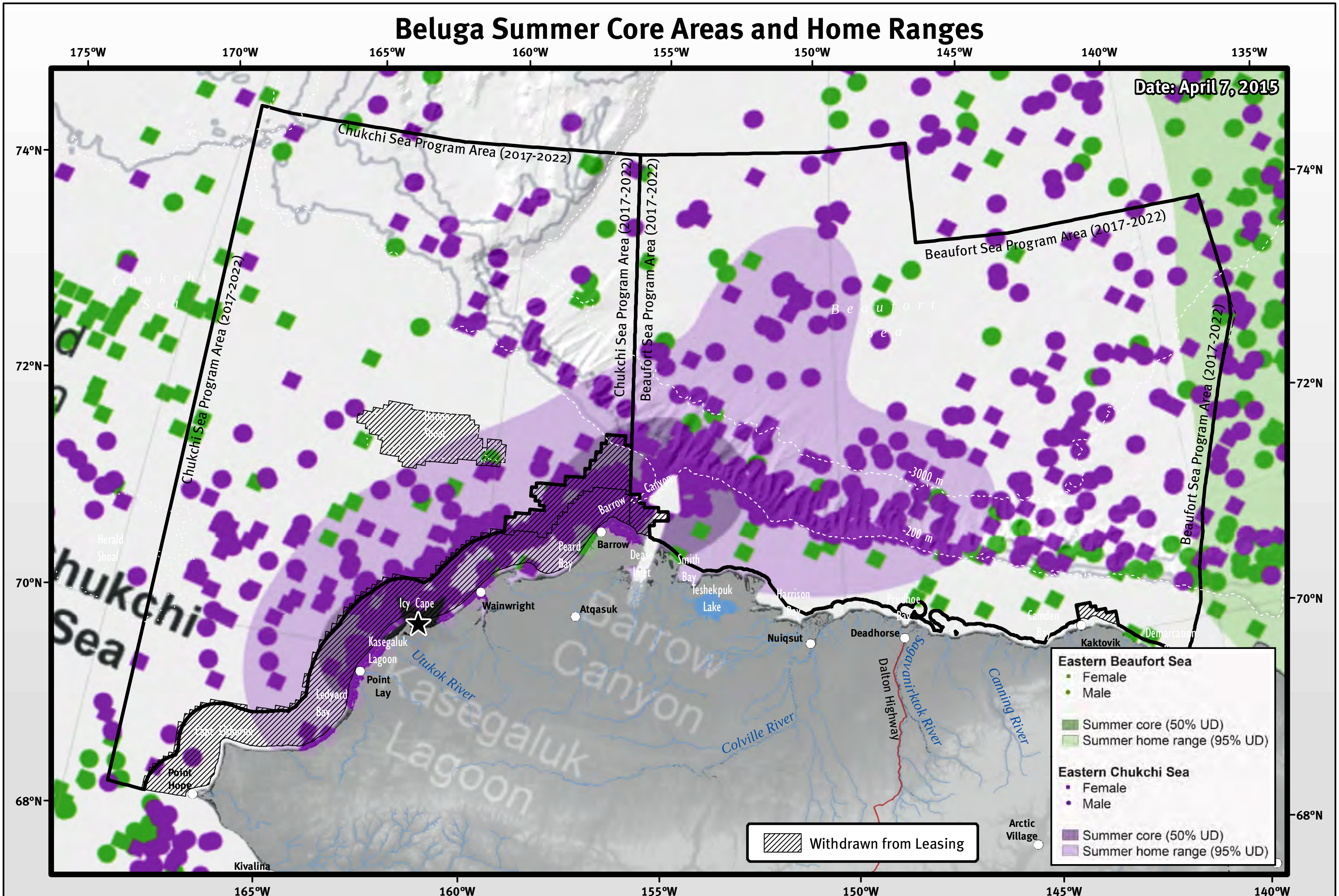
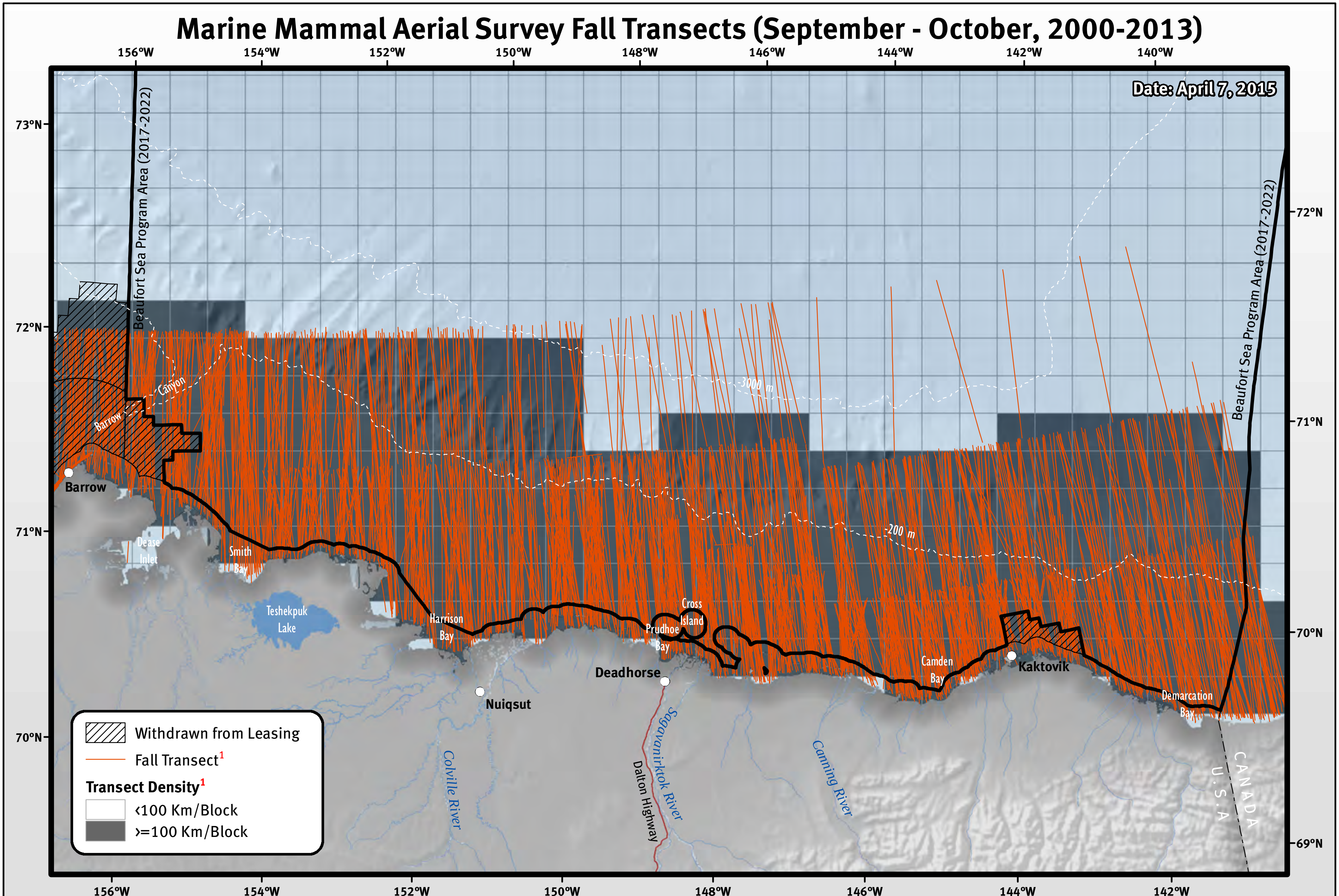


Figure modified from Hauser et al. 2014.

Daily locations of BS and ECS satellite-tagged beluga whales (n = 40 and 24, respectively), July–November, and place names mentioned in the text. Shaded polygons represent the summer (i.e., July and August) core areas [50 % probability contour of the utilization distribution (UD)] and home range (95 % probability). Black stars indicate approximate tagging locations.

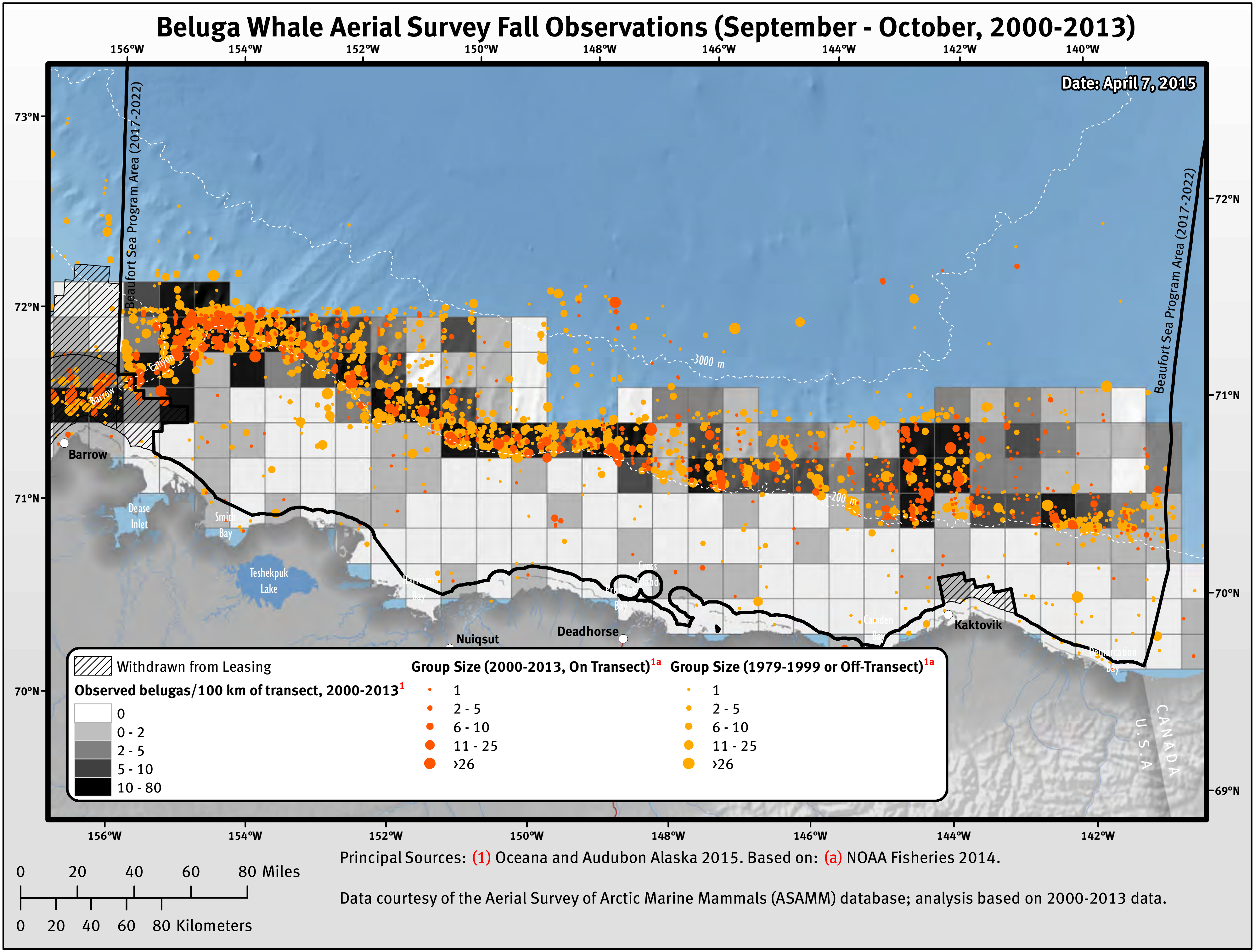
Figure 13.



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.

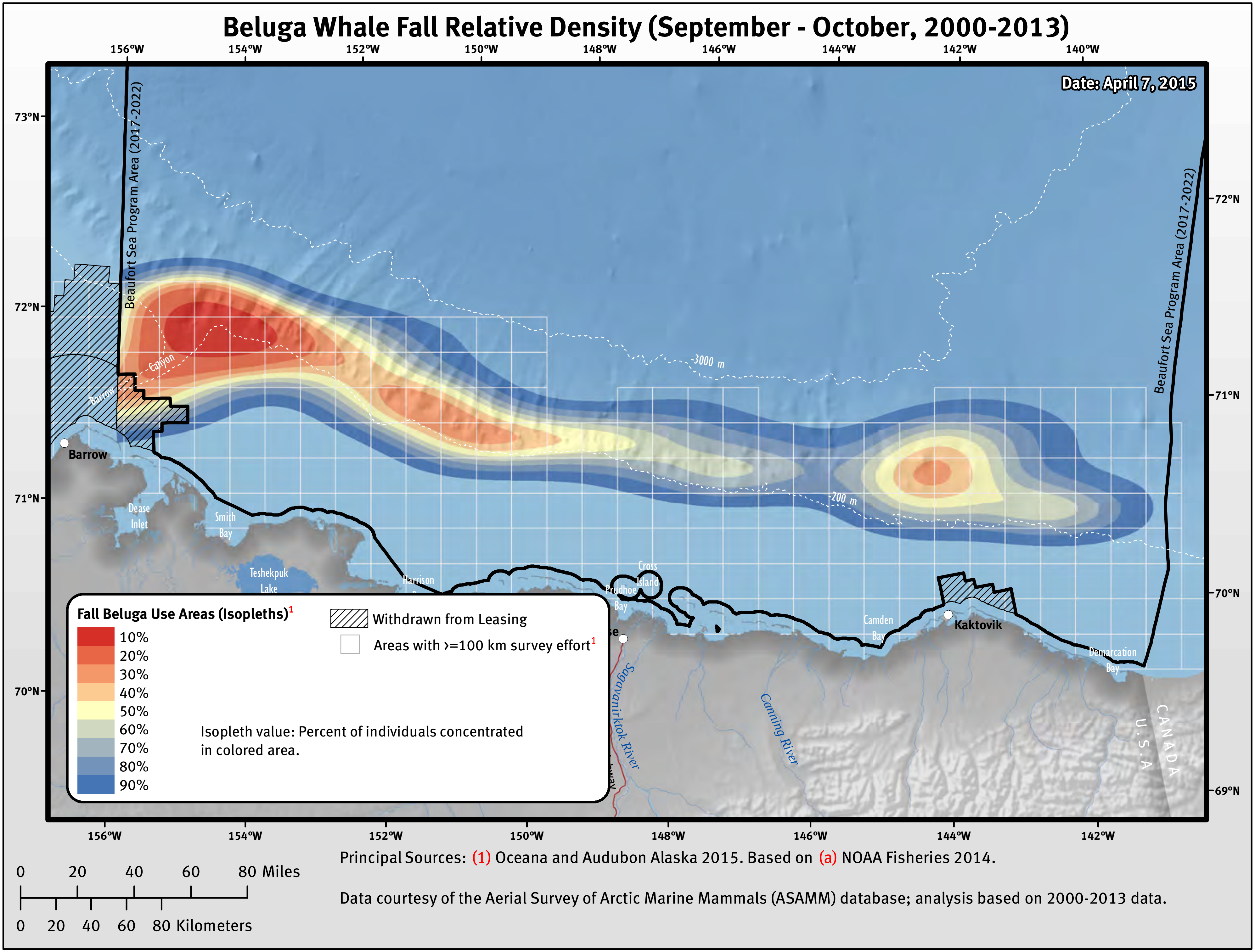
Figure 14.



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.

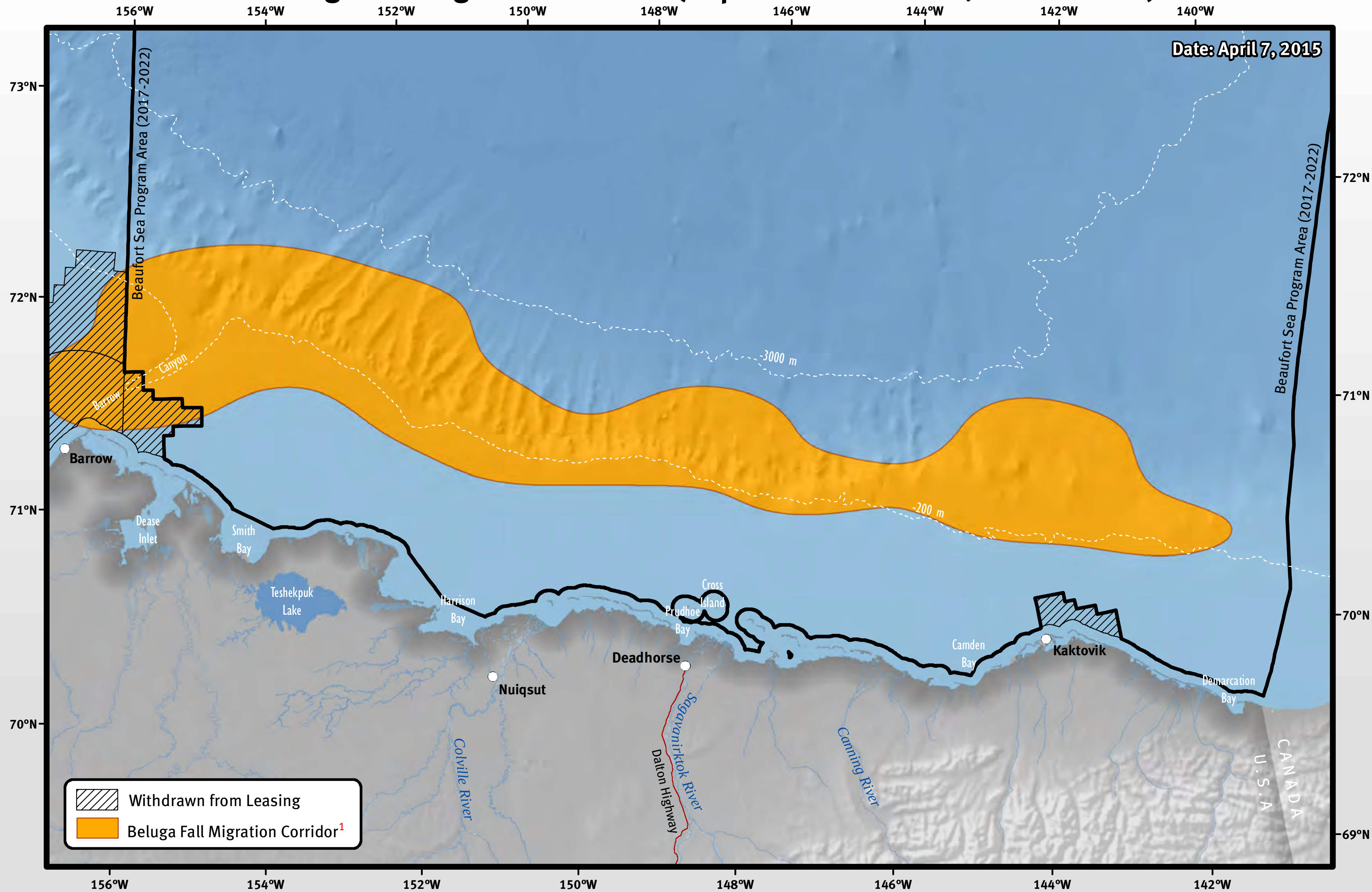
Figure 15.

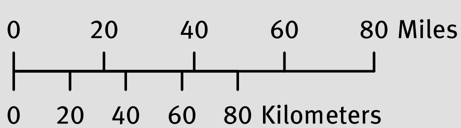


Beluga Whale Fall Relative Density (September - October, 2000-2013)
Date: April 7, 2015
156°W
154°W
152°W
150°W
148°W
146°W
144°W
142°W
140°W
73°N
72°N
71°N
70°N
69°N
Beaufort Sea Program Area (2017-2022)
Beaufort Sea Program Area (2017-2022)
3000 m
200 m
Barrow Canyon
Barrow
Dease Inlet
Smith Bay
Teshekpuk Lake
Harrison
Prudhoe Bay
Cross Island
Camden Bay
Kaktovik
Demarcation Bay
Sagavanirktok River
Canning River
U.S.A
CANADA
Fall Beluga Use Areas (Isopleths)[1]
10%
20%
30%
40%
50%
60%
70%
80%
90%
Withdrawn from Leasing
Areas with >=100 km survey effort[1]
Isopleth value: Percent of individuals concentrated in colored area.
0 20 40 60 80 Miles
0 20 40 60 80 Kilometers
Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.
Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.

Figure 16.

Beluga Fall Migration Corridor (September - October, 2000 - 2013)

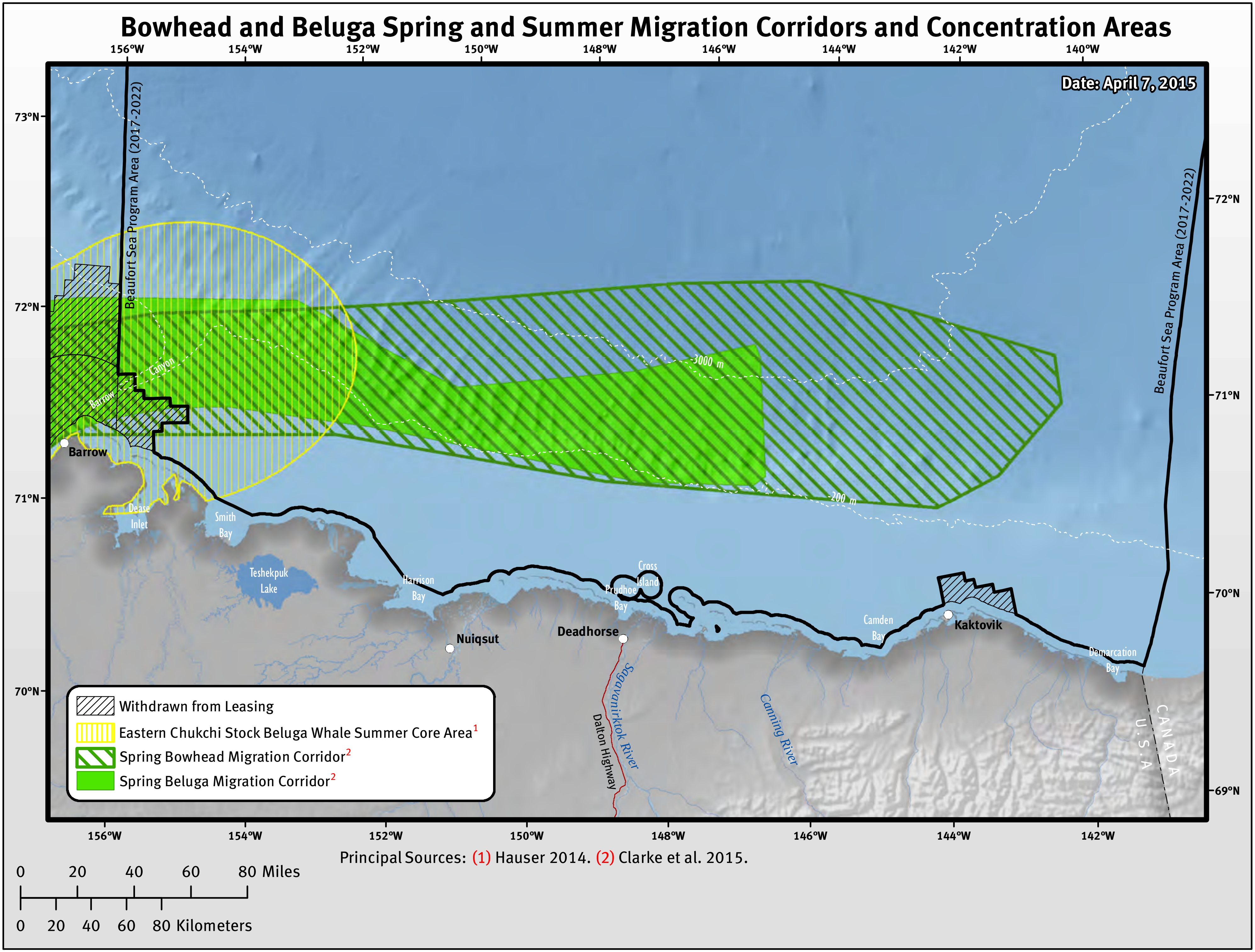




Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

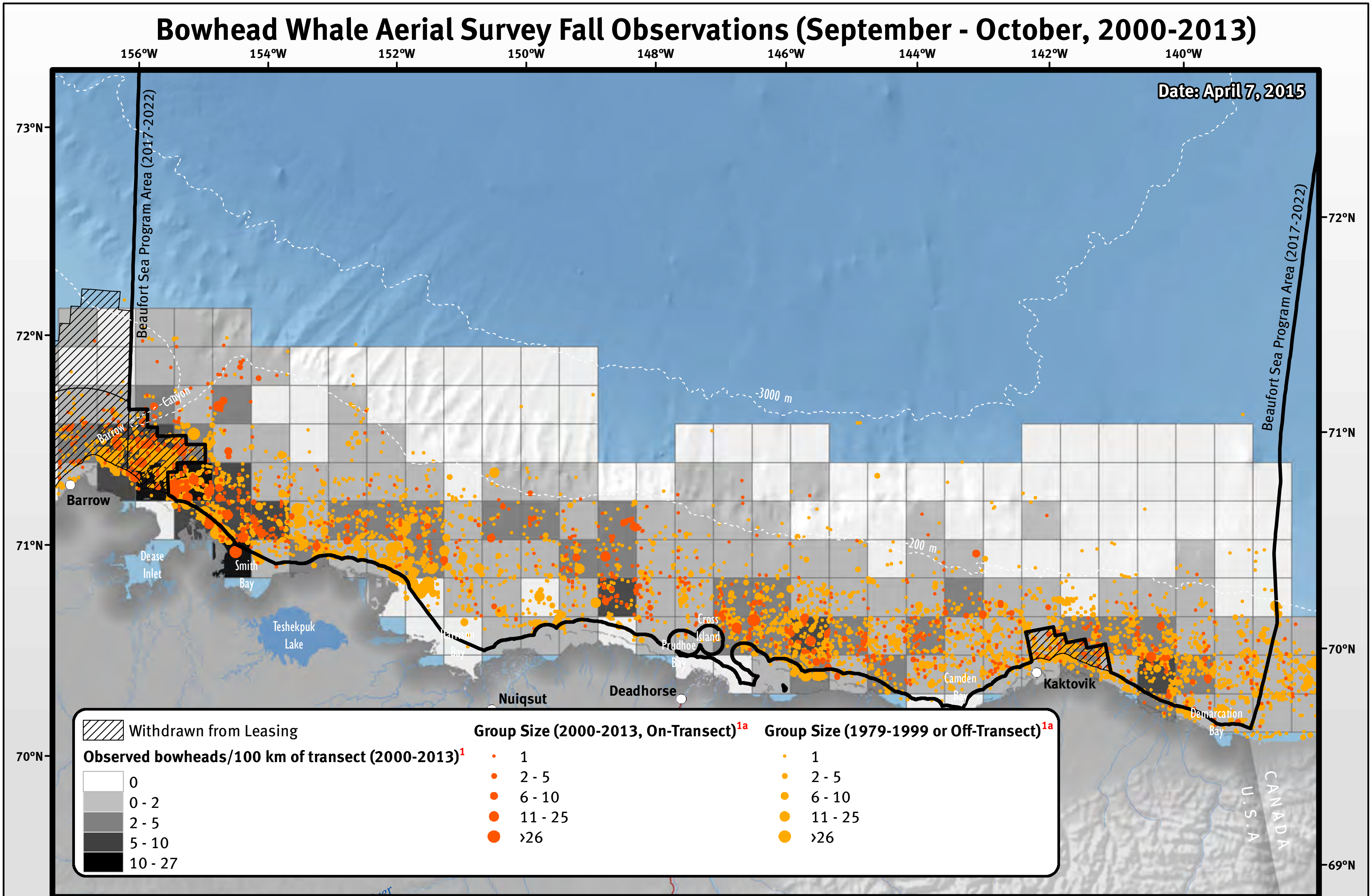
Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.
Migration corridor represents 80% isopleth: 80% of individuals are found in this area.

Figure 17.



Bowhead and Beluga Spring and Summer Migration Corridors and Concentration Areas
Date: April 7, 2015
156°W
154°W
152°W
150°W
148°W
146°W
144°W
142°W
140°W
73°N
72°N
71°N
70°N
69°N
Beaufort Sea Program Area (2017-2022)
Barrow
Canyon
3000 m
200 m
Barrow
Dease Inlet
Smith Bay
Teshekpuk Lake
Harrison Bay
Cross Island
Prudhoe Bay
Camden Bay
Kaktovik
Demarcation Bay
Nuiqsut
Deadhorse
Sagavanirktok River
Dalton Highway
Canning River
CANADA
U.S.A
Withdrawn from Leasing
Eastern Chukchi Stock Beluga Whale Summer Core Area[1]
Spring Bowhead Migration Corridor[2]
Spring Beluga Migration Corridor[2]
Principal Sources: (1) Hauser 2014. (2) Clarke et al. 2015.
0 20 40 60 80 Miles
0 20 40 60 80 Kilometers

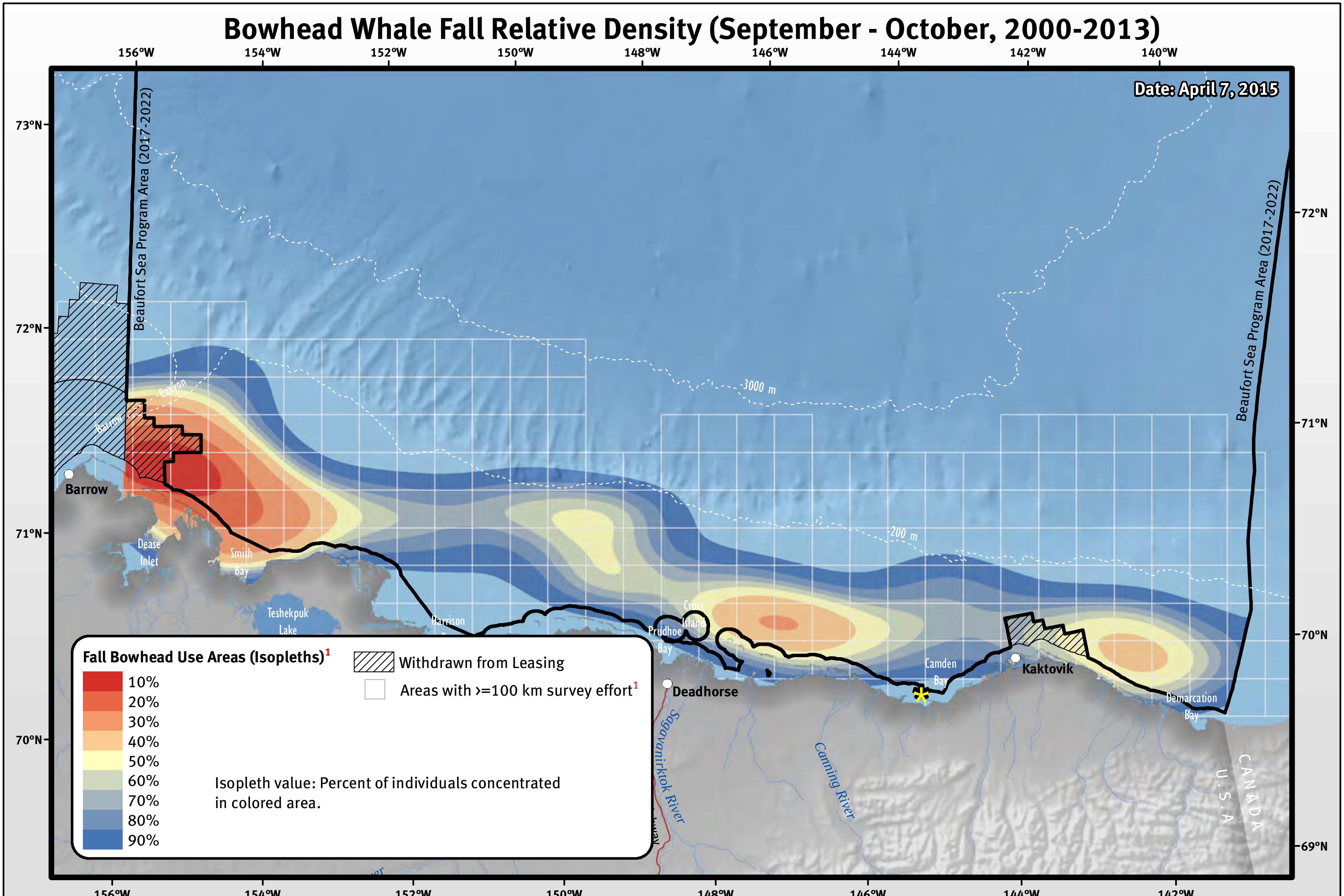
Figure 18.



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.

Figure 19.

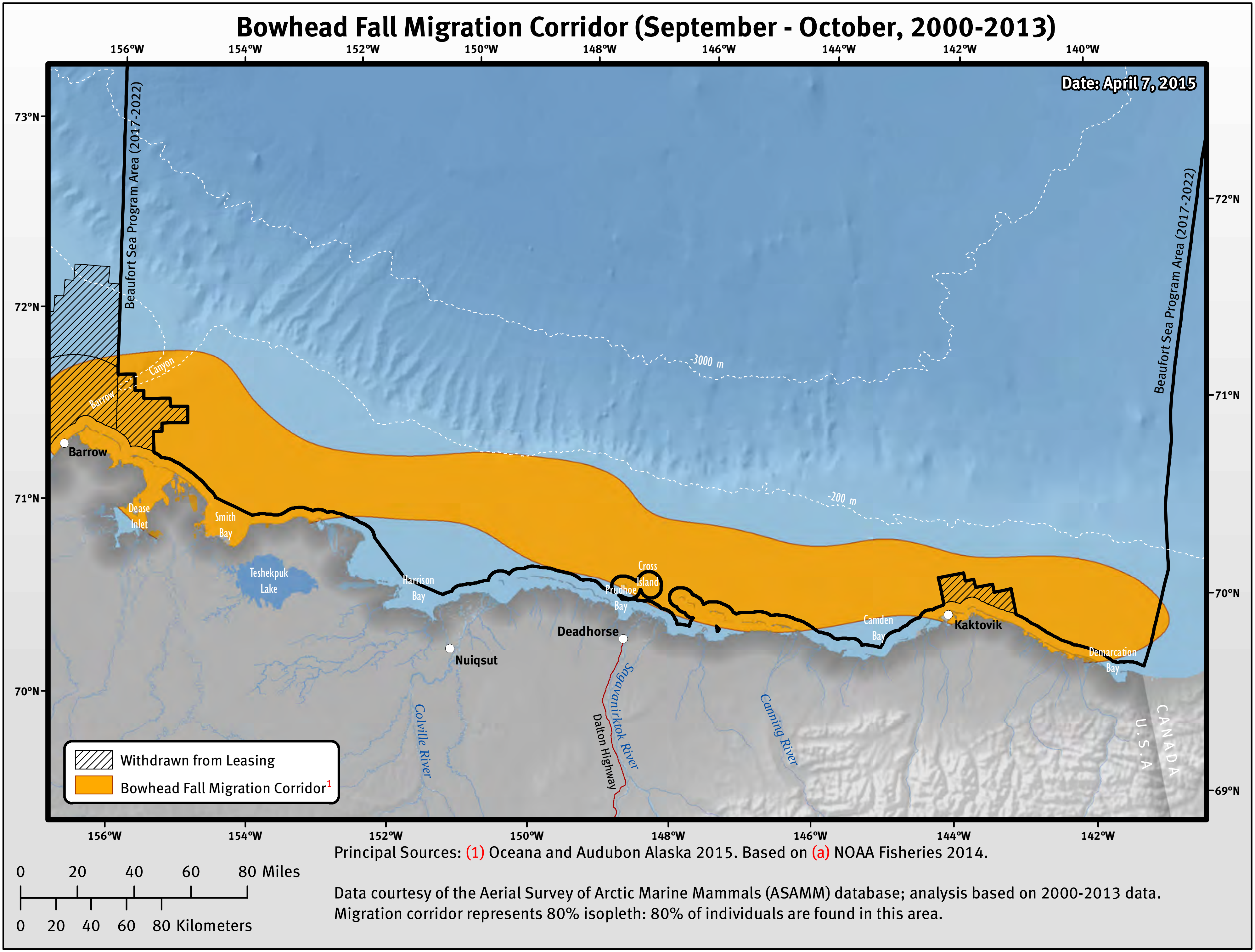


Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on: (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data.

* Whalers from Kaktovik and Nuiqsut have repeatedly identified Camden Bay as an important area for bowheads (Huntington 2013). The North Slope Borough and others are developing a research plan to investigate further.

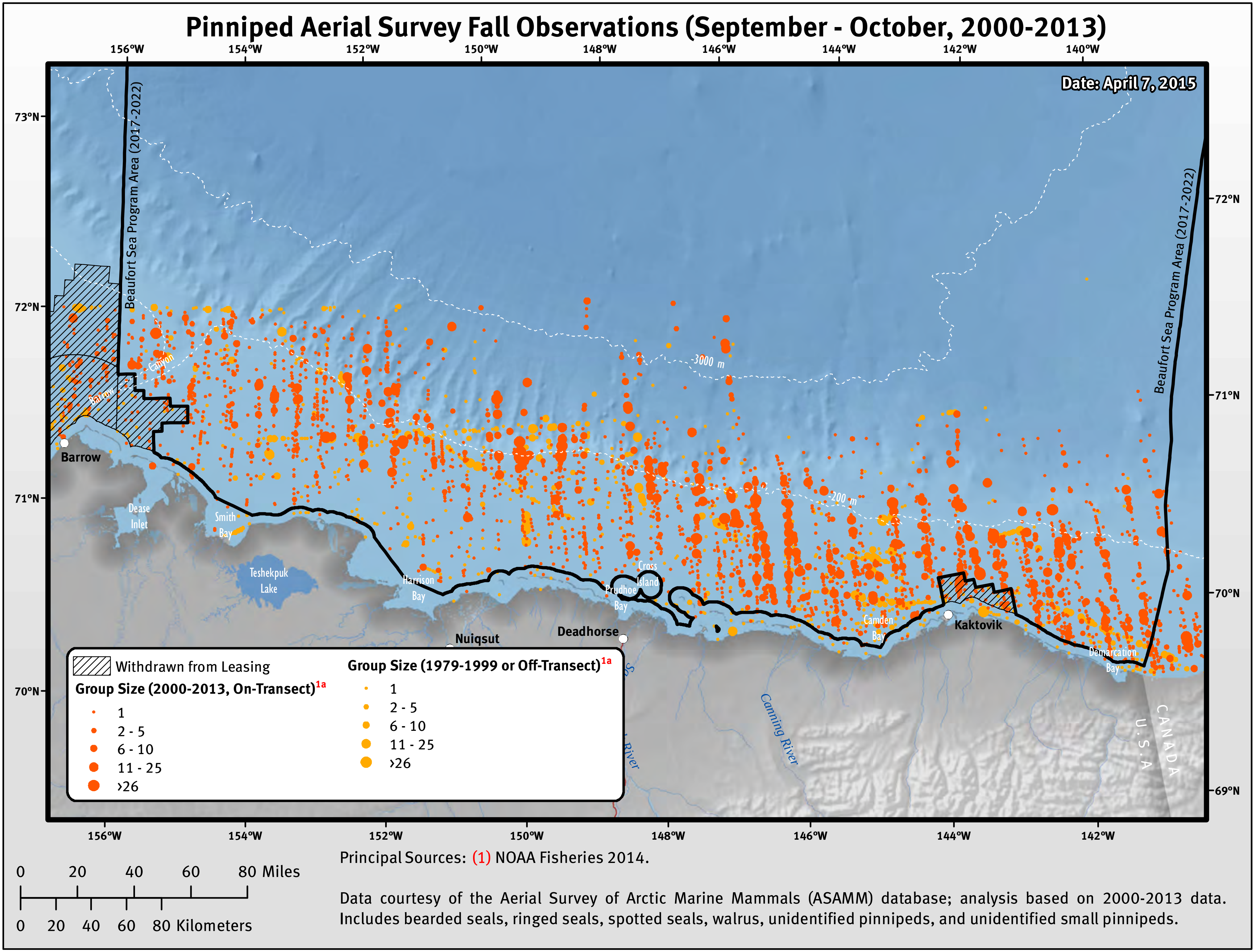
Figure 20.



Principal Sources: (1) Oceana and Audubon Alaska 2015. Based on (a) NOAA Fisheries 2014.

Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data. Migration corridor represents 80% isopleth: 80% of individuals are found in this area.

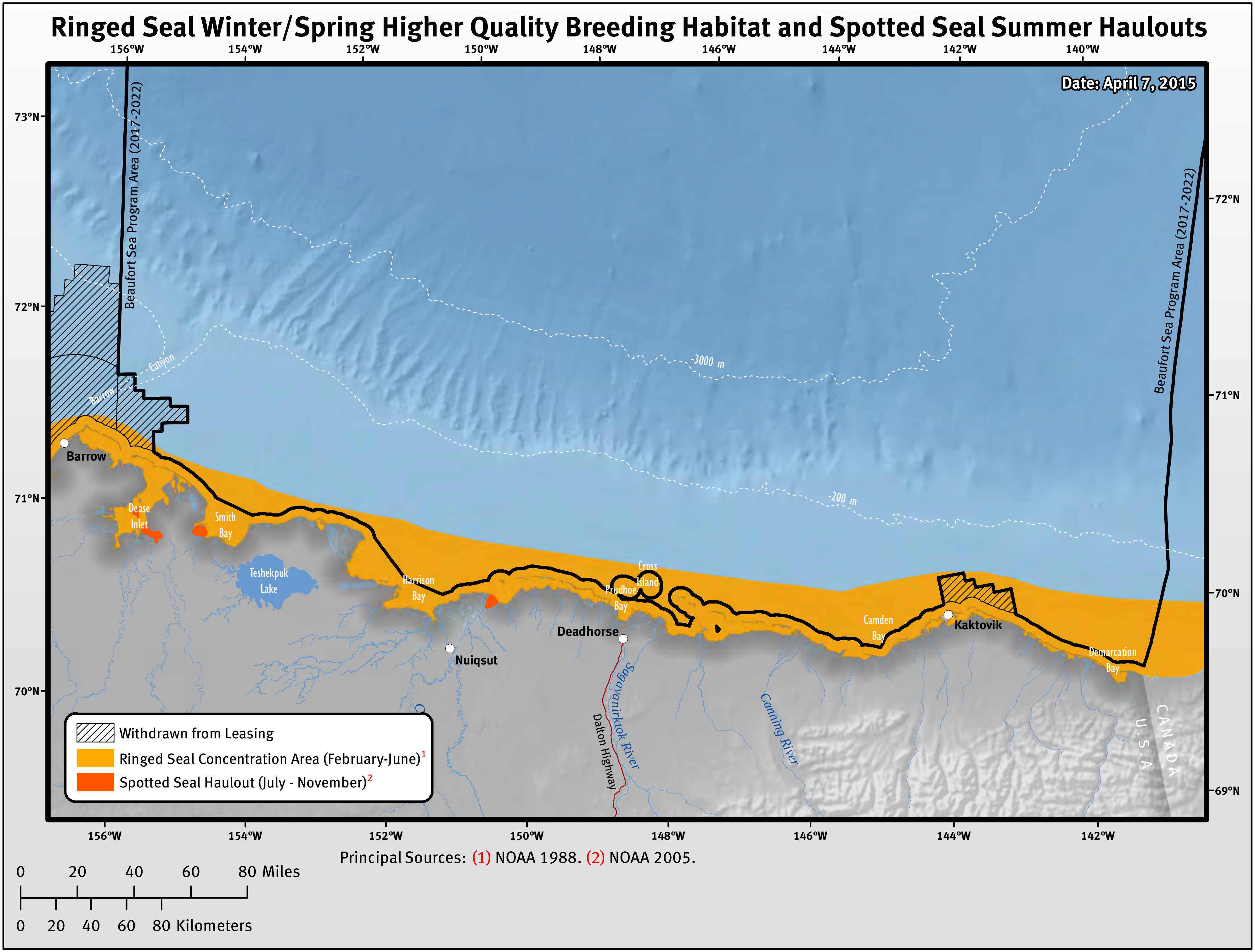
Figure 21.



Principal Sources: (1) NOAA Fisheries 2014.

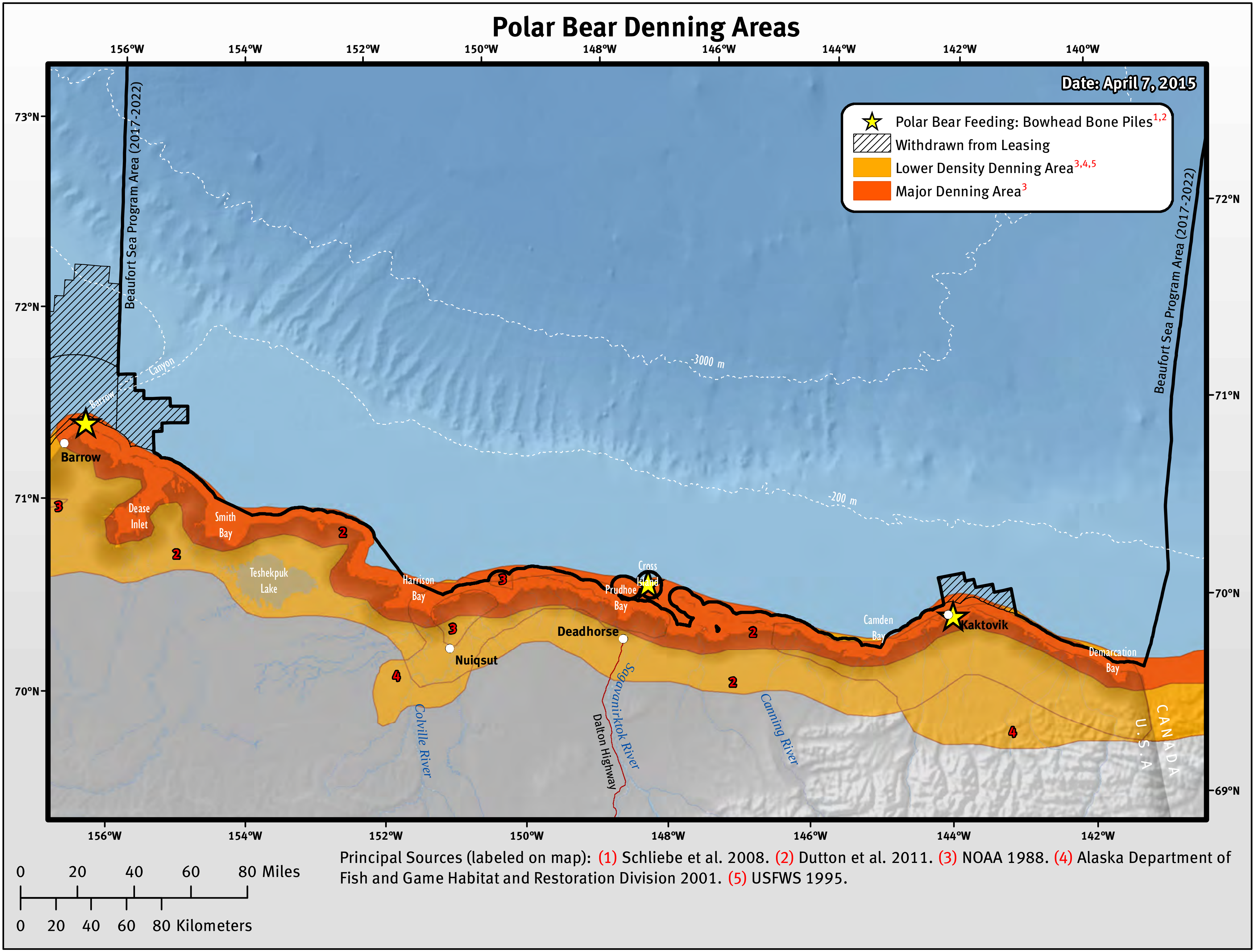
Data courtesy of the Aerial Survey of Arctic Marine Mammals (ASAMM) database; analysis based on 2000-2013 data. Includes bearded seals, ringed seals, spotted seals, walrus, unidentified pinnipeds, and unidentified small pinnipeds.

Figure 22.



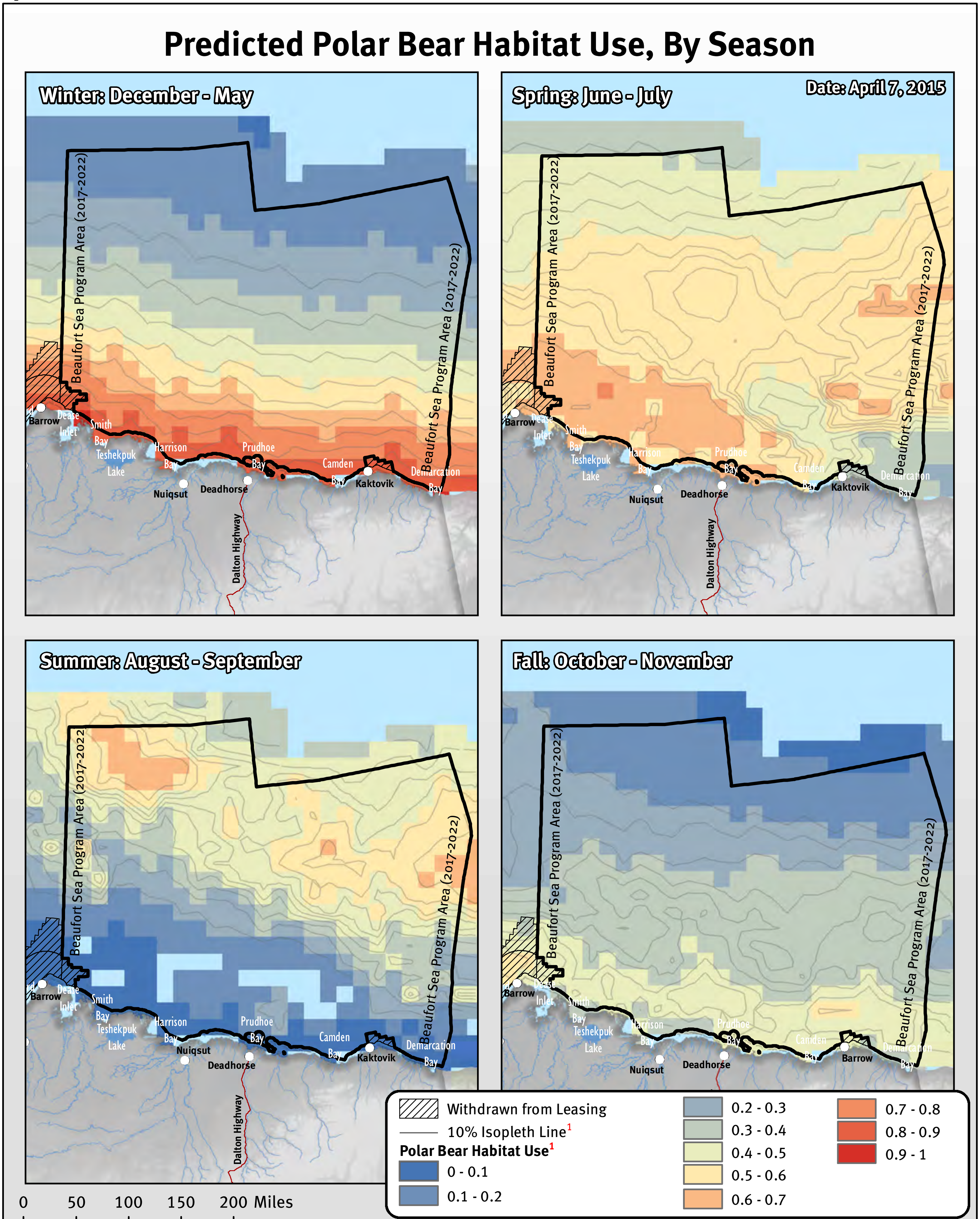
Principal Sources: (1) NOAA 1988. (2) NOAA 2005.

Figure 23.



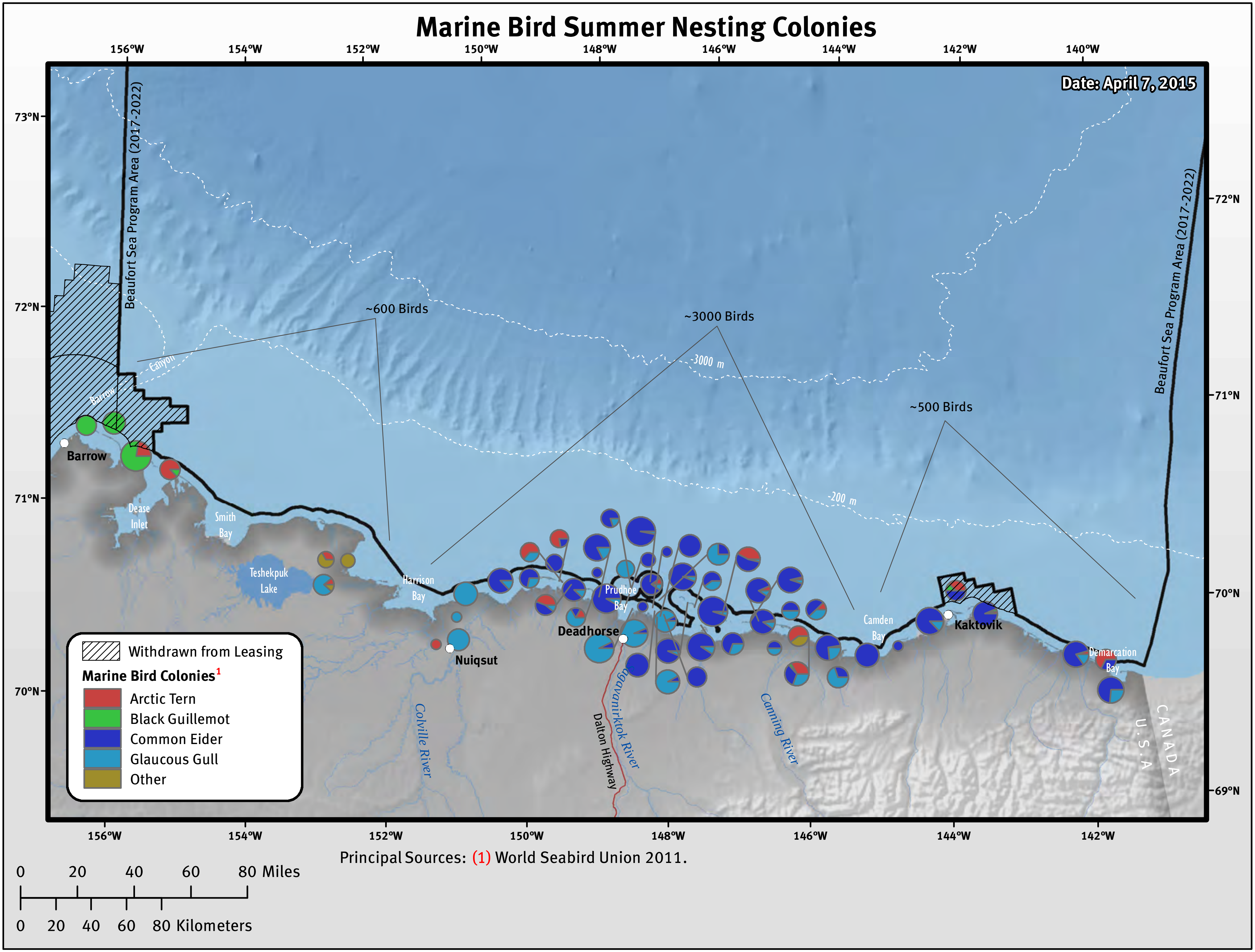
Principal Sources (labeled on map): (1) Schliebe et al. 2008. (2) Dutton et al. 2011. (3) NOAA 1988. (4) Alaska Department of Fish and Game Habitat and Restoration Division 2001. (5) USFWS 1995.

Figure 24.



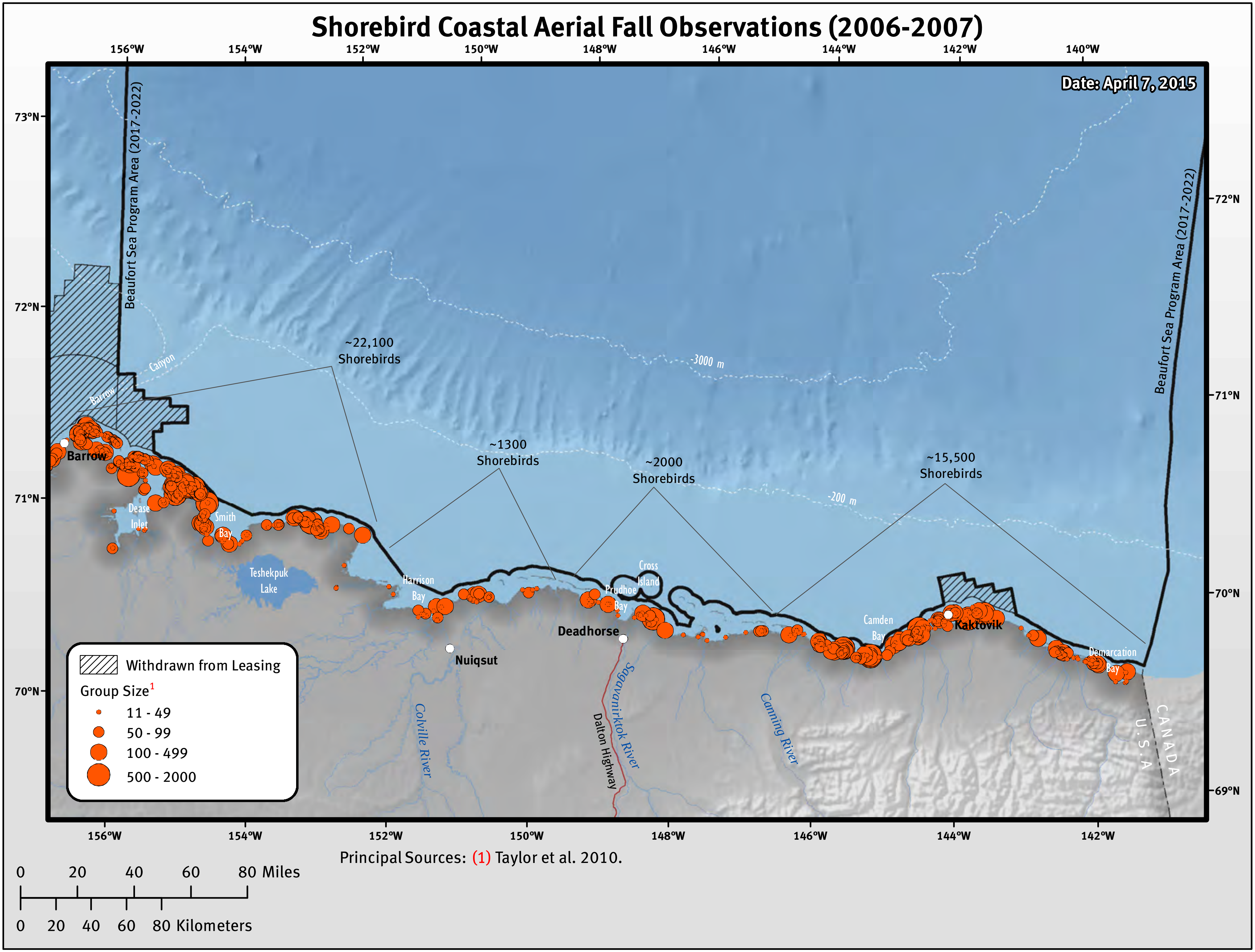
Principal Sources: (1) Audubon Alaska 2014d. Based on resource selection models from (a) Durner et al. 2009.

Figure 25.



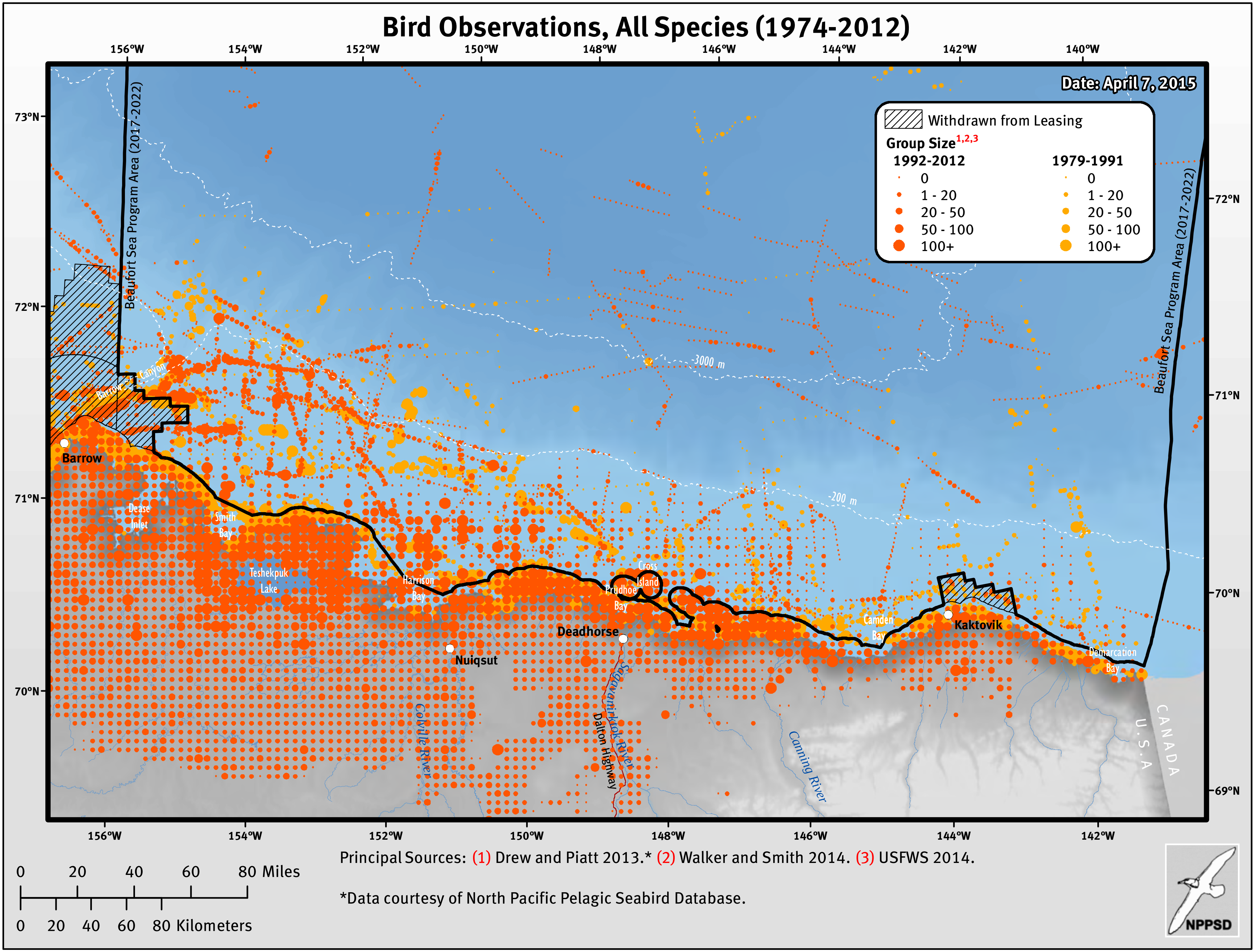
Principal Sources: (1) World Seabird Union 2011.

Figure 26.



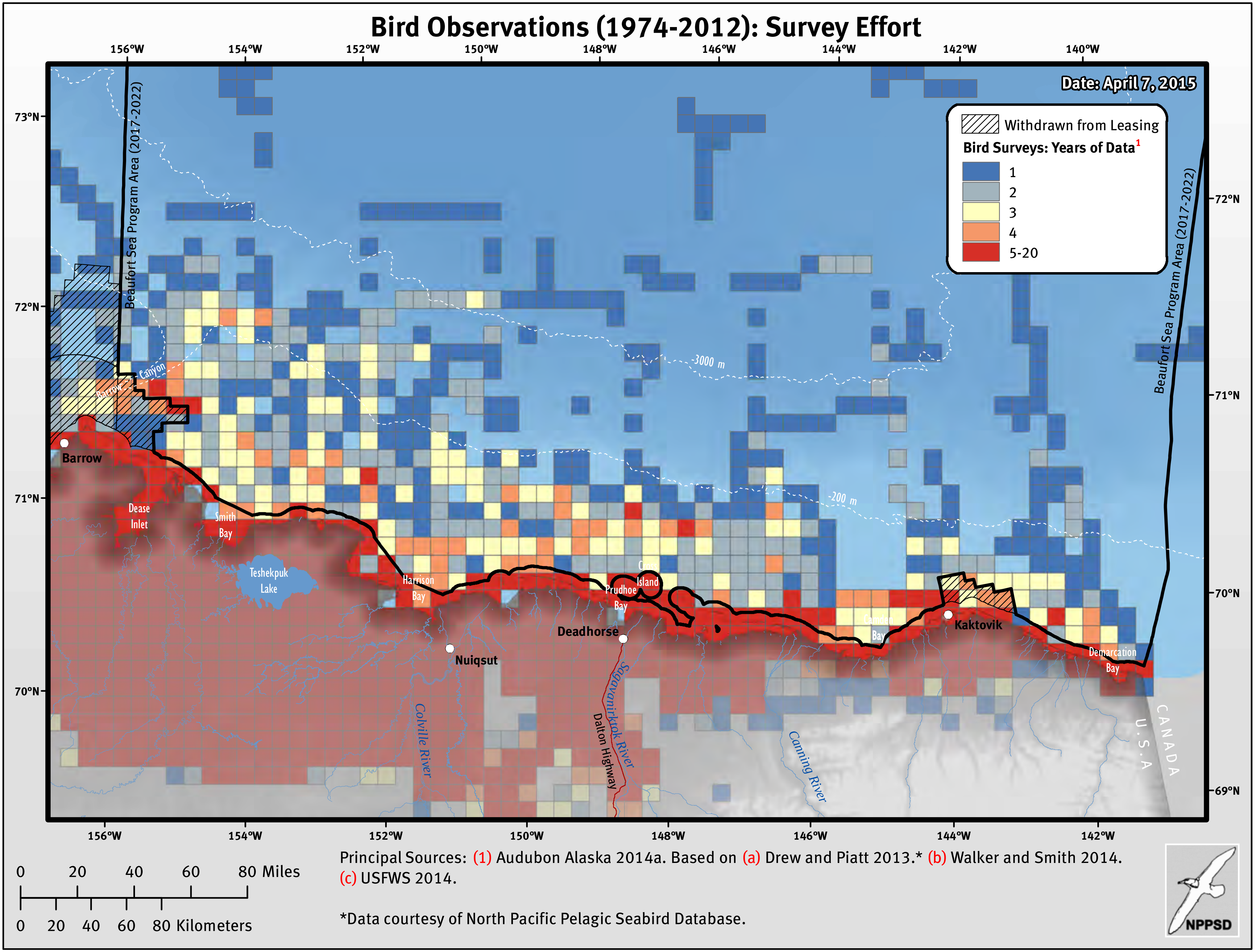
Principal Sources: (1) Taylor et al. 2010.

Figure 27.



Bird Observations, All Species (1974-2012)
Date: April 7, 2015
Withdrawn from Leasing
Group Size[1,2,3]
1992-2012
1979-1991
0
1 - 20
20 - 50
50 - 100
100+
Beaufort Sea Program Area (2017-2022)
156°W
154°W
152°W
150°W
148°W
146°W
144°W
142°W
140°W
73°N
72°N
71°N
70°N
69°N
-3000 m
-200 m
Barrow Canyon
Barrow
Dease Inlet
Smith Bay
Teshekpuk Lake
Harrison Bay
Cross Island
Prudhoe Bay
Deadhorse
Nuiqsut
Camden Bay
Kaktovik
Demarcation Bay
Colville River
Sagavanirktok River
Dalton Highway
Canning River
U.S.A.
CANADA
0 20 40 60 80 Miles
0 20 40 60 80 Kilometers
Principal Sources: (1) Drew and Piatt 2013.* (2) Walker and Smith 2014. (3) USFWS 2014.
*Data courtesy of North Pacific Pelagic Seabird Database.
NPPSD

Figure 28.

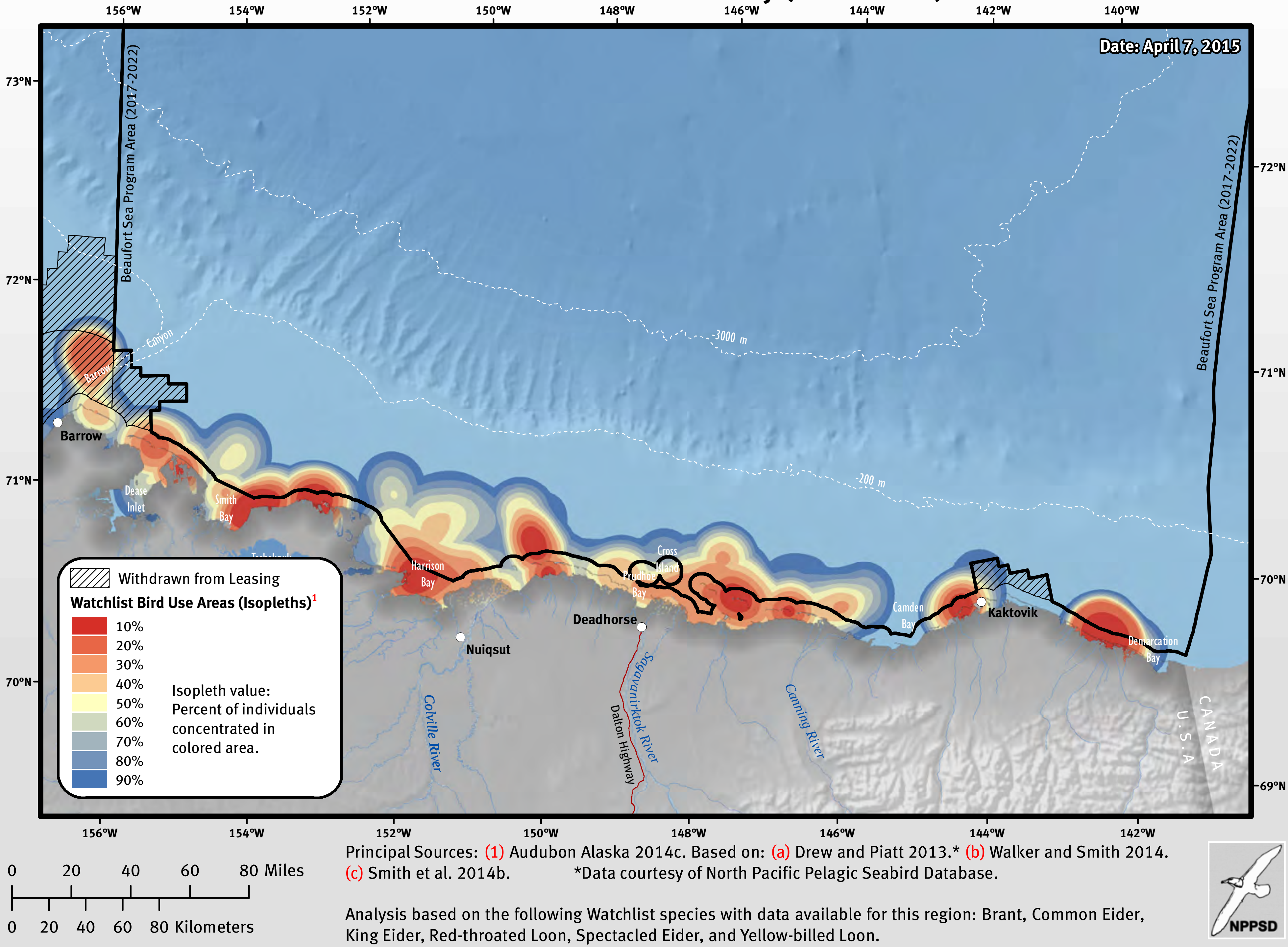


Principal Sources: (1) Audubon Alaska 2014a. Based on (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. (c) USFWS 2014.

*Data courtesy of North Pacific Pelagic Seabird Database.

Figure 29.

Watchlist Bird Relative Density (1979-2010)

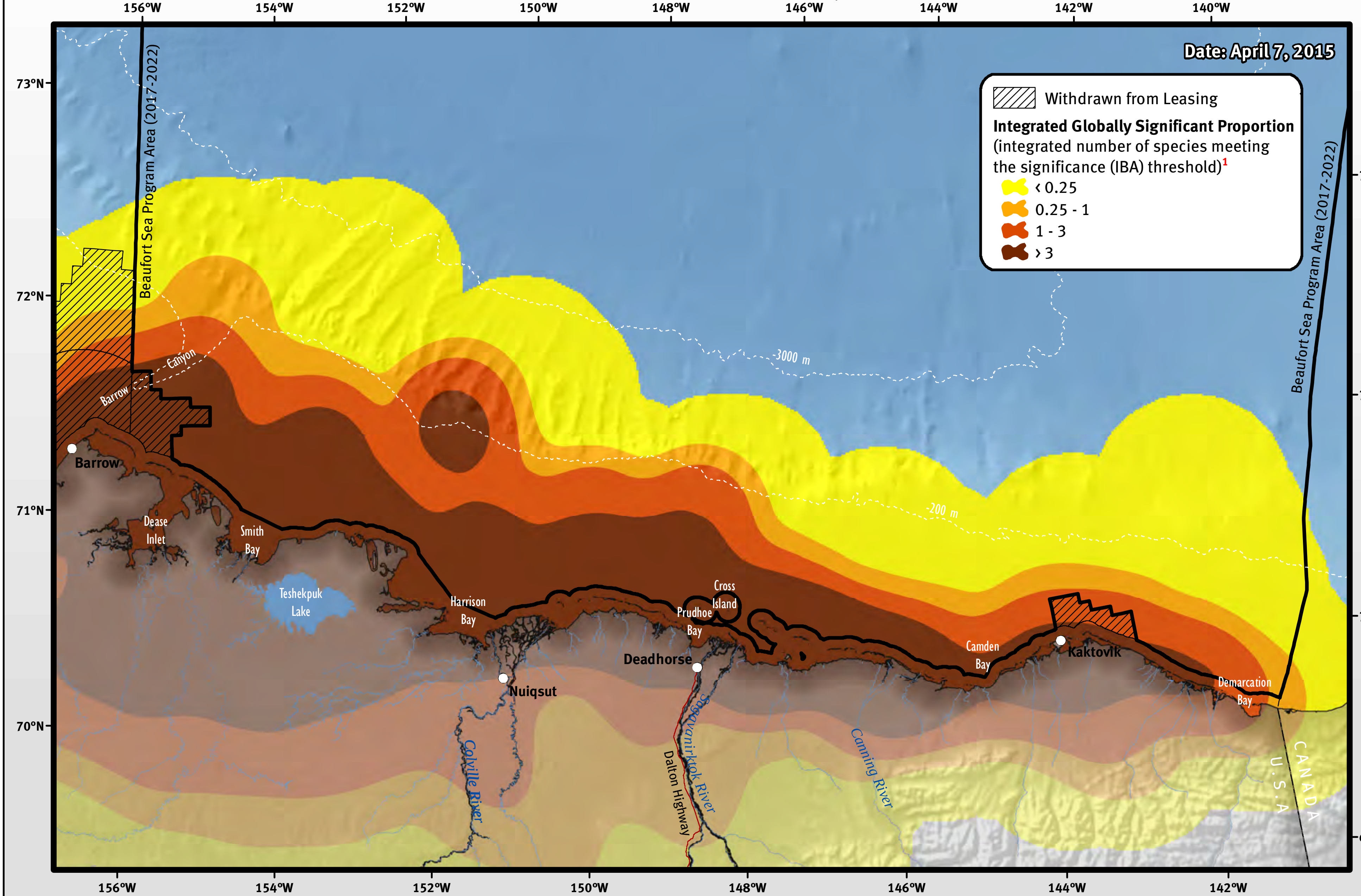


Principal Sources: (1) Audubon Alaska 2014c. Based on: (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. (c) Smith et al. 2014b. *Data courtesy of North Pacific Pelagic Seabird Database.

Analysis based on the following Watchlist species with data available for this region: Brant, Common Eider, King Eider, Red-throated Loon, Spectacled Eider, and Yellow-billed Loon.

Figure 30.

Marine Birds: Relative Importance

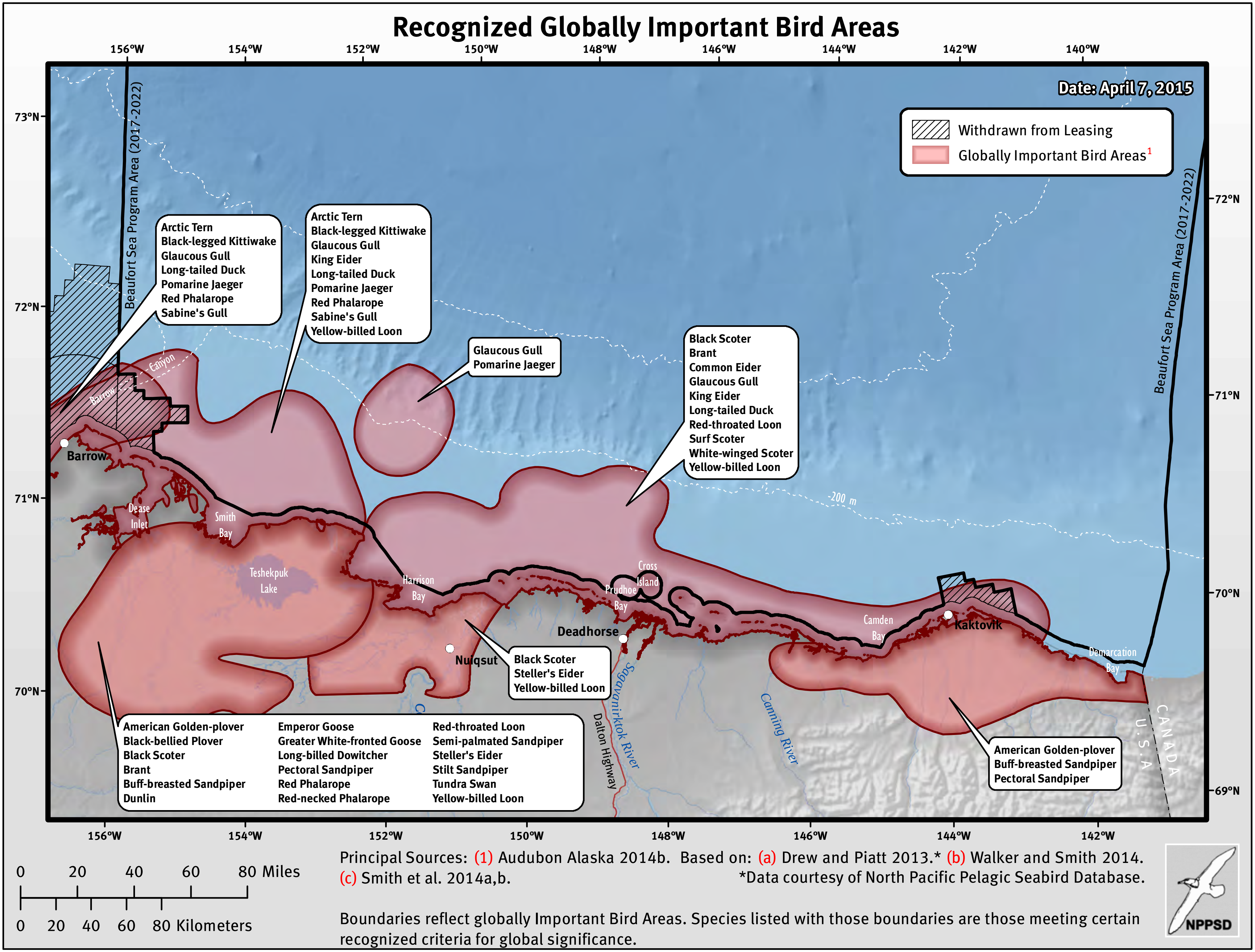


Principal Sources: (1) Audubon Alaska 2015b. Based on: (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. (c) Smith et al. 2014b. *Data Courtesy of North Pelagic Seabird Database.

The integrated globally significant proportion of birds provides a measure of importance by looking at a combination of both species abundance and species rarity, integrated over multiple species. The data indicates relative importance using abundance normalized by population size, using the % of IBA threshold achieved, summed (integrated) for all regularly occurring species. The IBA threshold is 1% of the population, based on global population numbers for seabirds or on continental population numbers for waterbirds.

NPPSD

Figure 31.



Principal Sources: (1) Audubon Alaska 2014b. Based on: (a) Drew and Piatt 2013.* (b) Walker and Smith 2014. (c) Smith et al. 2014a,b.

*Data courtesy of North Pacific Pelagic Seabird Database.

Boundaries reflect globally Important Bird Areas. Species listed with those boundaries are those meeting certain recognized criteria for global significance.

Figure 32.

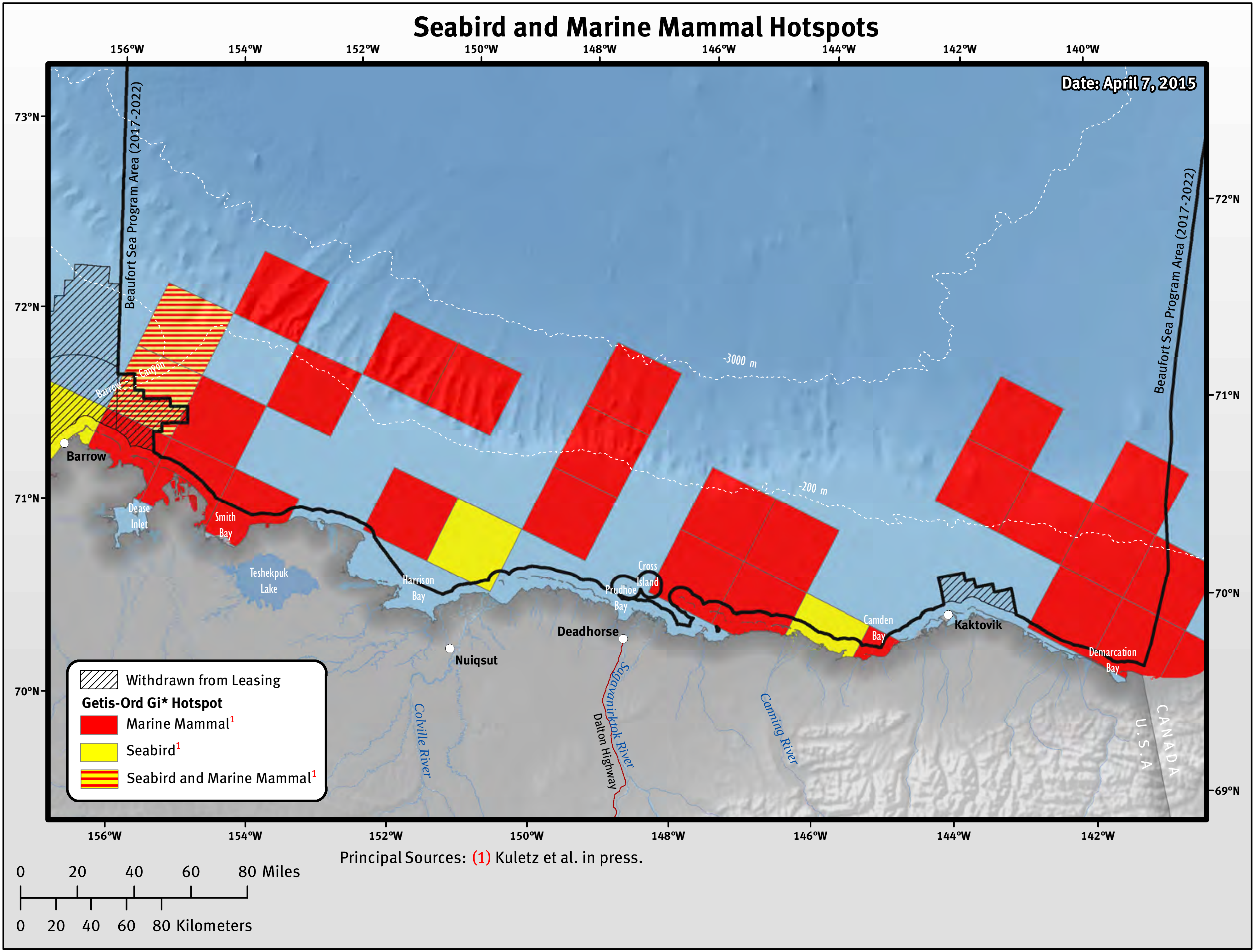
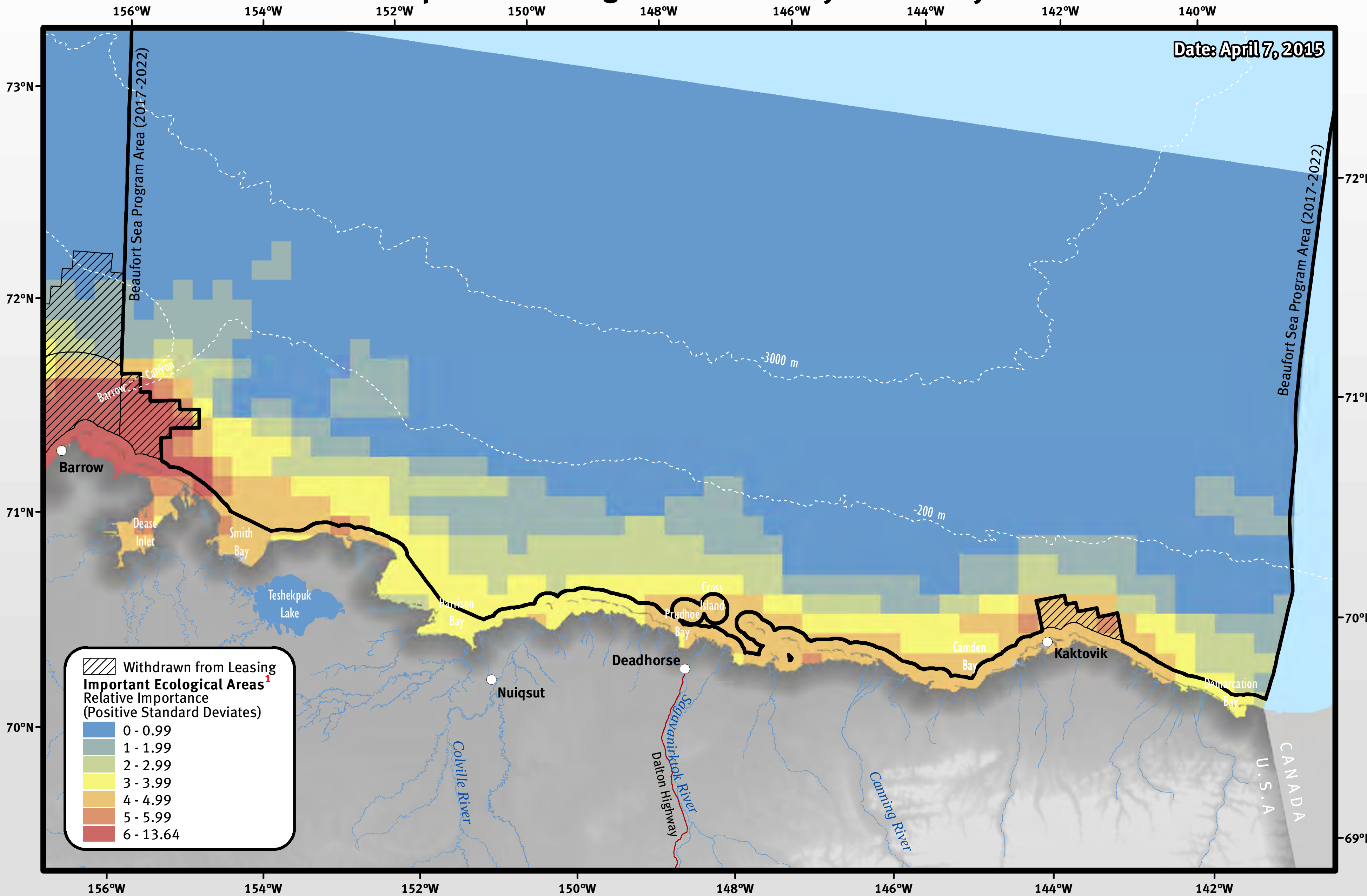

Seabird and Marine Mammal Hotspots
Date: April 7, 2015
156°W
154°W
152°W
150°W
148°W
146°W
144°W
142°W
140°W
73°N
72°N
71°N
70°N
69°N
Beaufort Sea Program Area (2017-2022)
-3000 m
-200 m
Barrow Canyon
Barrow
Dease Inlet
Smith Bay
Teshekpuk Lake
Harrison Bay
Cross Island
Prudhoe Bay
Deadhorse
Nuiqsut
Camden Bay
Kaktovik
Demarcation Bay
Colville River
Sagavanirktok River
Dalton Highway
Canning River
U.S.A.
CANADA
Withdrawn from Leasing
Getis-Ord Gi* Hotspot
Marine Mammal[1]
Seabird[1]
Seabird and Marine Mammal[1]
Principal Sources: (1) Kuletz et al. in press.
0 20 40 60 80 Miles
0 20 40 60 80 Kilometers

Figure 33.

Important Ecological Area - Ecosystem Analysis



0 20 40 60 80 Miles

0 20 40 60 80 Kilometers

Principal Sources: (1) Oceana 2013.

This analysis combined information on ecological features of the ecosystem: subsistence, marine mammals, seabirds, seafloor biomass, primary productivity, and sea ice habitat features. Importance values >0 indicate places that are above average for one or more ecological features. Higher relative values indicate importance for multiple overlapping features. The study area over which relative importance was measured includes most of the U.S. Chukchi and Beaufort waters north of 68° latitude and south of 73° latitude. Analysis specifics and citations for source data analyzed are available at http://www.regulations.gov/#!documentDetail;D=NOAA-NMFS-2013-0054-0070 or by contacting ckrenz@oceana.org.

APPENDIX D

BIOLOGICAL VALUES AND SUPPORTING SCIENCE FOR

BEAUFORT SEA IMPORTANT AREAS

This appendix describes the data sources and spatial information cited on our Beaufort Sea maps and used in our spatial analyses. It provides information relating to:

- Cetaceans (bowhead and beluga whales);
- Pinnipeds (walrus, ringed seal, spotted seal, and bearded seal);
- Polar bears;
- Marine birds;
- Lower trophic levels and physical features (primary productivity, benthic biomass, sea ice);
- Subsistence; and
- Important ecological areas (IEAs).

We begin with a brief introduction of each topic, focusing on the key features relative to the Beaufort Sea Planning Area. Then, we list and explain the principal data sources that informed our GIS analyses. We summarize the key information from each source, and document with reference to specific page and figure numbers the text or maps that describe concentration areas or other relevant data.

1. CETACEANS

1.1 Bowhead Whale

The bowhead whale population that inhabits the Beaufort Sea Planning Area is the Western Arctic Stock (Allen and Angliss 2013, Clarke et al. 2014). The Western Arctic Stock winters (December to March) in the Bering Sea, and migrates to the Beaufort Sea in spring (April through May) to summertime foraging grounds. In the fall (October through December) they migrate back to the Bering Sea (Moore and Reeves 1993, Quakenbush et al. 2013). Bowhead whales are closely associated with sea ice for much of the year, with the exception of their time at summering grounds, particularly in recent years. Their spring migration route travels along the shear zone between the shorefast and pack ice. In the Chukchi Sea, their route passes the coastal communities of Point Hope, Point Lay, Wainwright, and Barrow (Quakenbush et al. 2013, Clarke et al. 2015). During the fall migration, bowhead whales follow continental slope habitat along the Beaufort Sea coast (Moore 2000) where their route passes the whaling communities of Kaktovik, Nuiqsut and Barrow. There are important resting and feeding areas along the Beaufort Sea coast along the fall migration route, particularly for mother-calf pairs (Christman et al. 2013, Clarke et al. 2014). There are also important areas for shelter during inclement weather; these areas have not been documented during aerial surveys flown under good weather conditions, but from traditional knowledge of whalers (Huntington 2013). These areas could become increasingly important with longer periods of open water. After passing Point Barrow, they move across the Chukchi

Sea toward the Russian coastline toward the Bering Strait and St. Lawrence Island (Quakenbush et al. 2010). Along these migratory pathways are important areas for foraging and resting, known from systematic surveys (Moore et al. 2000, Clarke et al. 2014, Clarke et al. 2015), satellite tagging data (Citta et al. 2014, Citta et al. 2015), and traditional knowledge of hunters (Huntington and Quakenbush 2009, Huntington 2013). The bowhead whale subsistence hunt has a central cultural role in the subsistence way of life of some coastal communities, and it plays an important role in the health and well-being of many Arctic peoples, from communities in the Bering Strait region to the Beaufort Sea.

The mapped concentration areas for bowhead whales are based on the following scientific source materials.

- **Analysis of Aerial Surveys of Arctic Marine Mammals (ASAMM) data for the Beaufort and Chukchi seas**
  - Summer and fall bowhead whale, beluga whale, gray whale, and walrus core use areas were delineated by analyzing the Bureau of Ocean Energy Management (BOEM)-funded ASAMM data for the Beaufort and Chukchi seas (formerly Bowhead Whale Aerial Survey Project – BWASP, and Chukchi Offshore Monitoring in Drilling Area – COMIDA). Megan Ferguson and Janet Clarke, the points of contact for this database and associated reports, were consulted and provided valuable advice and feedback on the analyses used to delineate the fall bowhead whale migration corridor. Aerial survey methods, data, and metadata for the ASAMM database are readily available at: http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php. We used the following methods to analyze the ASAMM data:
    - Confined the analyses to 2000-2013 survey data (note Chukchi surveys have only been conducted from 2008 onwards except around Point Barrow), which are the recent years for which data are available and better represents current distribution patterns;
    - Utilized data for the fall bowhead whale migration as well as the summer and fall beluga whale, gray whale, and walrus use areas. We defined summer as July and August and fall as September to the end of October (note: surveys were not conducted past the end of October during 2000–2013). For gray whales that did not show significant seasonal variability, we pooled data across the two seasons;
    - Used only on-transect survey effort, versus including all observations of whales that included off-transect search effort;
    - Established a 20×20km grid over the Beaufort Sea and Chukchi Sea planning areas;
    - Calculated survey effort as the distance surveyed in each 20×20 km grid cell (total over all years);
    - Removed grid cells with less than 100 km of total survey effort from the rest of the analysis to establish adequate sampling;
    - Calculated an observation rate (i.e., relative density) for each whale species and walrus in each grid cell by dividing the observed number of animals over all years by the measure of total transect length over all years;

    - Smoothed grid cell values by first converting the grid cell values into point data with one point per grid cell at the centroid, and then running an anisotropic kernel density function with a 40 km north-south search radius and a 80 km east-west search radius;
    - Used the 50% isopleth (concentration of 50% of sightings) of the kernel density analysis to identify core areas—places with high relative density within the migration corridor. The 50% isopleth is the standard isopleth most often used to identify species core areas (e.g. Person et al. 2007, Western Arctic Caribou Herd Working Group 2011, Jay et al. 2012, Sexson et al. 2012). Migration corridors for bowhead whales and beluga whales were delineated by using the 80% isopleth;
    - Analyses were run for each planning area separately (Beaufort Sea Planning Area and Chukchi Sea Planning Area) as well as both planning areas together. In the accompany maps, if only one planning area is shown than the analysis only covered that planning area unless noted otherwise. If both planning areas are shown on the same map, than the analysis was across both planning areas.
    - While previous research has documented a difference in the bowhead migration path that is related to whether the year is a heavy or light ice year (Moore 2000), the data we analyzed is for light ice years. With the rapid loss of Arctic sea ice, we presume this analysis of light ice years is representative of current conditions that are predicted to continue into the near future (Overland and Wang 2013).

- **Fall migration corridor, biologically important areas for reproduction and feeding, and high relative density areas**
  - Our analyses of ASAMM data delineate the fall migration corridor for bowhead whales across the Beaufort Shelf in the Beaufort Sea Planning Area. Consistent with other studies, our analysis identified the migration corridor as occurring over the mid- to inner-shelf. We also identified core use areas within the migration corridor at and to the east of Point Barrow, east of Cross Island, and east of Kaktovik. Our results are consistent with other analyses of the ASAMM data (Clarke et al. 2014) and with other research documenting Point Barrow as an important bowhead whale feeding area (Ashjian et al. 2010, Moore et al. 2010, Citta et al. 2014).
  - Reports and previous studies of BWASP and ASAMM surveys have helped document the bowhead whale fall migration corridor and areas with high relative densities of bowhead whales along the migration corridor (Moore et al. 2000, Clarke et al. 2011, Clarke et al. 2012, Clarke et al. 2013b, Clarke et al. 2014), which are consistent with our analysis.
    - Figure 5 on page 437 of Moore et al. (2000) shows observations of bowhead whale in the Beaufort Sea from 1982–1991, which is a good representation of the general Bowhead whale migration corridor during that decade.
    - Figure 19 on pages 63–67 of Clarke et al. (2014) show high use areas during the fall bowhead whale migration based on a relative abundance rate model with high use

areas off Point Barrow, to the east of Cross Island, and to the east of Kaktovik, which correspond to the high relative density areas identified in our analysis of the ASAMM data. Figure 40b on page 116 shows foraging and milling bowhead whales, which appear consistent with the high use areas identified in our analysis of the ASAMM data being feeding areas.

  - Figure 40(B) on page 116 of Clarke et al. (2014) shows the 2000–2013 sightings of feeding and milling bowhead whales in fall. The areas off Point Barrow, east of Cross Island, and east of Kaktovik are all locations where a fair number of feeding bowhead whales have been spotted across multiple years.

- Satellite telemetry of bowhead whales documents the importance of feeding areas near Barrow Canyon and Point Barrow (Quakenbush et al. 2010, Quakenbush et al. 2013), which is supporting information for a high density use area in the Point Barrow region.

  - Quakenbush et al. (2010) used Kernel Density Estimation to identify areas of concentrated use. Page 293 describes the methodology. "*Kernel density estimation is a non-parametric method for calculating the probability that an animal occurs within a defined area. Such probability distributions are also known as utilization distributions (e.g., Kernohan et al., 2002); however, we use the term "kernel density" because it describes the method used to generate the probability distribution of animal locations.*"

  - Quakenbush et al. (2013) also used Kernel Density Estimation to identify areas of concentrated use. Figure 30 on page 47 shows high density areas, including the Point Barrow area, and Figure 30 on page 51 shows the timing of use of the Point Barrow high density area, which is primarily from mid-August to early November.

- The Bowhead Whale Feeding Ecology Study (BOWFEST) has documented the use of the Point Barrow region by bowheads (Ashjian et al. 2010, Moore et al. 2010).

  - Ashjian et al. (2010) in a study on the distribution of zooplankton and bowhead whales off Point Barrow concluded on page 192: "*Transport of euphausiids from the Pacific Ocean to Barrow in the large-scale circulation, coupled with local wind forcing, provides at least two mechanisms by which euphausiids are concentrated on the western Beaufort Sea shelf near Barrow, resulting in a predictable and abundant food supply for the bowhead whales during their migration. Because the development of this feeding region and the arrival of the whales appear to persist despite ongoing climate variability, the fall whale harvest by the Iñupiat community at Barrow should be relatively resilient to climate change. The whale harvest at Barrow could, however, be particularly vulnerable to anthropogenic activities such as ship traffic, oil development, or an oil spill.*"

- Satellite telemetry of bowhead whales and analysis of physical and biological oceanography documents the importance of feeding areas near Barrow Canyon (Citta et al. 2014).

- Page 17 and Figures 2 and 6 describe and show the use of Point Barrow as an important feeding area. *"The core-use area we identified using bowhead tag locations (Fig. 2) closely corresponded with the area identified by Ashjian et al. (2010) as having a high density of krill (see Fig. 9 in Ashjian et al., 2010) and a high density of whale sightings (see Fig. 13 in Ashjian et al., 2010 and Fig. 5a and b in Okkonen et al., 2011). However, the krill trap was difficult to identify with the oceanographic model because of its episodic nature and how we were summarizing (averaging) model results. Zooplankton must first be available to seed the shelf. East winds are then necessary to advect zooplankton onto the shelf and then must relax to trap zooplankton. If east winds do not relax, zooplankton exit the shelf to the northwest. This process was impossible to identify using salinity or temperature gradients because we averaged model results across years while whales were present. Instead, we illustrated the krill trap by plotting velocity under different wind regimes (Fig. 6e and f). We could only do so because we knew what pattern we were trying to identify; hence, the oceanographic model, as we applied it, was generally not useful for identifying features that may aggregate zooplankton near Point Barrow over shorter time frames."*

o There is strong evidence that the number of feeding and milling (suspected feeding) bowhead whales observed by aerial surveys in the ASAMM database from 2008–2012 is higher within the Barrow core bowhead whale area (50% isopleth area identified in our analysis) than within non-core bowhead whale areas. Aerial surveys can capture feeding of bowhead whales that occurs at the surface and at the bottom if there is mud on the whale, but aerial surveys do not document mid-water and some bottom feeding of whales very well (Clarke et al. 2013a). Therefore caution should be used in drawing conclusions about bowhead whale feeding areas from aerial survey data. Our analysis of the ASAMM bowhead whale feeding data used the following methods:

  - We used the 50% isopleth from our relative density analysis of the ASAMM data to define three core areas for bowhead whales in the U.S. Beaufort Sea, which are the Barrow Canyon Complex core bowhead area, the Central U.S. Beaufort core bowhead area, and the Eastern U.S. Beaufort core bowhead area.
  - We utilized on-transect 2008–2012 bowhead whale data, because that is when systematic observations (instead of opportunistic observations) for feeding and milling have been confirmed (personal communication, M. Ferguson to C. Krenz August 11, 2014).
  - Observations of bowhead whales were divided into the following three categories: feeding, milling, and all other behaviors.
  - We compared the ratio of feeding whales to all other observations of whales within each core area to the ratio of feeding whales to all other observations of whales in the area outside of the core areas (within the U.S. Beaufort Sea).

- We also compared the ratio of feeding and milling (suspected feeding) whales to all other observations of whales within each core area to the ratio of feeding and milling whales to all other observations of whales in the area outside of the core areas (within the U.S. Beaufort Sea).
- There was strong evidence ($p < 0.00001$) that in the ASAMM database for 2008–2012 there was a higher proportion of feeding and feeding and milling whales within the Barrow Canyon Complex bowhead whale core area than in non-core bowhead whale areas of the U.S. Beaufort Sea. There was no evidence of higher proportions of feeding or feeding and milling in the other core bowhead whale areas in the ASAMM database.

o A hotspot analysis of aerial marine mammal surveys from 2007 to 2012 indicated multiple biologically important areas for bowhead whaled during the fall (September 1 to November 20) (Kuletz et al. in press).

- Using a Getis-Ord Gi analysis, the analysis identified hotspots in Barrow Canyon, Harrison Bay, and the Central and Eastern U.S. Beaufort Sea.
- Figure 8b in the paper shows these hotspots along the fall migration corridor.

o Clarke et al. (2015) provides a recent synthesis of Biologically Important Areas (BIAs) for cetaceans. On page 95 and Figure 8.1(c) and (d) they describe the occurrence of fall and summer reproduction BIAs for bowhead whales. *"Bowhead whale reproductive BIAs for summer and fall (July–October) were based on locations of cow-calf sightings made during ASAMM surveys from 1982 to 2012 (Clarke et al., 1987, 2012, 2013a; Clarke & Ferguson, 2010a, 2010b). ASAMM surveys encompassed a large geographic area, with fairly consistent temporal coverage within and between years, and these data were considered the best representation of bowhead whale calf distribution in the western Beaufort Sea. Bowhead whales were recorded as calves when they were noticeably smaller, particularly in comparison to a nearby adult, with which they were usually in close association. Bowhead whale calves are often, though not always, light gray in color. Calves grow quickly in the first year, increasing in length from 3.6 to 5.5 m at birth to > 8 m by August (Koski et al., 1993). This rapid growth during the first year makes differentiating calves from yearlings difficult, particularly in September and October. The reproductive BIAs (Figure 8.1b, c & d; Table S8.1) encompass areas where the majority of bowhead whales identified as calves were observed each season (Clarke et al., 2013a). Bowhead whale cow-calf pairs were observed in the eastern Alaskan Beaufort Sea in summer (July through August) and in the western Beaufort Sea in fall (September and October). They were seen in the northeastern Chukchi Sea only in October."*

o Clarke et al. (2015) on pages 95–97 and in Figure 8.2 describe bowhead whale late summer and fall feeding BIAs.

- They describe the constraints on identifying feeding whales from aerial surveys, which indicates considerable feeding behavior is missed. *"Bowhead whales feed on* *a variety of zooplankton, including copepods, euphausiids, mysids, and amphipods (Lowry, 1993), taking advantage of food sources near the seafloor, in the water column, and at the water surface. Feeding behavior is likely under-represented in aerial survey data due to the difficulty of identifying feeding behavior in the brief periods of time when whales are observed. Some indications of feeding can be observed during initial sightings, including open mouth at the surface, mud on the rostrum, and echelon "V" formation (Lowry, 1993). Milling, or whales moving very slowly at the surface with various headings, is also indicative of feeding even when direct evidence of feeding is not observed. Other behaviors that might be indicative of feeding, however, such as synchronous diving, flukes-up diving, and defecation, may not be apparent unless the whales are circled upon for extended periods. Several factors affect the survey aircraft's ability to circle sightings, including weather, visibility, and fuel reserves. Aerial photographs also have been used to detect bowhead whale feeding events as a bowhead whale with mud on its dorsal surface was assumed to have recently fed near the seafloor (Mocklin et al., 2011)."*

- The consistent feeding area off Point Barrow is described as: *"In most years, the area from Smith Bay to Point Barrow (Figure 8.2) is the most consistent feeding area for bowhead whales from August to October (Table S8.2). Bowhead whale feeding in this area was documented by ASAMM (Clarke & Ferguson, 2010a, 2010b; Clarke et al., 2011a, 2011b, 2012, 2013a), the Study of Northern Alaska Coastal System (SNACS) program (Moore et al., 2010b), and the Bowhead Whale Feeding Ecology Study (BOWFEST) (Goetz et al., 2008, 2009, 2010, 2011; Moore et al., 2010b). It is thought that this feeding area is supported by the occurrence of upwelling-favorable winds from the east or southeast, followed by weak or southerly winds, which produce conditions that trap aggregations of krill at the western end of the Beaufort shelf near Barrow (Ashjian et al., 2010). Bowhead whales in this feeding area, which is identified as a BIA, are generally seen in shallow depths (≤ 20 m) or near Barrow Canyon."*
- Much of the Beaufort shelf is considered a feeding BIA. *"In other areas of the western Beaufort Sea, bowhead whales may feed on the continental shelf, out to approximately the 50-m isobath, in September and October (Figure 8.2). Information on bowhead whale feeding in the eastern Alaskan Beaufort Sea in fall was available from ASAMM data (Clarke et al., 2013a) and a review of several studies, including site-specific industry-sponsored studies and feeding studies sponsored by the Minerals Management Service (MMS), that took place in the 1980s and 1990s (Richardson & Thomson, 2002). Although observations indicate that bowhead whale feeding in this area is variable and ephemeral with intra- and inter-year variability (Clarke et al., 2013a), those observations are likely indicative of more extensive feeding activity that is not observed due to the limitations of the visual aerial survey methodology mentioned above. Therefore, this area is considered a feeding BIA (Figure 8.2; Table S8.2)."*

- **Summer bowhead use areas**
  - It appears that the use of the U.S. Beaufort Sea by bowhead whales during summer has changed since the early 1980s. Aerial surveys for bowhead whales conducted during summer in the first half of the 1980s found bowhead whales were predominantly located in the eastern portion of the U.S. Beaufort Sea during summer with no whales observed west of Prudhoe Bay (Moore et al. 2000). During 2012 and 2013 aerial surveys were conducted during July and August, and whales were routinely spotted to both the east and west of Prudhoe Bay (Clarke et al. 2013b, Clarke et al. 2014). Satellite tagging data of bowhead whales also indicate the whales are using the U.S. Beaufort Sea during summer (Quakenbush et al. 2013). Bowhead whale summer use of the U.S. Beaufort Sea appears to be further offshore than during the fall migration, with bowheads using slope (Clarke et al. 2013b, Clarke et al. 2014) and basin waters (Quakenbush et al. 2013), which is consistent with the surveys conducted in the early 1980s (Moore et al. 2000). There is not yet enough information on summer bowhead whale use (Christman et al. 2013) to delineate any possible relative density core areas in the U.S. Beaufort Sea.
    - Figure 5 on page 437 of Moore et al. (2000) on the top panel shows the locations of observed bowhead whales in the early 1980s, which shows the whales located in the eastern portion of the U.S. Beaufort. The top panel in Figure 5 compared to the bottom panel shows that the observed whales in summer were generally offshore of the whales observed in fall. Moore et al. (2000) Figure 8 on page 441 shows the change in depth of waters used by bowhead whales in summer and fall, which was described in the text: *"[i]n the Alaskan Beaufort Sea, bowhead whales shifted towards shore: from slope and outer shelf habitat in summer to inner/outer shelf waters in autumn.*"
    - Figure 7 on page 39 of Clarke et al. (2013b) and Figure 7 on page 36 of Clarke et al. (2014) show observations of bowhead whales by month in 2012 and 2013 respectively. Observations of bowhead whales were made both east and west of Prudhoe Bay, and the observations were generally in slope waters compared to the fall observations (but see August 2013 observations).
    - Figure 22 on page 30 of Quakenbush et al. (2013) shows the locations by season of satellite tagged bowhead whales. Many of the summer locations are offshore in the U.S. Beaufort Sea and are clearly offshore of the locations for bowhead whales during the fall migration, which occurs on the U.S. Beaufort shelf.
    - Christman et al. (2013) highlighted the lack of survey information for bowhead whales in the U.S. Beaufort during summer: "*[f]ew studies have focused on bowhead whale distribution in the Alaskan Beaufort Sea in early to mid-summer, and no long-term, region-wide surveys have been conducted during summer.*"
    - Clarke et al. (2015) using aerial survey information from the 1980s and 2012–2013 identified a bowhead whale reproductive BIA. Page 95 and Figure 8.1(b) describe

the data and area, which is already included in the section on bowhead whale fall use areas.

    - Clarke et al. (2015) also describe the consistent feeding BIA for bowhead whales between Point Barrow and Smith Bay from August to October, which is information also presented above in the bowhead whale fall use areas.

- **Spring bowhead migration corridor**
  - During spring bowhead whales migrate across the Beaufort Sea following leads in the sea ice (Moore and Laidre 2006). Recent satellite tagging data has enabled a refinement of the location of the spring migration corridor for bowhead whales crossing the U.S. Beaufort Sea (Quakenbush et al. 2013).
    - Figure 20 on page 29 of Quakenbush et al. (2013) shows the tracks of 16 bowhead whales that migrated across the U.S. Beaufort in spring of 2006, 2009 or 2010. Figure 29 on page 46 of Quakenbush et al. (2013) shows the seasonal areas of use for bowhead whales based on their satellite tagging data. This figure outlines the spring migration corridor across the U.S. Beaufort Sea, which we digitized and included in our maps to show the spring bowhead migration corridor.
  - Clarke et al. (2015) pages 97–98 and Figure 8.3 describe the spring bowhead whale migratory corridor BIA along the coast of the northeastern Chukchi Sea and along the continental slope area of the Beaufort Sea.

> "*In spring, most bowhead whales migrate north within the lead system that occurs annually in the Chukchi Sea along the Alaska coast*." … "*In the northeastern Chukchi Sea, the lead system is relatively well defined due to the warm water transported from the Pacific Ocean, high percentage of first-year ice compared to multi-year ice, and variable surface winds that move ice toward and away from the coastline (Mahoney, 2012).*"

> "*The bowhead whale spring migration continues past Point Barrow before turning east to cross the Beaufort Sea in continental slope waters. Leads in the Beaufort Sea are fewer and more isolated, due to the movement of sea ice parallel to the coastline (under the influence of the Beaufort Gyre) and the higher percentage of multi-year ice (Mahoney, 2012). Bowhead whales are capable of breaking ice up to 18-cm thick to create breathing holes (George et al., 1989), and they have been detected acoustically (Clark et al., 1986) and satellite tracked in areas of very heavy ice (Quakenbush et al., 2010a). Based on data from aerial surveys conducted from 1979 to 1984 (Ljungblad et al., 1985); ice-based studies from 1978 to 2001 (George et al., 2004); and satellite-tagged whales (n = 16) in 2006, 2009, and 2010 (Quakenbush et al., 2010a, 2010b), the spring migratory corridor BIA was delineated by the Chukchi Sea lead system and the continental slope area of the western Alaskan Beaufort Sea (Figure 8.3; Table S8.3).*"

- Clarke et al. (2015) page 95 and Figure 8.1(a) describe and show the location of a reproduction BIA during the spring migration. "*BIAs for bowhead whale reproduction in spring and early summer (April–June) were based on neonate (recently born) calf sightings collected near Barrow during two studies (Figure 8.1a; Table S8.1). In the first study, calves were photographed in leads in the sea ice north and northeast of Point Barrow during aerial surveys conducted by the North Slope Borough and NOAA Fisheries in 2011 for the purposes of abundance estimation (Mocklin et al., 2012). These surveys started on 19 April, but the first cow-calf pair was not sighted until 9 May. In the second study, neonate calf sightings were recorded during ice-based counts conducted by the North Slope Borough and others from 1978 to 2001 (George et al., 2004). Segregation of size classes during the spring bowhead whale migration near Point Barrow has been documented, with cow-calf pairs generally the later migrants (Zeh et al., 1993; George et al., 2004). Bowhead whale cow-calf pairs are found in greatest density in this reproductive BIA from late May to early June.*"
- Clarke et al. (2015) pages 95–96 and Figure 8.2 describe and show the location of a feeding BIA near Point Barrow and Barrow Canyon during the spring migration. "*The BIA for bowhead whale feeding in May was based on aerial photographs of muddy whales taken in 1985, 1986, 2003, and 2004 (Mocklin et al., 2011) during the annual bowhead whale spring migration past Barrow (Figure 8.2; Table S8.2).*"

1.2 Beluga Whale

Two populations of beluga whales use the Beaufort Sea Planning Area: the Eastern Chukchi Stock (ECS) of beluga whales, which is estimated to have approximately 4,000 whales; and the Beaufort Sea Stock (BSS), which is estimated to have approximately 40,000 whales (Allen and Angliss 2013). Beluga whales usually spend the winter in the Bering Sea pack ice (NOAA 1988, Frost and Lowry 1990). In spring they migrate to their summering grounds (NOAA 1988, Frost and Lowry 1990, Moore et al. 1993), where the whales congregate in shallow waters in specific locations along the coast in late June to July (Frost and Lowry 1990, Frost et al. 1993, Huntington and The Communties of Buckland 1999, Richard et al. 2001). These congregation areas are stock-specific (ABWC 2011;2013, Allen and Angliss 2013). The whales disperse from the congregation sites, apparently following one of two strategies. Some tagged whales have been found to head far offshore into the ice pack, while others spend time in areas closer to shore with more open water (NOAA 1988, Richard et al. 2001, Suydam et al. 2001, Suydam et al. 2005). In the fall the whales migrate back toward and into the Bering Sea (Richard et al. 2001, Suydam et al. 2005).

The mapped concentration areas for beluga whales are based on and supported by the following scientific source materials.

- **The spring migration corridor for the BSS**
    - Clarke et al. (2015) provide a recent synthesis of BIAs for cetaceans. On Page 100 and Figure 8.5 they describe and show the spring migration corridor BIA for beluga whales. *"The spring migration of some belugas from the Bering Sea is generally similar to that of bowhead whales in that they use nearshore leads in the sea ice (Ljungblad et al., 1985; Mocklin et al.,*

2012). Acoustic data from overwintered recorders in the northeastern Chukchi Sea indicated that belugas also migrate farther offshore (Delarue et al., 2011). Most belugas sighted during this time period are heading northeast in the Chukchi Sea and east in the western Beaufort Sea, suggesting these early migrants are likely the BS Stock (Ljungblad et al., 1985). Based on these data, a migratory BIA for BS belugas in April and May was defined in the Chukchi and Beaufort Seas (Figure 8.5; Table S8.6)."

- Aerial surveys were conducted along much of the northwestern Alaskan coast in the spring during the years 1980–84. The surveys conducted in the early 1980s suggest that the BSS beluga whales migrate to the Beaufort Sea from the Bering Sea by following a path through the Bering Strait, following the coastal Chukchi Sea lead system along the Alaska coast, and turning east around a degree north of Point Barrow in offshore leads (Moore et al. 1993).
- NOAA (1988) atlas summarizes the movements of beluga whales along the Chukchi Sea lead system. "*Some [belugas] continue to the Beaufort Sea via eastern Chukchi flaw zone to Pt. Barrow and via offshore leads to Banks Island and Amundsen Gulf.*"
- Moore et al. (2000) summarize the BSS beluga stock along the Chukchi Sea lead system. "*The BS beluga stock follows a migration cycle similar to bowheads. In spring, white whales are often seen along the same route as bowheads.*"
- Based on the information that beluga whales are often seen along the same route as bowheads, we use the bowhead whale spring migration corridor developed by Quakenbush et al. (2013) to also represent the beluga whale migration corridor (see Bowhead Whale section for details). Further research is needed to ensure this is a valid assumption to make for the BSS spring migration route.

➢ **Summer beluga use areas**

- After gathering at the Kasegaluk Lagoon hotspot, beluga whales from the ECS move northward along the northern Alaskan Chukchi Sea coastline (Huntington and The Communties of Buckland 1999). During this time and through the rest of the summer the ECS is concentrated in Barrow Canyon and the shelf break off Point Barrow. The evidence for this concentration area is derived primarily from satellite tagging data as well as from aerial surveys.
- While some whales continue into Barrow Canyon and keep going north into the central Arctic basin (Suydam et al. 2001, AFSC), a large number of whales spend considerable time along the coast, in Barrow Canyon, and along the shelf break in the vicinity of Barrow Canyon (Suydam 2009). See Figures 1 and 2 in Suydam et al. (2001).
  - More recent beluga whale satellite tagging data corroborates these patterns (NMFS 2013).
- Figure 1 in Hauser et al. (2014) shows satellite tagged beluga whale locations by stock and summer core use areas. The core use area for the ECS in summer covers Barrow Canyon, and many of the whale locations are in Barrow Canyon or along the U.S. Beaufort Sea shelf break. The U.S. Beaufort Sea shelf is not part of the BSS home range during the summer. Figure 2 in this paper shows the core use areas and home ranges by month. From July

through October, Barrow Canyon is a core use area for ECS whales, and the Beaufort Sea shelf is part of the ECS home range during this time.

- o ASAMM surveys in July and August of 2012 (Figure 28 on page 84 in Clarke et al. (2013b))and 2013 (Figure 28 on page 89 in Clarke et al. (2014)); the only post 2000 years for which there were concerted Beaufort Sea summer surveys) observed beluga whales regularly in shelf waters and in Barrow Canyon. Figure 31 on page 88 in Clarke et al. (2013b) and Figure 30 on page 91 in Clarke et al. (2014) show that the beluga whales observed per unit of transect survey effort was higher in summer than fall, which suggest that summer is also likely to be an important time for beluga whales in the U.S. Beaufort Sea.
- o Figure 6 on page 437 of Moore et al. (2000) shows summer observations of beluga whales from the first half of the 1980s, which were primarily observed in the slope waters north of Kaktovik. There were not concerted efforts to monitor whales during summer in the U.S. Beaufort Sea from 1987–2011 (see ASAMM database).
- o A hotspot analysis of surveys from 2007 to 2012 indicated multiple biologically important areas for beluga whales in summer (June 15 to August 31) and fall (September 1 to November 20) (Kuletz et al. in press).
  - ▪ Using a Getis-Ord Gi analysis, the analysis identified hotspots in Barrow Canyon for both seasons.
  - ▪ Figure 8c and d in the paper show the hotspots for beluga whales in summer and fall. The areas show the shelf break by Barrow Canyon for both seasons as hot spots. Figure 8c shows the shelf break in the Eastern U.S. Beaufort Sea as a hotspot for beluga whales in summer.

➢ **Fall beluga migration corridor and high relative density areas**

- o Our analysis of ASAMM sightings for beluga whales indicates there are two areas of higher relative density of beluga whales in the U.S. Beaufort Sea during fall. One area is Barrow Canyon and the waters to the east of Barrow Canyon along the shelf break, and the other area is an area of slope waters north of Kaktovik. These are areas within the corridor of slope waters near the shelf break where beluga whales are observed consistently during the fall. The lack of recent aerial survey data north of 72° N is a data gap, especially in the vicinity of the mouth of Barrow Canyon where large numbers of beluga whales have been observed right up to the end of transects at 72° N latitude and satellite tagging data indicates a core use area (Hauser et al. 2014).
- o Hauser et al. (2014) analyzed satellite tracking data for migration timing and core use areas for the ECS and BSS, which has helped clarify the fall migration patterns of both stocks. Figures 2 and 3 show that the BSS migrates relatively quickly through the U.S. Beaufort Sea during September, while the ECS uses the U.S. Beaufort Sea from July through October. The authors also note "*Our analyses support earlier conclusions that beluga whales concentrate near Barrow Canyon, slope regions of the western and eastern Beaufort Sea.*"
  - ▪ The analyses in Hauser et al. (2014) were based in part on satellite tagging data presented previously in Suydam et al. (2005) and Richard et al. (2001). Figures 2–12

in Suydam et al. (2005) show the high use of Barrow Canyon and the western Beaufort slope of the ECS (as well as broad use of the Arctic basin). Table 5 in Richard et al. (2001) provides timing of the BSS fall migration past lines of latitude and longitude, which demonstrates the relatively rapid migration in September of BSS whales. Figure 6 in Richard et al. (2001) shows the migration of the tagged whales across the Alaskan Arctic, which shows that some whales are utilizing slope waters whales while other whales are transiting much further north across the Arctic basin.

- Prior studies of the BWASP aerial survey data and recent reports on the ASAMM and earlier surveys corroborate that Barrow Canyon and the western Beaufort slope waters are an important use area for beluga whales.
  - Figure 6 on page 437 in Moore et al. (2000) show the concentrated observations of beluga whales during the fall that occur along the Beaufort slope and in Barrow Canyon, which is also clearly apparent in Figure 29 on page 90 of Clarke et al. (2014) that shows aerial survey observations of beluga whales in light ice years.
- A hotspot analysis of surveys from 2007 to 2012 indicated multiple biologically important areas for beluga whales in summer (June 15 to August 31) and fall (September 1 to November 20) (Kuletz et al. in press).
  - Using a Getis-Ord Gi analysis, the analysis identified hotspots in Barrow Canyon for both seasons.
  - Figure 8d in the paper shows the hotspots for beluga whales in the fall near the shelf break in the Central U.S. Beaufort Sea.
- Clarke et al. (2015) provide a recent synthesis of BIAs for cetaceans. On Page 100 and Figure 8.5 they describe and show the fall migration corridor BIA for beluga whales. *"Sightings of belugas from aerial surveys in the western Beaufort Sea in fall are primarily on the continental slope, with relatively few sightings on the shelf; most belugas in the fall are swimming west-northwest (Clarke et al., 1993, 2011a, 2011b, 2012, 2013a). Satellite telemetry data show a strong preference for the slope (Richard et al., 2001; Suydam et al., 2001, 2005; Citta et al., 2013; Hauser et al., 2014). Although tagging data indicate that belugas from the BS Stock appear to use the shelf more and migrate out of the western Beaufort Sea earlier than belugas from the ECS Stock (Richard et al., 2001; Suydam et al., 2001, 2005; Hauser et al., 2014), sightings from aerial surveys in the western Beaufort Sea during fall may be either the BS or ECS Stock. The fall migratory corridor BIA for belugas in the western Beaufort Sea was based on these aerial survey and tagging data (Figure 8.5; Table S8.7, see also Figure 7.9 in Ferguson et al., 2015c, within this issue)."*

2. PINNIPEDS

Pinnipeds found in the Beaufort Sea planning area in larger numbers include the spotted seal, bearded seal, and ringed seal (Boveng et al. 2009, Cameron et al. 2010, Kelly et al. 2010b). The documented range of Pacific walrus and ribbon seals range extends only towards the east of Point Barrow into the Beaufort Sea (Boveng et al. 2013). However information for most of these species distribution and concentration areas is largely lacking in the Beaufort Sea as there are few directed large-scale surveys for individual species and many of these species have proven difficult to capture for satellite tagging studies. ASAMM surveys are designed with a focus on large migrating baleen whales. ASAMM surveys have recorded incidental sightings of pinnipeds. These data are useful in that they show the presence of pinnipeds in the Chukchi and Beaufort Sea planning areas. However, these data should be cautiously utilized with analyses for identifying habitat of importance for non-walrus pinnipeds. This lack of landscape-level information on pinnipeds points toward a significant gap in knowledge.

Beaufort Sea pinniped concentration area maps are supported by the following scientific source materials.

2.1 Pacific Walrus

Pacific walrus are distributed across the shallow continental shelf waters of the Bering and Chukchi Seas (Smith 2010, Department of the Interior 2013, USFWS Marine Mammals Management 2014). Winter breeding sites are usually found by areas of open water; historically that includes recurring polynyas near Nunivak Island, St. Lawrence Island, and the Gulf of Anadyr (USFWS Marine Mammals Management 2014). During the summer months, walrus typically range widely across the Arctic continental shelf on ice floes from which they forage on benthic organisms in water depths up to 100 meters (Smith 2010, USFWS 2011, USFWS Marine Mammals Management 2014). The primary prey of walrus are benthic invertebrates (Fay 1982, Sheffield and Grebmeier 2009, USFWS 2011), however other taxa are periodically consumed. During the summer large concentrations of walrus are found near Hanna Shoal and Wrangell Island (Brueggeman et al. 1990, Brueggeman et al. 1991, Smith 2010, Jay et al. 2012, MacCracken 2012, Department of the Interior 2013, USFWS Marine Mammals Management 2014). Historically, there have been land-based haul-out sites with scant walrus occupancy; however, the use of land-based haul-out sites has increased in recent years due to diminishing sea ice cover over shallow continental shelf waters (Jay and Fischbach 2008, Clarke et al. 2011, Garlich-Miller et al. 2011, Jay et al. 2011). There have been recent walrus sightings in the Barrow Canyon region and east of Point Barrow (Clarke et al. 2014) and some sightings by hunters on the western shorelines of the Beaufort Sea. A traditional knowledge study on bowhead whales conducted in Camden Bay also noted that walrus are occasionally seen in the Kaktovik area (Huntington 2013). In the past they were only seen infrequently, but in recent years they have been seen almost every summer. Walrus may haul out on the barrier islands west of Kaktovik and have been documented feeding on seals in this area.

2.2 Spotted Seal

Spotted seals in Alaska, including those that utilize the Beaufort Sea Planning Area, belong to the Bering Distinct Population Segment (DPS) (Allen and Angliss 2013). They are widely distributed along the Bering, Chukchi and Beaufort continental shelves. Their distribution is determined both by seasonal sea ice and life history events (Boveng et al. 2009). Pupping, breeding and molting usually occur in association with the movement of seasonal sea ice from late fall through spring when spotted seals are primarily in the Bering Sea. As the sea ice recedes each year, spotted seals move north into Arctic Ocean waters and regularly use barrier islands and coastal haulout sites. During the open water period seals haul out on land, presumably closer to areas with dense aggregations of prey (Frost et al. 1983, Burns 2002) or as resting bouts in between long-distance foraging trips offshore (Lowry et al. 1998).

The Outer-Continental Shelf Environmental Assessment Program (OCSEAP) conducted large-scale aerial surveys of land-based haulout sites for pinnipeds in the Bering Sea and Arctic Ocean, including the Arctic coastline during the late 1980s. These surveys determined that for spotted seals, one of the most utilized sites in northern Alaska was Kasegaluk Lagoon where over 1,000 seals haul out regularly (Frost et al. 1983). Spotted seals occur at Beaufort Sea haul outs from July through November, and are usually observed in numbers less than one hundred (NOAA: Office of Response and Restoration 2005). Spotted seals observed at Beaufort Sea haulout sites may be on long distance foraging trips originating from Kaseaguluk Lagoon (Lowry et al. 1998) or other large haulout sites located in the Chukchi or Bering seas (Frost et al. 1993). Satellite telemetry studies of spotted seals captured at Kasegaluk Lagoon indicate that seals often rest briefly at Kasegaluk Lagoon before making long distance foraging trips to other places including the Beaufort Sea (Lowry et al. 1998).

Spotted seals exhibit high sensitivity to aircraft within 1.25 miles, and sensitivity to human disturbances at their haul-out sites (Quakenbush 1988, Johnson et al. 1992, Frost et al. 1993). Minimizing disturbance to seals at haulout sites is a conservation priority. Furthermore, with increasing duration of late summer ice-free periods, the time seals spend hauled-out on land may be critical to animals molting later in the season, such as males and maturing pups that molt later in the season (Boveng et al. 2009). The need to minimize disturbance to important spotted seal habitat is identified in the Stock Assessment Reports for spotted seals, especially the need to minimize disturbance from OCS exploration and development in the form of "*disturbance from vessel traffic, seismic exploration noise, or the potential for oil spills*" (Allen and Angliss 2013).

Spotted seals are also an important subsistence resource for communities along the coast from the Beaufort Sea to Bristol Bay.

Beaufort Sea pinniped concentration area maps that include spotted seal sightings are supported by the following scientific source materials.

- **Spotted seal haulout areas**
    - Information for the location of land-based haulout sites during the open water season for spotted seals comes from surveys conducted in the 1980s and 1990s (Frost et al. 1993).
        - Aerial surveys were conducted in 1989, 1990 and 1991 to document distribution, abundance and habitat use of spotted seals during July, August, and September, with surveys extended in 1991 until November.
    - Satellite tracking studies have provided information about spotted seal movements in the Bering, Chukchi and Beaufort Seas (Lowry et al. 1998).
        - Movement and dive behavior of 12 spotted seals (8 males and four females) captured at Kaseagaluk Lagoon was studied using satellite telemetry during 1991–1993.

    - Open water season (August–November) movements: During the open water season in August-November, satellite-tagged seals alternated haul-out periods at coastal sites with trips to sea. Two seals made long distance movements into the western Beaufort Sea and one seal hauled out at Smith Bay four times. The second seal remained in coastal waters traveling as far east as Harrison Bay but the satellite tag did not detect any haulout activity in the Beaufort Sea (Figure 1, Table 2)
    - Table 2 on page 224 shows the number, characteristic and location of spotted seal haul out periods on land in Beaufort, Chukchi and Bering Seas, August to October 1991–1993.
    - Figure 2 on page 225 shows a map of the Bering, Chukchi, and Beaufort Seas showing average daily at-sea locations of satellite-tagged spotted seals, August to November 1991–1993.
    - Page 224: "*When they were away from haul-outs, seals were located in both coastal and offshore areas (Fig. 2).*"
  - Concentration of spotted seals in the Beaufort Sea from traditional knowledge studies.
    - A traditional knowledge study conducted on bowhead whales in Camden Bay noted that spotted seals frequently haul out on boulders along the shore to the west of Konganevik Point (Huntington 2013).
  - Environmental Sensitivity Index (NOAA: Office of Response and Restoration 2005)
    - The NOAA Environmental Sensitivity Index indicates haulout areas where spotted seals may be present during July through November in numbers less than 100 in Dease Inlet/Admiralty Bay, Smith Bay and at the mouth of the Colville River. Important haulout areas for spotted seals are included on Map 7 (Area 118), Map 11 (Area 247) and Map 12 (Areas 247 and 108).

2.3 Bearded Seal

Bearded seals are circumpolar in their distribution; in Alaska they inhabit the shallow continental shelves of the Bering, Chukchi, and Beaufort Seas in waters less than 200m where they feed primarily on benthic organisms (Boveng and Cameron 2013). The Beringia Distinct Population Segment (DPS) occupies these general areas and thus the Beaufort Planning Area. In general, bearded seals are closely associated with sea ice, in particular offshore pack ice between 70–90% coverage about 20–100 nautical miles offshore (Bengtson et al. 2005, Allen and Angliss 2013). Sea ice is important during critical life history events such as pupping and molting when hauling out of the water may be important for thermoregulation or resting. It is during these critical time periods that bearded seals are known to concentrate in specific areas (Boveng and Cameron 2013). As such, bearded seals follow the seasonal movements of the pack ice. The Bering, Beaufort and Chukchi Seas contain some of the most continuous habitat across their circumpolar range and it is here that the longest migrations occur (Cameron et al. 2010).

Bearded seals are an important subsistence resource for communities from the Yukon-Kuskokwim delta all the way to Beaufort Sea communities. Some bearded seals that use the Beaufort Planning Area also use areas in the Bering and Chukchi Seas. As a result, decisions affecting bearded seals in the Arctic Ocean OCS Planning Areas may impact communities in the Yukon-Kuskokwim, Bering Strait and Chukchi coastal regions (Boveng and Cameron 2013).

Beaufort Sea pinniped concentration area maps that include bearded seals sightings are supported by the following scientific source materials:

- **Concentrated bearded seal habitat – spring and summer**
    - Movement and behavior and data used to identify marine habitats of importance to bearded seals from satellite telemetry (Boveng and Cameron 2013).
        - Boveng and Cameron (2013) identified seasonal movements and dive behavior of bearded seals as determined by deployment of satellite-linked time-depth recorders. A specific objective of the study was to determine the distribution and habitat use of seals within the Beaufort and Chukchi planning areas.
            - Figure 9 shows that the majority of the locations in the planning areas were in a corridor relatively near the Alaska coast and on page 64 they state: "*In the BSPA, 96.5% of the locations obtained were within 50 km of the coast. Small numbers of locations were obtained from the narrow region between the coast and the boundaries of the CSPA and BSPA; these composed only 3.2% and 0.6% of the total locations within and coast-ward of the CSPA and BSPA, respectively.*"
            - The majority of dives by tracked seals were shallow while over the continental shelf with deeper diving by seals foraging off-shelf. On page 62 they state: "*The vast majority of dives made by these 7 adult and sub-adult bearded seals were to depths less than 70 m throughout the seasons and times of day (Figure 7). There were a few records of dives deeper than 150m, made by individuals that were over canyons or the continental shelf break in the Beaufort and northern Chukchi seas*."
        - To identify specific marine habitats in the Chukchi Sea Planning Area movement and diving data were fit to a multi-state random walk model that allows for transitions between states of movement behavior for: foraging, transit and resting. Two bearded seals in this study utilized the Beaufort Sea Planning Area in all behavioral categories.
            - Figure 11, page 68 depicts the model and on page 64 the movements of the satellite tracked bearded seals are described relative to the planning areas: "*All seven of the bearded seals tracked in this study moved through the Chukchi Sea Planning Area (CSPA) and two of the seven also used the Beaufort Sea Planning Area (BSPA) (Figure 8). The tagged bearded seals' use of the habitat within the planning areas was a mix of transit, foraging, and*

resting, as determined by the multi-state movement and behavior modeling (see next section)."

- Figure 11 on page 68 shows the modeled tracks of bearded seals for the summer period (June–September), fall (October–December) and winter (January–April) periods.
- Two tagged bearded seals traveled offshore into the Beaufort planning area and engaged in foraging behavior, (see Figure 11, page 68). Areas of resting/foraging identified by the multi-state random walk model corresponded with pinniped concentration areas identified by the ASAMM data analysis in the Central and Eastern U.S. Beaufort areas that likely represent important marine mammal habitat use areas.

▪ There are some limitations as to the extent that bearded seal tracking results can be extrapolated from the Bering Sea DPS, as the sample size is limited to five subadult and two adult bearded seals.

o A traditional knowledge study conducted on bowhead whales in Camden Bay noted that 50–100 bearded seals were seen on the ice in Camden Bay, from the air during a flight from Kaktovik to Prudhoe Bay (Huntington 2013).

o NOAA: Office of Response and Restoration (2005) documents highly concentrated bearded seal habitat for spring and summer. Beaufort Sea waters and coastal areas were included as being important for bearded seals from Barrow to Kaktovik, offshore and in coastal areas. Bearded seals were identified specifically in waters for maps 1–9 and 11–13 to the extent of the Beaufort Sea waters represented by the maps.

o NOAA (1988) documents concentrated bearded seal habitat for summer and fall. In the map included in Section 3.74, the NOAA atlas (1988) identifies much of the Beaufort Sea continental-shelf waters as a "Concentration Area" for the months of July through September.

2.4 Ringed Seal

Ringed seals have a circumpolar distribution, and in the U.S. are found in the Bering, Chukchi and Beaufort Seas (Allen and Angliss 2013). In Alaska, they are considered one stock, and regional migratory patterns and movements are not well-known. Ringed seals are closely associated with sea ice and adapted to both pack ice and shorefast ice (Kelly 1988). In the Beaufort and Chukchi Seas, as the pack ice retreats, they generally follow the ice edge; however, some animals may remain near their fast ice habitats during the open water period (Kelly et al. 2010b). In the winter months, ringed seals in the Beaufort and Chukchi Seas remain in Arctic waters near landfast ice as well as leads and areas of open waters. Relative to other pinnipeds, they are among the most well-adapted to shorefast ice; they return to nearshore habitats prior to freeze-up and their densities tend to be the highest in fast ice regions (Frost et al. 2004). As water freezes, they maintain breathing holes in the ice, and as snow accumulates they excavate snow caves and maintain lairs for resting and pupping (Kelly et al. 2010b). As spring warms and melts snow accumulated over breathing holes, seals begin their annual molting cycle and will bask on top of ice for longer periods of time. Molting in adults may extend into July in the U.S. Arctic (Kelly et al. 2010b). Increasingly, there are concerns about the impacts of climate change on ringed seals. In particular, the loss of sea ice and changes in snow cover may impact the timing and quality of lairs (Kelly et al. 2010b).

Beaufort Sea concentration areas for ringed seals are supported by the following scientific source materials.

- **Concentrated ringed seal fast ice habitat**
  - Information about key environmental correlates to determine density of ringed seals in the Beaufort Sea (Frost et al. 2004). Both water depth and location relative to fast ice edge are both factors that could be applied in identifying areas of important habitat for ringed seals.
    - Aerial surveys were conducted in the Beaufort Sea from late May through early June 1996–1999 using strip-transect methodology. They examined the effects of habitat, weather, and time of day on observed seal densities using univariate chi-square goodness-of-fit tests, and a multivariate generalized linear model to estimate the relationship between seal counts and covariates.
    - Observed densities ranged from 0.81 seals/km^2 in 1996 to 1.17 seals/km^2 in 1999. Water depth and location relative to fast ice edge and ice deformation were important determinants for higher densities.
    - Highest densities occurred at depths between 5–35m. Densities were also high in relatively flat ice and near fast ice edge, declining both shoreward and seaward.
    - Seals may return to shorefast ice regions before freeze-up as food resources in those regions may be plentiful and in the case of males, may start defending home ranges (Kelly et al. 2010a).
  - Density and population estimates of ringed seals in the Chukchi Sea (Bengtson et al. 2005).
    - Page 842: "*Ringed seals were four to ten times more abundant in nearshore fast and pack ice environments than in offshore pack ice. This distribution is consistent with the pattern reported by other authors such as Smith (1973), who reported that densities of ringed seals were much lower beyond 29 km from shore. The higher densities of ringed seals in the coastal areas was not surprising, given the importance of shorefast ice for ringed seal lairs and breeding habitat (Burns 1970; Smith and Stirling 1975; Smith and Hammill 1981; Lydersen and Gjertz 1986; Hammill and Smith 1989; Lydersen et al. 1990; Lydersen and Ryg 1991; Smith et al. 1991; Furgal et al. 1996).*"
  - Movement and behavioral and data used to identify marine habitats of importance to ringed seals using movement and dive data.

- Kelly et al. (2010a) used radio and ultra-sonic tags to track ringed seals during the winter-spring period when adult seals occupy shorefast ice and satellite-linked transmitters in summer and fall (when the seals ranged away from their winter sites) on long-distance foraging trips.
    - Page 1095 documents the home range size of adult ringed seals: "*In the shorefast ice habitat, the home ranges of 27 adult males ranged from\1 to 13.9 km2 (median = 0.628) while the home ranges of 28 adult females ranged from \1 to 27.9 km2 (median = 0.652).*"
    - During the late summer and fall foraging period, ringed seals traveled up to 1800 km from their tagging sites but continued to use sea ice as a resting platform. Eight of nine seals tracked from one subnivean period to the next returned to locations close to their original capture sites (Kelly et al. 2010a).
- Harwood et al. (2012) identified seasonal movements and dive behavior of seven ringed seals (one adult female, three subadult males, two subadult females and one male pup) instrumented with satellite-linked (SLTDR-16) transmitters, and released at Cape Parry, Northwest Territories, Canada in 2001 and 2002.
    - Figure 1 on page 36 shows the tracks of ringed seals during the fall migration period with some deployments lasting into the winter (January–April) period.
    - All ringed seals tracked in this study migrated westward across the Beaufort Sea Planning Area into areas in the Chukchi Sea with one seal moving south into the Bering Sea at the end of the tracking period.
        - Page 42: "*The tracks and timing of westward fall migrant seals in this study revealed a routing through three political jurisdictions and included present-day oil and gas industry lease areas in all three. This fact points to the importance of cooperation between the United States, Canada, and Russia in the management of this species.*
    - While traveling through the Beaufort Sea planning area seals moved through relatively shallow coastal waters almost exclusively over the continental shelf, similar to the migratory corridor of bowhead whales.
        - Page 39: "*Along the Alaska North Slope, seals moved through waters almost exclusively over the continental shelf, in average depths of 40 m in 2001 and 307 m in 2002. The westward routes used in 2001 and 2002 were similar; although two seals in 2002 travelled beyond the shelf for part of the migration, they almost always stayed within 100 km of shore. Average distance from shore*

was 38.9 km (range: 5.1–67.0 km) in 2001 and 60.6 km (range: 13.7 – 101.5 km) in 2002 (Fig. 1).”

  - Page 40: *“The tracking route included (1) oceanographic areas in the Canadian Beaufort Sea known from other studies to be important late summer feeding habitat for seals and bowhead whales (Harwood and Stirling, 1992; Harwood and Smith, 2002), (2) a relatively rapid migration over the continental shelf and slope offshore of the Alaska North Slope, and (3) divergent tracks across the shallower Chukchi Sea to the Russian coast off the Chukotka Peninsula, where the last locations we received were transmitted from five of the seven seals.”*

- To identify ringed seal use of specific marine habitats in the Beaufort and Chukchi Seas the data from Harwood et al. (2012) were fit to a Bayesian Switching State-Space movement model that classified location and behavioral data into 12-hour timesteps with an associated behavioral state estimation defined as either traveling or resident/foraging (Harwood et al. in press). Figure 26 in Appendix A shows the results of the model.

  - The tagged ringed seals’ use of the habitat within the Beaufort Sea planning area as determined by the state-space model was a combination of traveling through the central Beaufort Sea migratory corridor and concentrated use of areas for resting/foraging at the eastern and western ends of the planning area (Figure 26, Appendix A, adapted from Harwood et al. (in press)).
  - Areas of resting/foraging identified by the state-space model corresponded with pinniped concentration areas identified by the ASAMM data analysis in the Barrow Canyon Complex and the Eastern U.S. Beaufort that likely represent important, recurrently used, marine mammal feeding areas.
  - Harwood et al. (2012) Page 39: “*The route used by the tagged seals during migration through the Canadian Beaufort Sea included areas with oceanographic features known to be productive and to concentrate seal prey items (Fig. 1). These included the mouth of the Horton River, offshore of Cape Bathurst, along the Yukon coast near King Point, Herschel Island and Komakuk Beach*.”

- There are some limitations as to the extent that ringed seal tracking results can be extrapolated from the Beaufort/Chukchi Sea analysis, as the sample size is limited to one adult ringed seal, five subadults and one pup.

- A traditional knowledge study conducted on bowhead whales in Camden Bay noted that ringed seals are abundant in the area, especially between Collinson Point and Anderson, on the eastern side of the bay and have been seen hauled out on the beach at Collinson Point (Huntington 2013).

- NOAA (1988) documents highly concentrated ringed seal fast ice habitat.
  - In Section 3.72 with regards to ringed seal movements it states "*Seals wintering in Bering Sea apparently move to Chukchi in May–June, returning October–November. Others non-migratory, except for inshore-offshore movements. Fast ice mainly inhabited by adults in winter-spring; immature seals reside offshore, moving too fast and remnant ice for molt, late spring-early summer*" with emphasis added. In addition, the associated map identifies the region of shorefast ice as a "Major Adult Area" for the months from February to June.
- NOAA: Office of Response and Restoration (2005) documents highly concentrated ringed seal fast ice habitat.
  - The NOAA Environmental Sensitivity Index indicates that ringed seals are present in concentrations throughout the Beaufort Sea in coastal waters and shorefast ice from October through July, engaging in pupping from March to May and molting from March to July. Ringed seals were identified specifically in waters for maps 1–9 and 11–13 to the extent of the Beaufort Sea waters represented by the maps.

3. POLAR BEAR

Polar bears occur throughout the Arctic in close association with the seasonal ice pack. The worldwide population of polar bears is estimated to be approximately 20,000–25,000 individuals distributed among 19 subpopulations (Schliebe et al. 2008). Within the United States portion of the range, polar bears most commonly occur at low densities over shallow continental shelf waters (<300 meters) within 180 miles of the Alaskan coast (USFWS 2013a). Polar bears from two separate sub-populations or stocks occur in Alaska: (1) the Chukchi-Bering Seas stock (CS); and (2) the Southern Beaufort Sea stock (SBS) (USFWS 2013b). The SBS population is estimated to have approximately 1,500 polar bears that range between Icy Cape on the Northwest coast of Alaska and Pearce Point in Canada. The distribution of the CS stock extends westward into the eastern portion of the Eastern Siberian Sea, Russia Federation, east past Point Barrow, Alaska, and southward into the Bering Sea, where the southern boundary is determined by the extent of annual ice. The size of the CS population is estimated at approximately 2000 individuals and may be declining, however there is a low level of confidence in the current population estimate (Evans et al. 2003).

Polar bears utilize sea ice habitat for foraging, and are most often concentrated near the ice edge, leads, or polynyas over shallow continental shelf waters (Durner et al. 2004). The primary prey of polar bears in most areas of the Arctic are ringed seals, and bearded seals are also a common prey. Pacific walrus calves are taken occasionally and polar bears will also scavenge walrus and bowhead whale carcasses. Changes in the concentration and distribution of arctic sea ice that reduce access to prey may have a negative effect on polar bear growth and survival (Schliebe et al. 2008). Sea ice is also important for pregnant females to access denning sites. Pregnant females enter maternity dens by late November, and give birth in late December or early January. Changing sea ice patterns may negatively impact polar bear reproductive success and may also reduce foraging opportunities for females and cubs after they emerge from maternal dens. Based on recent satellite tracking studies, denning of pregnant females from the Chukchi Sea population occurs primarily on Wrangel and Herald Islands, and on the Chukotka coast in the Russian Federation (USFWS 2010a). Denning on the northwest coast of Alaska has decreased in recent decades, likely due to reduced sea ice connectivity with the Chukchi coastline during the late fall (Fischbach et al. 2007, USFWS 2010a).

The polar bear was listed as a threatened species under the Endangered Species Act (ESA) on May 15, 2008 and is listed as vulnerable in the IUCN Red List of Threatened Species (Schliebe et al. 2008). The USFWS designated critical habitat for polar bear populations in the United States effective January 6, 2011 (USFWS 2010a). In the Federal Register listing, USFWS designated three separate units as components of polar bear critical habitat: (1) Sea-ice Habitat; (2) Terrestrial Denning Habitat; and (3) Barrier Island Habitat. The designation of critical habitat was challenged in Federal Court by several parties, including the State of Alaska and the Alaska Oil and Gas Association. On January 11, 2013, the District Court for the District of Alaska, issued an order vacating and remanding to the Service specific sections of this rule (USFWS 2013a). As a result there is no legally designated critical habitat for the polar bear at this time.

The primary threat to the survival of threatened polar bear populations is the loss of sea-ice habitat throughout the species range (Durner et al. 2009, USFWS 2010a). If current trends of sea-ice loss due to climate change continue, polar bears may decrease by 30–50% in the next 50 years and may become extirpated from most of their range within 100 years (Schliebe et al. 2008). Other anthropogenic threats including oil and gas exploration and development, shipping, over-harvesting and the effects of toxic contaminants may also impact recruitment and survival (Schliebe et al. 2008). The potential effects of human activities are much greater in areas where there is a high concentration of dens (USFWS 2010a). Low-level negative impacts on polar bears due to oil and gas exploration and development include disturbance due to noise and human interaction and toxic effects from chronic releases of contaminants. The greatest threat to polar bears and their habitat from future oil and gas development is the potential effect of an oil spill or discharges into the marine environment (USFWS 2010a). Amstrup et al. (2006) estimated that "*the numbers of bears potentially oiled by a hypothetical 5912 barrel spill (the largest spill thought probable from a pipeline breach) ranged from 0 to 27 polar bears for September open water conditions, and from 0 to 74 polar bears in October mixed ice conditions.*" If a spill of the magnitude of the Deepwater Horizon in the Gulf of Mexico were to occur, the effects could be catastrophic, especially if oil persisted in the marine environment over the winter and entered the coastal sea-ice lead systems where polar bears, the ice seals they prey upon, and other marine life would be severely impacted.

The mapped concentration areas for polar bears submitted in this package are based on the best available scientific source materials. As stated in the Federal Register notice designating critical sea-ice habitat (USFWS 2010a), the main problem in identifying important areas for polar bears lies in identifying specific areas that are spatially and temporally consistent given the variability in sea ice extent and seasonal location within and between years. However we note that there is an extensive history of radio and satellite tracking of polar bears and habitat utilization information and data layers exist from previous studies (e.g. Amstrup et al. 2006, Durner et al. 2009). USFWS and USGS are conducting new satellite tracking studies on bears from the Chukchi Sea population (USFWS 2010a); see also http://alaska.usgs.gov/science/biology/polar_bears/tracking.html). Analysis of data from new studies in conjunction with previously collected information may address this data gap for both the Chukchi Sea and Southern Beaufort Sea populations. We will continue to monitor the results of this research to determine whether further deferral recommendations to protect important polar bear habitat areas are warranted in the future.

The maps showing polar bear denning and feeding areas and seasonal habitats display three data layers from four sources.

- **Major denning area**
  - The 1988 NOAA Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment Data Atlas delineated the boundaries within which major polar bear denning areas are located. Within the Beaufort Program Area the major denning area is coincident with the western extent of the area that was designated as ESA critical habitat. Within the Beaufort Sea Program Area these boundaries are consistent with recent studies of maternal denning habitat in Alaska (e.g. Fischbach et al. 2007).
- **Lower density denning area**
  - Key references that we used for lower density denning for polar bear included: NOAA (1988), USFWS (1995), Alaska Department of Fish and Game Habitat and Restoration Division (2001), Fischbach et al. (2007). This map layer is derived from the 1988 NOAA Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment Data Atlas in combination with the USFWS Habitat conservation strategy for polar bears in Alaska (USFWS 1995). Use of the area west of Point Barrow by polar bears for denning has historically been lower than the Southern Beaufort Sea coast and may be decreasing due to the loss of late-fall sea ice connectivity. Conversely however, the importance of terrestrial denning habitat may be increasing due to the decline in multi-year sea ice. Radio and satellite telemetry studies elsewhere indicate that denning can occur in multi-year pack ice and on land. Recent studies of the SBS indicate that the proportion of dens on pack ice have declined from approximately 62% in the time period from 1985–1994 to 37% in the time period from 1998–2004 (Fischbach et al. 2007).

Seasonal habitat selection

- On the advice of George Durner at USGS, our team mapped polar bear sea ice habitat selection by applying seasonal resource selection coefficients presented in Durner et al. (2009) to the last five years of available sea ice data.
- Average sea ice concentration data were acquired as 25-km monthly grids from the National Snow and Ice Data Center (2014) for each month from October 2008 through September 2013. Durner et al. (2009) presented four seasonal models. We assigned months to season

based on the most common assignment in their analysis: winter—December through May, spring—June through July, summer—August through September, and autumn—October through November. The models were run for each of the 60 months, then monthly results were grouped by season and averaged into four final seasonal layers representing mean habitat selection value over the most recent five-year period.

4. Marine Birds

The Beaufort Sea is an important region for marine birds migrating, nesting, foraging, and staging through spring, summer, and fall. Multiple Important Bird Areas (IBAs) and other seabird hotspots line the Beaufort Sea coast stretching into the offshore waters out as far as about 60 miles.

The mapped concentration areas for marine birds are based on the following scientific source materials.

- **Seabird Colonies**
  - The World Seabird Union, on behalf of the U.S. Fish and Wildlife Service and other entities, manages the North Pacific Seabird Data Portal, formerly the Beringian Seabird Colony Catalog. This extensive dataset includes ~1700 nesting colonies in Alaska (World Seabird Union 2011).
    - The abundance of each species present at each colony was recorded by surveyors counting the number of individuals, nests, or pairs over the last few decades. The database reports the best estimate made for that colony based on one or more site visits.
    - We eliminated records that were more than four decades old (pre-1971), rated as a poor quality estimate, or were otherwise questionable (Smith et al. 2012).
    - Based on this information, there are 62 mapped nesting colonies on the U.S. Beaufort coast adjacent to the program area, which are home to 6 breeding species. The largest colony, Cooper Island, was estimated to have ~500 black guillemots and Arctic terns nesting in summer; however in recent years these populations have declined due to horned puffin competition and polar bear predation (Day et al. 2011). There are approximately 4000 colonial birds nesting in this region, of which most are common eiders utilizing barrier islands in the Central U.S. Beaufort.

Table 4-1. Estimate of breeding birds present at nesting colonies near the Chukchi Sea Program Area[1].

Location	ARTE	BLGU	COEI	GLGU	HOPU	SAGU	Total
Beaufort Barrow Canyon Complex	130	446			2		**578**
Harrison Bay	6		72	93		10	**181**
Central U.S. Beaufort	89	2	1960	755		6	**2812**
Eastern U.S. Beaufort	24	4	366	64			**458**
Total	**249**	**452**	**2398**	**912**	**2**	**16**	**4029**

[1]ARTE = Arctic tern; BLGU = black guillemot; COEI = common eider; GLGU = glaucous gull; HOPU = horned puffin; SAGU = Sabine's gull.

- **Seabird marine hotspots**
  - A hotspot analysis of surveys from 2007 to 2012 indicated multiple biologically important pelagic areas for seabirds in summer (June 15 to August 31) and fall (September 1 to November 20) (Kuletz et al. in press).
    - Using a Getis-Ord Gi analysis, the analysis identified hotspots in Barrow Canyon for all seabirds combined.
    - Surface-feeding and subsurface-feeding seabirds concentrated in Barrow Canyon in summer.
    - Benthic-feeding seabirds concentrated in summer in Harrison Bay; and in fall in Camden Bay.
    - Barrow Canyon was a particularly important area for shearwaters and thick-billed murres in summer and fall; black-legged kittiwakes in summer; and black guillemots and Kittlitz's murrelets in fall.
    - The eastern U.S. Beaufort was a particularly important area for black guillemots and Kittlitz's murrelets in fall.
  - Audubon Alaska (2014a) and Smith et al. (2014) analyzed globally significant coastal and marine IBAs through spatial analysis of at-sea survey data and aerial survey data.
    - The analysis was based on Drew and Piatt (2013) version 2 of the North Pacific Pelagic Seabird Database (NPPSD), a compilation of at-sea survey transect data that documents seabird densities in the Arctic Ocean and the North Pacific; as well as the Alaska Waterbird Database (AWD) version 1 which is a compilation of aerial survey data across the state of Alaska (Walker and Smith 2014).
    - The IBAs are based on BirdLife International's A4 criteria: places that regularly hold more than 1% of the North American population of a congregatory waterbird species (A4i), or more than 1% of the global population of a congregatory seabird species (A4ii) (National Audubon Society 2012).
    - Smith et al. (2014) developed a standardized and data-driven spatial method for identifying globally significant marine IBAs using six primary steps: 1) accounting for unequal survey effort, 2) filtering input data for persistence, 3) producing maps representing a gradient from low to high abundance, 4) drawing core area boundaries around major concentrations, 5) validating the results, and 6) combining overlapping boundaries into important areas for multiple species. A similar analysis was completed using aerial survey data for coastal and interior areas.

        - The authors "*tried to minimize uncertainty and leaned toward decisions that could potentially increase Type II error (false negatives, or failure to identify an area that is truly important) but decrease Type I error (false positives, or identifying an area as important that truly is not). This approach, along with survey coverage gaps in the available data, likely means that important areas exist in places not identified. Therefore, failure to identify an IBA did not necessarily mean that a particular area was unimportant*."
    - Audubon Alaska conducted an additional analysis of core concentration areas for marine birds in the Beaufort and Chukchi Sea Planning Areas (Audubon Alaska 2014b).
        - They used two main data sources: the NPPSD (Drew and Piatt 2013) and the AWD (Walker and Smith 2014). The NPPSD is a compilation of ~40 years of at-sea, boat-based survey data that summarize bird densities by transect. The AWD is compilation of ~25 years of land and coastal aerial surveys that summarizes bird density in 5 km bins.
        - Audubon acquired and analyzed these data to establish the aforementioned IBAs in two separate analyses: for at-sea areas and for interior and coastal areas. For this exercise, they combined 25-km kernel density data layers representing the average at-sea (NPPSD-based) and coastal (AWD-based) bird abundance, by taking the maximum estimated abundance of the two datasets, by species.
        - Only WatchList bird species of concern (Kirchhoff and Padula 2010) were considered in the analysis. In this region those species included: yellow-billed and red-throated loons; spectacled, king, and common eiders; and brant. Steller's eider, Kittlitz's murrelet, and marbled murrelet were not included in the analysis for lack of adequate data.
        - After creating a single layer representing average relative bird abundance for the selected species, they conducted an isopleth analysis to identify core concentration areas for 50% of the individuals mapped. The 50% isopleth is the standard isopleth most often used to identify species core areas (e.g. Person et al. 2007, Western Arctic Caribou Herd Working Group 2011, Jay et al. 2012, Sexson et al. 2012).
        - Finally, the 50% isopleths (core areas) for the assessed bird species were combined into one data layer with overlaps in isopleth values dissolved. The result is presented in Figure 27.
    - Using data generated for the IBA analysis, Audubon Alaska (2015) analyzed a new product: the integrated globally significant proportion of birds, which provides a measure of importance by looking at a combination of both species abundance and species rarity, integrated over multiple species.
        - The data indicates relative importance using abundance normalized by population size, integrated for multiple species. It is the % of IBA threshold achieved, summed for all regularly occurring species.

- The IBA threshold is 1% of the population, based on global population numbers for seabirds or on continental population numbers for waterbirds (BirdLife International 2012).

Table 4-2 Globally significant IBAs overlapping the Beaufort Sea Planning Area (Audubon Alaska 2014a).

IBA Name	Global Trigger Species[1,2]	Continental Trigger Species	State Trigger Species	Estimated Abundance for Assessed Species	Species Richness
Barrow Canyon & Smith Bay	ARTE; BLKI; GLGU; KIEI; LTDU; POJA; REPH; RTLO; SAGU; SPEI	BRAN; COEI	PALO	723,154	55
Beaufort Sea Shelf Edge 152W71N	GLGU; POJA		SAGU	35,407	15
Beaufort Sea Nearshore	ARTE; BRAN; GLGU; KIEI; LTDU; RTLO; SPEI	COEI; REPH; BRAN	BLKI; PALO; SAGU	443,024	53

[1]ARTE = Arctic tern; BLKI = black-legged kittiwake; BRAN = brant; COEI = common eider; GLGU = glaucous gull; KIEI = king eider; LTDU = long-tailed duck; POJA = pomerine jaeger; PALO = Pacific loon; REPH = red phalarope; RTLO = red-throated loon; SAGU = Sabine's gull; SPEI = spectacled eider.

[2]Trigger species are those that met the global criteria, for which the IBA was recognized.

5. LOWER TROPHIC LEVELS AND PHYSICAL FEATURES

Productivity and production at lower trophic levels can shape Arctic ecosystems, especially considering the relatively short food chains that occur in the Arctic (Grebmeier et al. 2006, Grebmeier 2012). Primary production is ultimately the foundation of any ecosystem. In the northern Bering, Beaufort and Chukchi seas ecosystems, a greater proportion of primary productivity moves through the benthic portion of the food web compared to more southern regions, such as the southern Bering Sea (Hunt et al. 2002, Grebmeier et al. 2006). This makes productivity of seafloor communities particularly important. The Beaufort Sea continental shelf and slope waters generally have lower productivity and lower levels of benthic biomass than the northern Bering Sea and Chukchi Sea (Dunton et al. 2005). Regardless, seafloor communities are an important prey resource in the Arctic for species at higher trophic levels, such as walrus, bearded seals, and diving sea ducks (Bogoslovskaya et al. 1981, Petersen et al. 1999, Suydam 2000, Cameron et al. 2010, Jay et al. 2012, Boveng and Cameron 2013).

Complete data are not available on primary production or movement of production through the food web. However, there are data sets on the distribution of patterns of water column algae during the open water period, as well as patterns of benthic biomass across the U.S. Beaufort Sea—specifically the review put together by Dunton et al. (2005) and Grebmeier et al. (2006). These are proxies that can be used to delineate areas that may be productive spots at lower trophic levels that are important to the productivity and structure of the Beaufort Sea ecosystem. The synthesis compiled by Grebmeier et al. (2006) will soon be updated by the PacMARS project, but those data have not been made readily available to the public yet. The areas that generally have high concentrations of water column algae or benthic biomass, are likely important to the health of Arctic ecosystems.

Dunton and Grebmeier generously shared their synthesis data sets for water column algae and benthic biomass with us. Specific methods they used to produce these data sets are described in their methods. In addition, the PacMARS project generously shared an update (Grebmeier et al. 2014) to the Grebmeier et al. (2006) benthic biomass data set with us.

5.1 Primary Productivity

Areas that tend to have higher concentrations of water column algae are the region around Point Barrow and the area near Kaktovik. To produce the map of primary productivity (integrated water column algae) in Appendix C we interpolated data values from Dunton et al. (2005), Grebmeier et al. (2014). For the analysis we:

- Established a 25×25km grid over the Beaufort Sea Planning Area;
- Calculated the average value for each grid cell;
- Smoothed grid cell values by first converting the grid cell values into point data with one point per grid cell at the centroid, and then running a simple kriging function with ESRI's Geostatistical Analyst extension.

Integrated water column algae are likely the best proxy available for the region. However, much of the data used in this interpolation are old, as they were gathered in the 1970s and 1980s (Dunton et al. 2005). The open water season is an important time for production, as sea ice cover does not limit light penetration into the water column. While algal growth at the ice edge, in polynyas, in and under the ice, and in melt ponds may be significant, accurate measurements are not available for the Beaufort Sea area (Krembs et al. 2000, Hill and Cota 2005, Arrigo et al. 2012, Frey et al. 2012, Boetius et al. 2013). While there are satellite data available for the region, these data may not reflect biomass accurately because of subsurface plumes of phytoplankton; and satellite measurements need to be calibrated to account for sediments in coastal waters, which is ongoing (Lee Cooper personal communication with Chris Krenz).

5.2 Benthic Biomass

The Beaufort Sea has lower levels of benthic biomass compared to the Chukchi Sea (Dunton et al. 2005). The mid shelf tends to have higher levels of benthic biomass than other areas, with the western portion of the U.S. Beaufort Sea tending to have somewhat higher levels of benthic biomass than the eastern portion of the U.S. Beaufort Sea. To develop the map in Appendix C, we used the same methods as used for primary productivity data.

While some of the data are relatively old—and sparse in some areas of the areas of the Beaufort Sea Planning Area—the patterns are probably a gross reflection of the distribution of benthic biomass.

5.3 Sea Ice

Sea ice is a defining ecosystem characteristic which consists of multiple types of features that influence the distribution of marine productivity and wildlife, such as pack ice, ice floes, leads,polynyas, landfast ice, river overflood, and under-ice freshwater pooling. In the Arctic, ice reaches it maximum extent in

March, reaching in some years nearly to the Aleutian Islands in the eastern Bering Sea. In September each year, sea ice reaches its minimum extent, receding past the U.S. Exclusive Economic Zone, more than 200 miles offshore, north of 75° latitude. This constantly changing, essential feature is a key to why the Arctic marine environment is so dynamic. Although the minimum sea ice extent varies significantly from year to year, the trend is an annually receding ice edge in all months of the year (Comiso 2002, Comiso et al. 2008). It is not known exactly how these dynamic sea ice features will change in a warming climate. Predictions of future sea ice conditions include earlier melting, later freeze-up, an increase in open water, retraction of sea ice from the productive continental shelf, declining multi-year ice, and less stability in landfast ice (USFWS 2010b). Wang and Overland (2009) predict a nearly sea ice-free Arctic summer in approximately 20 years, and more recent papers acknowledge that state could occur considerably sooner (Maslowski et al. 2012, Overland and Wang 2013).

Polynyas (recurrent, predictable open water areas in the sea ice) and open leads are important congregation and feeding areas for mammals and birds (Stringer and Groves 1991, Stirling 1997). Polynyas are continually changing in size and shifting position, which can make them difficult to map (Eicken et al. 2005). However, these openings are found consistently in some areas that are adjacent to land or grounded pack ice where the ice is blown offshore by the prevailing wind or pulled away by currents. Although summer ice pack has changed dramatically over the last four decades, winter ice openings have stayed fairly consistent (Eicken et al. 2005), indicating that areas important now and in the past are likely to persist into the future.

Another important sea ice feature is landfast ice, which is stable ice that is fastened to the shore and remains much of the year. This feature provides an important platform for wildlife and subsistence hunters. In the Alaskan Beaufort Sea, landfast ice "*first forms in October and is anchored to the coast. It then rapidly extends some 20–40 km offshore to eventually cover ~25% of the shelf area and remains in place through June*" (Gradinger 2008). Landfast ice in this area has not changed in extent, although formation and breakup are occurring later and earlier compared to data from the 1970s; the ice is also less stable, with impacts on local hunting (Gradinger 2008).

Variation in ice cover is the dominant factor in the spatial pattern of primary productivity from phytoplankton (Wang et al. 2005). Many of the phytoplankton blooms and much of the wildlife activity occurring in the Arctic environment is concentrated at the ice edge. The sea ice is very important to primary productivity as a platform for large algal blooms happening on the bottom of the sea ice in spring and summer (Homer and Schrader 1982, Gradinger 2008, Laidre et al. 2008). Production associated with the sea ice is the base of an ice-associated food web that includes amphipods, Arctic cod, seabirds, and seals. "*It remains unresolved how changes in the diversity and productivity of the ice related biota combined with changes of the timing and regions of ice melt and formation will impact the ice itself and the tight sea ice-pelagic-benthic couplings in the arctic shelf seas*" (Gradinger 2008). Complicated by climate warming, baseline biophysical processes are difficult to measure. Nonetheless, an effort should be made to better understand sea ice dynamics in relation to climate change, which has the potential to significantly change the Arctic marine ecosystem as we currently know it.

The sea ice maps are based on the following scientific source materials:

- **Sea ice concentration**
  - National Snow and Ice Data Center (2013) distributes daily sea ice extent data, which is a product of the National Ice Center. Derived from satellite imagery, these data are the most current and complete resource for examining sea ice patterns in the Northern Hemisphere.
    - The National Environmental Satellite, Data, and Information Service (NESDIS), part of the NOAA, has an extensive history of monitoring snow and ice coverage. Accurate monitoring of global snow and ice cover is a key component in the study of climate and global change as well as daily weather forecasting. By inspecting environmental satellite imagery, analysts from the Satellite Analysis Branch (SAB) at the Office of Satellite Data Processing and Distribution (OSDPD), Satellite Services Division (SSD), created a Northern Hemisphere snow and ice map from November 1966 until the National Ice Center (NIC) took over production in 2008.
    - Beginning in February 2004, further improvements in computer speed and imagery resolution allowed for the production of a higher resolution daily product with a nominal resolution of 4 km. NSIDC distributes the 24-km and the 4-km IMS product for February 2004 to present. In 2006, NSIDC started distributing 4-km GeoTIFF files for use with GIS applications.
  - Audubon Alaska (2013) collected five years of daily sea ice extent data, using spatial analysis to derive grids of the percent of days with sea ice by month for the Northern Hemisphere from 2008 through 2012.
    - Daily sea ice extent data for the circumpolar north were collected for five years from January 1, 2008 to December 31, 2012 at a 4 km resolution (National Snow and Ice Data Center 2013). These data define sea ice extent as those pixels with any detectable ice coverage.
    - The data layers were summed by month then divided by the total number of days of data available for that month (occasionally a daily grid was unavailable from NSIDC due to processing error). The resulting statistic represented the percent of days with sea ice for each of 60 months (12 months over 5 years). Next, five grids for each month (2008 to 2012) were averaged, resulting in one grid each for the months of January through December representing the average percent of days with sea ice. Finally, months were combined into seasons by averaging three months together, as shown on the map.

6. SUBSISTENCE

Subsistence use area data have been collected on the North Slope since at least the 1970s (Pedersen 1979b). Until recently, these data have been based primarily on recall interviews, in which hunters are asked after the fact where they have traveled and hunted. Some studies document lifetime use areas (Pedersen 1979b) whereas others have looked at specific years (Braund et al. 1993). While such data have been repeatedly shown to be reliable in providing a broad picture of subsistence patterns, there has always been a degree of uncertainty associated with the maximum extent, especially offshore where there are no landmarks by which hunters can connect their memories with a map. Widespread use of GPS by hunters has provided a much higher degree of certainty for hunting routes and harvest locations, whether by hunters noting where they are and reporting that information in interviews, or by hunters providing GPS data to researchers (Galginaitis 2014). The combination of GPS, taking uncertainty out of navigation, and larger boats with more powerful engines has given hunters the ability to travel farther offshore. Recent studies (e.g., as reported in Braund (2010) document subsistence activities farther offshore than have been documented previously. The areas recorded in previous studies are thus confirmed as still being used, with the addition of more distant areas, up to 85 miles offshore in the Beaufort Sea in some cases.

More recent studies have also differentiated use areas by season. Not surprisingly, the greatest extent of offshore use is during summer and fall, when hunters can travel by boat. In summer, such trips are typically in search of pack ice where hunters can find walrus and bearded seals. If animals can be found close to the community, hunters will not travel far. But with the rapid retreat of sea ice in recent summers, hunters often have to travel great distances, especially as the period between break up of shorefast ice (allowing boat launch and travel) and the disappearance of pack ice within boating range (ending the opportunity to get ice-associated animals) appears to be getting shorter. In fall, bowhead whaling may take hunters a long distance offshore as well, depending on environmental conditions and potential disturbance to migrating whales.

Harvest areas can vary considerably from one year to the next, depending on environmental conditions and also the degree to which subsistence needs have been filled already. Thus, studies that document harvest areas in a given year cannot be interpreted as representing the full use area over the course of many years. Even lifetime subsistence use areas, which in principle reflect the degree of spatial flexibility required for a hunter to continue to provide for his family and community over a long period, cannot be taken as indications of what will be required in future. Use areas can grow (e.g., as implied in Stephen R. Braund and Associates (2010) for offshore areas, assuming the areas farther offshore are in fact new use areas rather than areas that were inaccurately documented before), and they can also shrink due to environmental, social, and technological changes (e.g, Fienup-Riordan et al. (2013) for seal hunting in Emmonak). The essential feature is flexibility, so that hunters can adjust and adapt as needed, without unnecessary constraints. For example, the ability of bowhead whale hunters in Savoonga to hunt in fall (from the north side of St. Lawrence Island) as well as in spring (when they hunt from the south side of the island) was the result of changing ice conditions together with the lack of a restricted hunting season and the lack of any impediments or conflicting uses in what is now the fall whaling use area (Noongwook et al. 2007).

Recent subsistence use area studies have also estimated intensity of use (e.g., as shown in Stephen R. Braund and Associates (2010) in addition to aggregate spatial extent. Intensity can be a useful indicator of areas where conflicting uses would cause maximum disruption, but should not be over-interpreted to mean that areas of less intense use are unimportant or that activities in those areas would have minimal impact on harvests and food security. First, intensity of use can vary extensively from year to year, as noted earlier for annual use areas as a whole. Second, intensity of use for a community may not match intensity of use for individuals or households, some of whom may use different areas from the majority. Third, areas of lower use intensity may still be important at certain times or for procuring a full harvest. Thus, maps of intensity of harvest effort may be valuable for deciding the locations or routes of transitory phenomena (e.g., a barge bringing supplies to a village), but long-term facilities or impacts anywhere within the subsistence use area should be treated with great caution.

In addition to using data from subsistence studies, we also include in the subsistence map the area identified by the Alaska Eskimo Whaling Commission (AEWC 2013) as necessary for subsistence hunting. This area reflects the considered opinion of experienced whaling captains, which we regard as vital input from those most knowledgeable about the needs of subsistence hunters in the Beaufort Sea.

Finally, it is important to note that hunting areas are only one of the spatial aspects of successful hunting. The animals, too, need to thrive throughout their range in order to arrive in the hunting area healthy and in sufficient numbers to support an adequate harvest to meet local needs. Thus, protecting only the subsistence use area is unlikely to be adequate to protect food security of Beaufort coast villages. Disturbances within hunting areas are of most concern, because such disturbances can reduce the local availability of otherwise abundant animals or force hunters to travel farther, with greater risk, to have a successful hunt. Disturbances outside the hunting areas may not have as rapid or direct an effect on hunting success, unless they cause major changes in migratory routes, but they can affect the health and abundance of a population and thus lead to long-term impacts on subsistence harvests. A range of geographic characterizations of subsistence use areas, up to the “calorie-shed” (area from which one’s food comes) are described in Huntington et al. (2013), emphasizing that long-term activities need to be evaluated at the largest spatial scales.

It is important to recognize that subsistence activities cannot simply shift from one area to another, as hunting locations depend on a combination of accessibility from a given community, likelihood of encountering animals to be hunted, the distance that animals (especially bowheads) need to be towed before they are processed, and the risks taken by hunters as they travel long distances in small boats in uncertain conditions. To minimize the impacts of offshore oil and gas activity on subsistence hunting in the Beaufort Sea, BOEM should consider a range of options, including exclusion areas proposed by the hunters, seasonal restrictions, limits on the overall level of human activity in a given area, and other means of regulating industrial activity (such as the CAAs). Given that human lives and cultural well-being are at stake, subsistence use areas deserve the highest level of attention and protection throughout all phases of offshore oil and gas activity in the Beaufort Sea.

Table 6-1 Summary of subsistence studies in the U.S. Chukchi Sea

Study	Period	Village(s)	Recall/Real time	Species specific?	Seasonal/annual	GPS?
Pedersen (1979a)	Lifetime	Point Hope	Recall	Yes	Annual	No
Pedersen (1979b)	Lifetime	All North Slope	Recall	Yes	Annual	No
Nelson (c1982)	Lifetime	Wainwright	Recall	Yes	Annual	No
Braund and Burnham (1984)	1979–1983	Barrow, Point Hope, Point Lay, Wainwright	Recall	Yes	Annual	No
(Aagaard et al. 1999)	Lifetime	Point Lay	Recall	Yes	Annual	No
Stephen R. Braund and Associates and Institute of Social and Economic Research (1993)	1988–1989	Wainwright	Real time	Yes	Seasonal	No
Stephen R. Braund and Associates and Institute of Social and Economic Research (1993)	1987–89	Barrow	Real time	Yes	Seasonal	No
Kassam and Wainwright Traditional Council (2001)	Not specified	Wainwright	Recall	Yes	Annual	No
Stephen R. Braund and Associates (2010)	1997–2006, 2006	Barrow, Kaktovik, Nuiqsut	Recall	Yes	Annual	No

7. IEAs

Identification of Important Ecological Areas (IEAs) provides a way to prioritize spatial conservation, response, and restoration efforts. We define IEAs as geographically delineated areas which by themselves or in a network have distinguishing ecological characteristics, are important for maintaining habitat heterogeneity or the viability of a species, or contribute disproportionately to an ecosystem's health, including its productivity, biodiversity, functioning, structure, or resilience. For example, IEAs may encompass migration routes, subsistence areas, sensitive seafloor habitats, breeding and spawning areas, foraging areas, or areas of high primary productivity. As an exercise in valuation, determining "relative importance" requires a process for establishing and comparing values of individual or multiple ecological features on a similar scale. This can be accomplished using standard deviates, as described below.

The results we incorporate in our comments were based on an analysis in a 400,000 square kilometer area in the Beaufort and Chukchi seas off the north slope of Alaska. Ecological features used in the analysis were primary productivity, benthic biomass, sea ice, seabirds, marine mammals, and subsistence for which datasets were available or could be compiled. The study region was divided into a 10×10 km grid of study units. Spatial data for each ecological feature were overlaid on the grid and values for each study unit calculated. This created a distribution of study unit values for an ecological feature and values were then converted to standard deviates. Positive standard deviates from the different ecological features were added to provide a landscape of relative importance. Variability in the relative importance of planning units was found across the study region with Barrow Canyon, Point Barrow, and the Cross Island to Kaktovik region having high relative importance values.

Descriptions of the data layers used and the methods used to combine information are provided in a draft Atlas of Important Ecological Areas submitted during prior comment periods (Oceana 2013). That draft is available at: http://www.regulations.gov/#!documentDetail;D=NOAA-NMFS-2013-0054-0070.

8. References Cited

Aagaard, K., D. Darby, K. Falkner, G. Flato, J. M. Grebmeier, C. Measures, and J. J. Walsh. 1999. Marine Science in the Arctic: a strategy. Arctic Research Consortium of the United States (ARCUS), Fairbanks, AK.

ABWC. 2011. Alaska Beluga Whale Committee Report to the 2011 Open Water Meeting. http://www.nmfs.noaa.gov/pr/pdfs/permits/openwater/day1_abwc.pdf.

_____. 2013. Alaska Beluga Whale Committee Report to the 2013 Open Water Meeting. http://www.nmfs.noaa.gov/pr/pdfs/permits/openwater/abwc.pdf.

AEWC, 2013. Alaska Eskimo Whaling Commission website. Accessed online 6/15/13 2013 at http://www.aewc-alaska.com/.

AFSC, 2013. Movement of tagged beluga whales at Point Lay, Alaska 1998-2002. Accessed online 18 November at https://alaskafisheries.noaa.gov/protectedresources/whales/beluga/plmaps/summary98_02.pdf.

Alaska Department of Fish and Game Habitat and Restoration Division. 2001. Oil Spill Contingency Planning: Most Environmentally Sensitive Areas (MESA) Along the Coast of Alaska, Volume I. ADFG, Anchorage, AK.

Allen, B. M., and R. P. Angliss. 2013. Alaska Marine Mammal Stock Assessments, 2012.

Amstrup, S. C., D. G.M., M. T.L., and J. W.R. 2006. Estimating Potential Effects of Hypothetical Oil Spills on Polar Bears. US Geological Survey Alaska Science Center, Anchorage, Alaska.

Arrigo, K. R., D. K. Perovich, R. S. Pickart, Z. W. Brown, G. L. van Dijken, K. E. Lowry, M. M. Mills, M. A. Palmer, W. M. Balch, and F. Bahr. 2012. Massive phytoplankton blooms under Arctic sea ice. *Science* 336:1408-1408.

Ashjian, C. J., S. R. Braund, R. G. Campbell, J. George, J. Kruse, W. Maslowski, S. E. Moore, C. R. Nicolson, S. R. Okkonen, and B. F. Sherr. 2010. Climate variability, oceanography, Bowhead Whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. *Arctic* 63:179-194.

Audubon Alaska, 2013. Monthly Percent of Days with Sea Ice for the Northern Hemisphere, 2008-2012. Audubon Alaska, Anchorage, AK.

_____, 2014a. Important Bird Areas of Alaska, v3. Audubon Alaska, Anchorage, AK. Accessed online at http://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9.

_____, 2014b. Marine Bird Species Core Area Analysis. Anchorage, AK.

_____, 2015. Integrated Globally Significant Proportion. Anchorage, AK. Accessed online at

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.

BirdLife International, 2012. Important Bird Areas (IBAs). BirdLife International, Cambridge, UK. Accessed online August 28 2012 at http://www.birdlife.org/action/science/sites.

Boetius, A., S. Albrecht, K. Bakker, C. Bienhold, J. Felden, M. Fernández-Méndez, S. Hendricks, C. Katlein, C. Lalande, and T. Krumpen. 2013. Export of algal biomass from the melting Arctic sea ice. *Science*.

Bogoslovskaya, L. S., V. M. Votrogov, and T. N. Semenova. 1981. Feeding Habits of Gray Whale off Chukotka. International Whaling Commission,

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. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-200, Seattle, WA.

Boveng, P. L., J. L. Bengtson, M. F. Cameron, S. P. Dahle, E. A. Logerwell, J. M. London, J. E. Overland, J. T. Sterling, D. E. Stevenson, B. L. Taylor, and H. L. Ziel. 2013. Status Review of the Ribbon Seal. U.S. Department of Commerce, NOAA,

Boveng, P. L., and M. F. Cameron. 2013. Pinniped Movements and Foraging: Seasonal Movements, Habitat Selection, Foraging and Haul-out Behavior of Adult Bearded Seals in the Chukchi Sea. Anchorage, Alaska, USA.

Braund, S. R. 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Bureau of Ocean Energy Management, MMS OCS Study No. 2009-003. Anchorage, Alaska.

Braund, S. R., Associates, and Institute of Social and Economic Research. 1993. North Slope Subsistence Study Barrow 1987,1988, and 1989. MMS Alaska OCS Region,

Braund, S. R., and D. C. Burnham. 1984. Subsistence Economics, Marine Resource Use Patterns, and Potential OCS Impacts for Chukchi Sea Communities. Stephen R. Braund and Associates, Anchorage, AK.

Brueggeman, J. J., C. I. Malmoe, R. A. Grotefendt, D. P. Volsen, J. J. Burns, D. G. Chapman, D. K. Ljungblad, and G. A. Green. 1990. 1989 Walrus Monitoring Program: The Klondike, Burger, and Popcorn prospects in the Chukchi Sea. Report from Ebasco Environmental, Bellevue, WA., for Shell Western E&P, Incl. Houston, TX.

Brueggeman, J. J., D. P. Volsen, R. A. Grotefendt, G. A. Green, J. J. Burns, and D. K. Ljungblad. 1991. Final report Shell Western E&P Inc. 1990 Walrus Monitoring Program: The Popcorn, Burger, and Crackerjack Prospects in the Chukchi Sea. Report from Ebasco Environmental, Bellevue, WA for Shell Western E&P, Inc. Houston, TX.

Burns, J. J. 2002. Harbor seal and spotted seal, *Phoca vitulina* and *P. largha*. Pages 552-560 *in* eds W. F. Perrin, B. Wursig, andJ. G. M. Thewissen *Encyclopedia of Marine Mammals*. Academic Press, San Diego, CA.

Cameron, M. F., J. L. Bengtson, P. L. Boveng, J. Jansen, B. P. Kelly, S. Dahle, E. Logerwell, J. Overland, C. Sabine, and G. Waring. 2010. Status Review of the Bearded Seal (*Erignathus barbatus*). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-211. 246 p,

Christman, C. L., J. J. Citta, L. T. Quakenbush, J. T. Clarke, B. K. Rone, R. A. Shea, M. C. Ferguson, and M. P. Heide-Jorgensen. 2013. Presence and behavior of bowhead whales (*Balaena mysticetus*) in the Alaskan Beaufort Sea in July 2011. *Polar Biology*.

Citta, J. J., L. T. Quakenbush, S. Okkonen, J. George, R. J. Small, M. P. Heide-Jorgensen, L. A. Harwood, and H. Brower. 2015. Inter-annual variability in the fall movements of bowhead whales in the Chukchi Sea, *in Alaska Marine Science Symposium*. Anchorage, AK.

Citta, J. J., L. T. Quakenbush, S. R. Okkonen, M. L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J. C. George, H. Brower, R. J. Small, and C. J. Ashjian. 2014. Ecological characteristics of core-use areas used by Bering–Chukchi–Beaufort (BCB) bowhead whales, 2006–2012. *Progress in Oceanography*.

Clarke, J. T., A. A. Brower, C. L. Christman, and M. C. Ferguson. 2013a. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2013 Annual Report. NOAA National Marine Mammal Laboratory, US DOI Bureau of Ocean Energy Management, Anchorage, AK.

Clarke, J. T., A. A. Brower, C. L. Christman, and M. C. Ferguson. 2014. Distribution and Relative Abundance of Marine Mammals in the Northeastern Chukchi and Western Beaufort Seas, 2013.

National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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. Annual Report, OCS Study BOEM 2012-009. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

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

Clarke, J. T., C. L. Christman, M. C. Ferguson, and S. L. Grassia. 2011. Aerial surveys of Endangered Whales in the Beaufort Sea, Fall 2006-2008. Final Report, OCS Study BOEMRE 2010-042. 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Clarke, J. T., M. C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically important areas for cetaceans within U.S. waters - Arctic Region. *Aquatic Mammals*:94-103.

Comiso, J. C. 2002. A rapidly declining perennial sea ice cover in the Arctic. *Geophysical Research Letters* 29.

Comiso, J. C., C. L. Parkinson, R. Gersten, and L. Stock. 2008. Accelerated decline in the Arctic sea ice cover. *Geophysical Research Letters* 35.

Day, R. H., A. E. Gall, A. K. Prichard, G. J. Divoky, and N. A. Rojek. 2011. The status and distribution of Kittlitz's murrelet *Brachyramphus brevirostris* in northern Alaska. *Marine Ornithology* 39:53-63.

Department of the Interior. 2013. Marine Mammals; Incidental Take During Specific Activities; Final Rule.

Drew, G. F., and J. Piatt, 2013. North Pacific Pelagic Seabird Database (NPPSD) v2. US Geological Survey Alaska Science Center & US Fish and Wildlife Service, Anchorage, AK.

Dunton, K. H., J. L. Goodall, S. V. Schonberg, J. M. Grebmeier, and D. R. Maidment. 2005. Multi-decadal synthesis of benthic-pelagic coupling in the western arctic: role of cross-shelf advective processes. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3462-3477.

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.

Durner, G. M., D. C. Douglas, R. M. Nielson, S. C. Amstrup, T. L. McDonald, I. Stirling, M. Mauritzen, E. W. Born, O. Wiig, E. DeWeaver, M. C. Serreze, S. E. Belikov, M. M. Holland, J. Maslanik, J. Aars, D. C. Bailey, and A. E. Derocher. 2009. Predicting 21st century polar bear habitat distribution from global climate models. *Ecological Monographs* 79:107-120.

Eicken, H., R. Gradinger, A. Gaylord, A. Mahoney, I. Rigor, and H. Melling. 2005. Sediment transport by sea ice in the Chukchi and Beaufort Seas: Increasing importance due to changing ice conditions? 0967-0645.

Evans, T. J., A. Fischbach, S. Schliebe, B. Manly, S. Kalxdorff, and G. York. 2003. Polar bear aerial survey in the eastern Chukchi sea: A pilot study. *Arctic* 56:359-366.

Fay, F. H. 1982. Ecology and biology of the Pacific walrus, *Odobenus rosmarus divergens* Illiger. *North American Fauna* 74:279 p.

Fienup-Riordan, A., C. Brown, and N. M. Braem. 2013. The value of ethnography in times of change: the story of Emmonak. *Deep Sea Research Part II* 94.

Fischbach, A., 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.

Frey, K. E., K. R. Arrigo, and W. J. Williams 2012. Arctic Ocean Primary Productivity and Nutrient Distributions. *in Arctic Report Card 2012*. http://www.arctic.noaa.gov/reportcard.

Frost, K. J., and L. F. Lowry. 1990. Distribution, abundance, and movements of beluga whales, *Delphinapterus leucas*, in coastal waters of western Alaska. *In*: Advances in Research on the Beluga Whale. *Canadian Bulletin of Fisheries and Aquatic Sciences* 224:39-57.

Frost, K. J., L. F. Lowry, and J. Burns. 1983. Distribution of Marine Mammals in the Coastal Zone of the Eastern Chukchi Sea During Summer and Autumn. Outer Continental Shelf Environmental Assessment Program, Anchorage, AK.

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. 2004. Factors affecting the observed densities of ringed seals, *Phoca hispida*, in the Alaskan Beaufort Sea, 1996-99. *Arctic* 57:115-128.

Galginaitis, M. 2014. Monitoring Cross Island Whaling Activities, Beaufort Sea, Alaska: 2008-2012 Final Report, Incorporating ANIMIDA and cANIMIDA (2001-2007). U.S. Department of the Interior, Bureau of Ocean Energy Management, Alaska Region, Anchorage, Alaska.

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*). *USFWS, Anchorage AK. 163pp*.

Gradinger, R. 2008. Sea ice. *in* eds R. Hopcroft, B. Bluhm, andR. Gradinger *Arctic Ocean Synthesis: Analysis of Climate Change Impacts in the Chukchi and Beaufort Seas with Strategies for Future Research*. University of Alaska, Fairbanks, Institute of Marine Science, Fairbanks, AK.

Grebmeier, J. M. 2012. Shifting Patterns of Life in the Pacific Arctic and Sub-Arctic Seas. *Annual Review of Marine Science* 4:63-78.

Grebmeier, J. M., L. W. Cooper, H. M. Feder, and B. I. Sirenko. 2006. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

_____. 2014. Ecosystem dynamics of the Pacific-influenced Northern Bering and Chukchi Seas in the Amerasian Arctic. *Progress in Oceanography* 71:331-361.

Harwood, L. A., T. G. Smith, and J. C. Auld, 2012. Fall migration of Ringed Seals (*Phoca hispida*) through the Beaufort and Chukchi seas, 2001-02 65.

Harwood, L. A., T. G. Smith, J. C. George, S. J. Sandstrom, W. Wojciech, and G. J. Divoky. in press. Changes in the Beaufort Sea ecosystem: diverging trends in the body condition of marine mammals, seabirds and anadromous char revealed through long-term monitoring. *Progress in Oceanography. Special Issue, Synthesis of Arctic Research (SOAR)*.

Hauser, D. D., K. L. Laidre, R. S. Suydam, and P. R. Richard. 2014. Population-specific home ranges and migration timing of Pacific Arctic beluga whales (*Delphinapterus leucas*). *Polar Biology*:1-13.

Hill, V., and G. Cota. 2005. Spatial patterns of primary production on the shelf, slope and basin of the Western Arctic in 2002. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3344-3354.

Homer, R., and G. C. Schrader. 1982. Relative contributions of ice algae, phytoplankton, and benthic microalgae to primary production in nearshore regions of the Beaufort Sea. *Arctic* 35:485-503.

Hunt, G. L., P. Stabeno, G. Walters, E. Sinclair, R. D. Brodeur, J. M. Napp, and N. A. Bond. 2002. Climate change and control of the southeastern Bering Sea pelagic ecosystem. *Deep Sea Research Part II: Topical Studies in Oceanography* 49:5821-5853.

Huntington, H. 2013. Traditional Knowledge Regarding Bowhead Whales and Camden Bay, Beaufort Sea, Alaska. Eagle River, AK.

Huntington, H. P., I. Ortiz, G. Noongwook, M. Fidel, L. Alessa, A. Kliskey, D. Childers, M. Morse, and J. Beaty. 2013. Mapping human interaction with the Bering Sea ecosystem: comparing seasonal use areas, lifetime use areas, and "calorie-sheds". *Deep Sea Research Part II* 94:292-300.

Huntington, H. P., and L. T. Quakenbush. 2009. Traditional knowledge of bowhead whale migratory patterns near Kaktovik and Barrow, Alaska. Report to the Alaska Eskimo Whaling Commission and the Barrow and Kaktovik Whaling Captains. in Quakenbush, L.T., J.J. Citta, R.J. Small. 2010. Satellite Tracking of Western Arctic Bowhead Whales, Final Report. OCS Study BOEMRE 2010-033. Department of the Interior; Bureau of Ocean Energy Management, Regulation and Enforcement.

Huntington, H. P., and E. The Communties of Buckland, Koyuk, Point Lay, and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the Eastern Chukchi and Northern Bering Seas, Alaska. *Arctic* 52:49-61.

Jay, C. V., and A. S. Fischbach. 2008. Pacific Walrus Response to Arctic Sea Ice Losses. U.S. Department of the Interior, U.S. Geological Survey, Alaska Science Center, Anchorage, 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.

Jay, C. V., B. G. Marcot, and D. C. Douglas. 2011. Projected status of the Pacific walrus (*Odobenus rosmarus divergens*) in the twenty-first century. *Polar Biology* 34:1065-1084.

Johnson, S. R., K. J. Frost, and L. F. Lowry. 1992. Use of Kasegaluk Lagoon, Chukchi Sea, Alaska, by Marine Birds and Mammals. LGL Alaska Research Associates and AK Department of Fish and Game,

Kassam, K.-A. S., and Wainwright Traditional Council. 2001. *Passing on the knowledge : mapping human ecology in Wainwright, Alaska*. Arctic Institute of North America, Calgary.

Kelly, B. P. 1988. Ringed seal, *Phoca hispida*. Pages 57-75 *in* ed. J. W. Lentfer *Selected Marine Mammals of Alaska. Species Accounts with Research and Management Recommendations*. The Marine Mammal Commission, Washington, D.C.

Kelly, B. P., O. H. Badajos, M. Kunnasranta, J. R. Moran, M. Martinez-Bakker, D. Wartzok, and P. Boveng. 2010a. Seasonal home ranges and fidelity to breeding sites among ringed seals. *Polar Biology* 33:1095-1109.

Kelly, B. P., J. Bengtson, P. Boveng, M. Cameron, S. Dahle, J. Jansen, E. Logerwell, J. Overland, C. Sabine, and G. Waring. 2010b. Status Review of the Ringed Seal (*Phoca hispida)*.

Kirchhoff, M. D., and V. Padula. 2010. The Audubon Alaska watchList 2010 technical report. Audubon Alaska, Anchorage, AK.

Krembs, C., R. Gradinger, and M. Spindler. 2000. Implications of brine channel geometry and surface area for the interaction of sympagic organisms in Arctic sea ice. *Journal of Experimental Marine Biology and Ecology* 243:55-80.

Kuletz, K. J., M. C. Ferguson, B. Hurley, A. E. Gall, E. A. Labunski, and T. C. Morgan. in press. Seasonal spatial patterns in seabird and marine mammal distribution in the Pacific Arctic: identifying biologically important pelagic areas. *Progress in Oceanography* 00:000-000.

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:S97-S125.

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.

MacCracken, J. G. 2012. Pacific Walrus and climate change: observations and predictions. *Ecology and evolution* 2:2072-2090.

Maslowski, W., J. Clement Kinney, M. Higgins, and A. Roberts. 2012. The Future of Arctic Sea Ice. *Annual Review of Earth & Planetary Sciences* 40:625-654.

Moore, S. E. 2000. Variability of Cetacean distribution and habitat selection in the Alaskan Arctic, autumn 1982-91. *Arctic* 53:448-460.

Moore, S. E., J. T. Clarke, and M. M. Johnson. 1993. Beluga Distribution and Movements Offshore Northern Alaska in Spring and Summer, 1980-84. Report of the International Whaling Commission.

Moore, S. E., D. P. DeMaster, and P. K. Dayton. 2000. Cetacean habitat selection in the Alaskan Arctic during summer and autumn. *Arctic* 53:432-447.

Moore, S. E., J. C. George, G. Sheffield, J. Bacon, and C. J. Ashjian. 2010. Bowhead whale distribution and feeding near Barrow, Alaska, in late summer 2005–06. *Arctic*:195-205.

Moore, S. E., and K. L. Laidre. 2006. Trends in sea ice cover within habitats used by bowhead whales in the western Arctic. *Ecological Applications* 16:932-944.

Moore, S. E., and R. R. Reeves. 1993. Distribution and movements. *in* eds J. J. Burns, J. J. Montague, andC. J. Cowles *The Bowhead Whale*. Special Publication of The Society for Marine Mammalogy, Lawrence, KS.

National Audubon Society, 2012. Important Bird Areas Criteria Overview. National Audubon Society, New York, NY. Accessed online January 2012 at http://web4.audubon.org/bird/iba/criteria.html.

National Snow and Ice Data Center, 2013. IMS Daily Northern Hemisphere Snow and Ice Analysis at 4 km and 24 km Resolution. NSIDC, Boulder, CO. Accessed online at http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html#acq_proc):.

_____, 2014. Sea Ice Concentrations from Nimbus-7 SMMR and DMSP SSM/I Passive Microwave Data. NSIDC, Boulder, CO. Accessed online at http://nsidc.org/data/nsidc-0051.

Nelson, R. K., c1982. Harvest of the Sea: Coastal Subsistence in Modern Wainwright. North Slope Borough's Coastal Management Program, Barrow, AK.

NMFS, 2013. Point Lay Beluga Whales. National Marine Fisheries Service, Juneau, AK. Accessed online 6/25/13 2013 at http://www.alaskafisheries.noaa.gov/protectedresources/whales/beluga/ptlay.htm#2012.

NOAA. 1988. Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas. Rockville, MD.

NOAA: Office of Response and Restoration, 2005. Environmental sensitivity index, version 3.0. Seattle, WA. Accessed online at http://response.restoration.noaa.gov/maps-and-spatial-data/download-esi-maps-and-gis-data.html#Alaska.

Noongwook, G., The Native Village of Savoonga, The Native Village of Gambell, H. P. Huntington, and J. C. George. 2007. Traditional knowledge of the bowhead whale (*Balaena mysticetus*) around St. Lawrence Island, Alaska. *Arctic* 60:47-54.

Oceana. 2013. Oceana Comments on Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement, 78 FR 21347. Oceana, Juneau, AK.

Overland, J. E., and M. Wang. 2013. When will the summer Arctic be nearly sea ice free? *Geophysical Research Letters* 40:2097-2101.

Pedersen, S. 1979a. Point Hope synopsis. *in Native Livelihood and Dependence: A Study of Land Use Values through Time*. U.S. Department of the Interior, Anchorage, AK.

_____. 1979b. Regional Subsistence Land Use, North Slope Borough, Alaska. Anthropology and Historic Preservation, Cooperative Park Studies Unit, University of Alaska., Fairbanks, AK.

Person, B. T., A. K. Prichard, G. M. Carroll, D. A. Yokel, R. S. Suydam, and J. C. George. 2007. Distribution and Movements of the Teshekpuk Caribou Herd 1990–2005: Prior to Oil and Gas Development. *Arctic* 60 (3):238-250.

Petersen, M. R., W. W. Larned, and D. C. Douglas. 1999. At-sea distribution of Spectacled Eiders: A 120-year-old mystery resolved. *Auk* 116:1009-1020.

Quakenbush, L. T. 1988. *Phoca largha*. *in* ed. J. Lentfer *Selected Marine Mammals of Alaska: Species Accounts with Research and Management Recommendations*. Marine Mammal Commission, Washington, DC.

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 within a potential petroleum development area. *Arctic* 63:289-307.

Quakenbush, L. T., R. J. Small, and J. J. Citta. 2013. Satellite Tracking of Bowhead Whales: Movements and Analysis from 2006 to 2012. OCS Study BOEM 2013-01110, Anchorage, AK.

Richard, 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.

Schliebe, S., Ø. Wiig, A. Derocher, and N. Lunn, 2008. *Ursus maritimus*. IUCN Red List of Threatened Species. Version 2012.2. IUCN, Accessed online 6/27/13 2013 at www.iucnredlist.org.

Sexson, M. G., M. R. Petersen, and A. N. Powell. 2012. Spatiotemporal distribution of Spectacled Eiders throughout the annual cycle, *in 15th Alaska Bird Conference*. Anchorage, AK.

Sheffield, G., and J. M. Grebmeier. 2009. Pacific walrus (*Odobenus rosmarus divergens*): differential prey digestion and diet. *Marine Mammal Science* 25:761-777.

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.

Smith, M. A. 2010. *Arctic Marine Synthesis: Atlas of the Chukchi and Beaufort Seas*. Audubon Alaska and Oceana, Anchorage.

Smith, M. A., N. J. Walker, C. M. Free, M. J. Kirchhoff, G. S. Drew, N. Warnock, and I. J. Stenhouse. 2014. Identifying marine Important Bird Areas using at-sea survey data. *Biological Conservation* 172:180-189.

Stephen R. Braund and Associates, 2010. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow. Anchorage, AK.

Stephen R. Braund and Associates, and Institute of Social and Economic Research. 1993. North Slope Subsistence Study: Wainwright, 1988 and 1989. Technical Report No.147. U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, Social and Economic Studies, Anchorage, AK.

Stirling, I. 1997. The importance of polynyas, ice edges, and leads to marine mammals and birds. *Journal of Marine Systems* 10:9-21.

Stringer, W. J., and J. Groves. 1991. Location and areal extent of polynyas in the Bering and Chukchi Seas. *Arctic*:164-171.

Suydam, R. 2000. King Eider (*Somateria spectabilis*). *in* eds A. Poole, andF. Gill *The Birds of North America*. The Birds of North America, Inc., Philadelphia, PA.

Suydam, R., 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. Coastal Marine Institute and US Department of the Interior, Minerals Management Service, Alaska OCS Region.

Suydam, R. S. 2009. *Age, growth, reproduction, and movements of beluga whales (Delphinapterusleucas) from the eastern Chukchi Sea*. Ph.D. Dissertation, University of Washington.

Suydam, R. S., L. F. Lowry, K. J. Frost, G. M. O'Corry-Crowe, and D. Pikok. 2001. Satellite tracking of eastern Chukchi Sea beluga whales into the Arctic Ocean. *Arctic* 54:237-243.

USFWS. 1995. Habitat Conservation Strategy for Polar Bears in Alaska.

_____. 2010a. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Polar Bear (*Ursus maritimus*) in the United States. Federal Register.

_____. 2010b. Polar Bear (*Ursus maritimus*). *in Stock Assessment Reports*. USFWS, Marine Mammals Management, Alaska Region, Anchorage, AK.

_____. 2011. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to List the Pacific Walrus as Endangered or Threatened. U.S. Fish and Wildlife Service, Federal Register.

_____. 2013a. Environmental Assessment: Endangered Species Act 4(d) Regulations for Threatened Polar Bears. Marine Mammals Management, Anchorage, Alaska.

_____, 2013b. Polar Bear: U.S.-Russia Bilateral Agreement. U.S. Fish and Wildlife Service, Marine Mammals Management, Alaska Region, Accessed online 6/25/13 2013 at http://alaska.fws.gov/fisheries/mmm/polarbear/bilateral.htm.

USFWS Marine Mammals Management. 2014. Pacific Walrus (*Odobenus rosmarus divergens*): Alaska Stock. *in Alaska Stock Assessment Report*. Anchorage, AK.

Walker, N. J., and M. A. Smith, 2014. Alaska Waterbird Database v1. Audubon Alaska, Anchorage, AK.

Wang, J., G. F. Cota, and J. C. Comiso. 2005. Phytoplankton in the Beaufort and Chukchi Seas: distribution, dynamics, and environmental forcing. *Deep-Sea Research Part Ii-Topical Studies in Oceanography* 52:3355-3368.

Wang, M., and J. E. Overland. 2009. A sea ice free summer Arctic within 30 years? *Geophysical Research Letters* 36:L07502.

Western Arctic Caribou Herd Working Group. 2011. Western Arctic Caribou Herd Cooperative Management Plan. Western Arctic Caribou Herd Working Group, Nome, AK.

World Seabird Union, 2011. Seabird Information Network: North Pacific Seabird Data Portal. World Seabird Union, www.seabirds.net. Accessed online at http://axiom.seabirds.net/portal.php.