MAMMALS

Terri Stinnett Photography

MAMMALS MAP INDEX

Polar Bear

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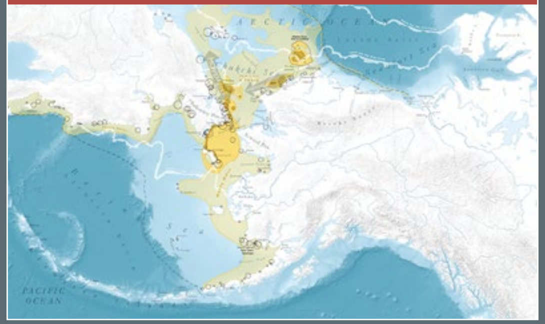

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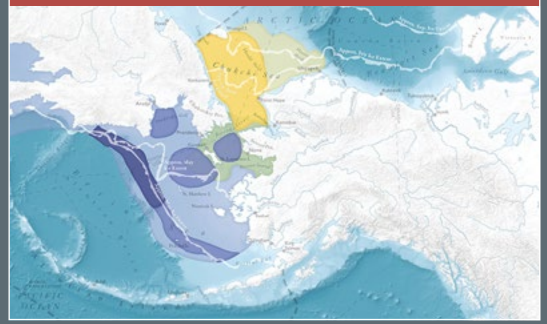

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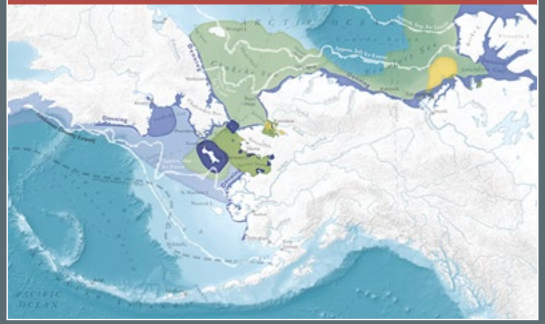

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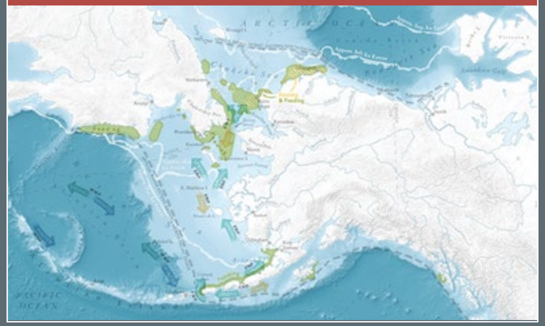

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Humpback Whale

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Polar Bear

Ursus maritimus

Max Goldman, Erika Knight, and Melanie Smith

One of the most recognizable species on the planet, polar bears (*Ursus maritimus*) are among the largest of the eight extant bear species, along with the American brown bear (*U. arctos*), a closely related cousin (Wozencraft 2005). Even the word Arctic is Greek for "of the bear." Polar bears are an ice-obligate species; they rely heavily on sea ice for travel, resting, breeding, and denning and have evolved to thrive on food resources (mainly seals) that utilize drifting pack ice (Moore and Huntington 2008). They are regarded as marine mammals by the US Marine Mammal Protection Act because of this reliance. Polar bears are relatively long-lived, reaching sexual maturity at an advanced age. They are characterized by substantial maternal investment in cub rearing and small litter sizes (Amstrup et al. 1986, Derocher and Stirling 1998). Although polar bears genetically diverged from brown bears relatively recently (from 150,000 to 500,000 years ago), they have developed distinct adaptations suited to their Arctic range (Ray 1971, Liu et al. 2014, Welch et al. 2014).

ADAPTATIONS

The polar bear is exceedingly well adapted to utilize the opportunities available in the Arctic. Their dense, white to yellowish fur is distinct and well suited to the snow-covered ice on which these bears evolved. Under their dense fur is black skin (evident in the color of their noses), which serves to absorb the sunlight that penetrates their hollow hair shafts and warms their bodies. Relative to the American brown bear, polar bears exhibit a longer skull and snout, as well as an elongated overall body structure (Stirling et al. 1977, Ramsay and Stirling 1988). The ears and tail of the polar bear are especially and predictably small, owing likely to adaptations related to thermoregulation (Allen 1877). Their large feet are covered in papillae, small bumps that improve traction on ice and snow. Their large feet also help to distribute their weight over ice and improve propulsion when swimming (Durner et al. 2011, Pagano et al. 2012, US Fish and Wildlife Service 2016). The pronounced curvature of their short claws makes escape by prey unlikely once captured. Specialized dentition, including incisors and long, sharp canines for catching and holding prey and carnassials (modified molars) for shearing meat and breaking bone, is due to an almost entirely carnivorous diet. Polar bears are sexually dimorphic, with boars weighing between 800 and 1,600 pounds (360 and 730 kg), twice the size of sows who generally weigh between 350 and 600 pounds (160 and 270 kg). Pregnant females weigh up to 1,100 pounds (500 kg) (US Fish and Wildlife Service 2016).

DISTRIBUTION

Polar bears are found in five Arctic nations, or "range states" including Greenland (Denmark), Canada, the US, Russia, and Norway. The circumpolar population of 26,000 polar bears is are divided into 19 subpopulations in 4 ecoregions (Amstrup et al. 2008, Regehr et al. 2016) (Figure 6.1-1). The ecoregions are "based on the spatial and temporal dynamics of sea ice" (US Fish and Wildlife Service 2016) and polar bear life history (Amstrup et al. 2008). These four ecoregions are:

- **Archipelago Ice Ecoregion**, characterized by year-round sea ice, providing consistent habitat for seals and polar bears.
- **Polar Basin Convergent Ice Ecoregion**, characterized by ice that formed in other parts of the Arctic converging on shore, creating hunting habitat for polar bears within this ecoregion.
- **Polar Basin Divergent Ice Ecoregion**, characterized by winter advance of sea ice across the continental shelf beneath the Chukchi, Beaufort, and Bering Seas and retreat of the ice margin north of the Chukchi shelf break in summer (US Fish and Wildlife Service 2016).
- **Seasonal Ice Ecoregion**, characterized by ice presence for much of the year, and complete ice absence throughout the rest of the year. This habitat is at the southernmost extent of polar bear habitat.

The Polar Basin Convergent and Archipelago Sea Ice Regions may well be the last strongholds for Polar Basin Divergent bears, as they are forced to seek out more suitable habitat. Since the sea ice they now rely upon is seasonal and highly variable, and they are not well-accustomed to utilizing terrestrial habitat for long periods, the Polar Basin Divergent bears are likely the most vulnerable to climate change (Atwood et al. 2015a, b).

Population Dynamics

The 19 subpopulation units developed by the International Union for Conservation of Nature's (IUCN) Polar Bear Specialist Group (PBSG) were established based on a combination of genetic information and practical considerations of range state managers, and effectively serve as management units for research, monitoring and reporting on polar bears. According to the PBSG (2017), bear numbers are stable in 6 of the 19 units (32%); declining in 3 units (16%); increasing in 1 unit (5%); and deemed data deficient in 9 units (47%).

Two of the three subpopulations that use the Chukchi and Beaufort Seas, the Chukchi Sea subpopulation (CS) and the Southern Beaufort Sea subpopulation (SBS), are considered to be part of the Polar Basin Divergent ice ecoregion (Amstrup et al. 2008, Regehr et al. 2016). They spend the vast majority of their time offshore hunting seals on sea ice, except when denning or when the lack of available sea ice necessitates coming ashore. The Northern Beaufort Sea subpopulation (NBS) is considered Polar Basin Convergent. The smaller, and less well-known Viscount Melville Sound polar bears (VM) are found at the extreme northeastern extent of the project area in the Archipelago Ecoregion, and are not featured here, due to the fact that they do not specifically use the Bering, Chukchi, or Beaufort Seas, and there is very little research regarding this subpopulation (Amstrup et al. 2008, Regehr et al. 2016).

While previous efforts that estimated the Chukchi Sea subpopulation at approximately 2,000 bears had been accepted by the PBSG (Belikov

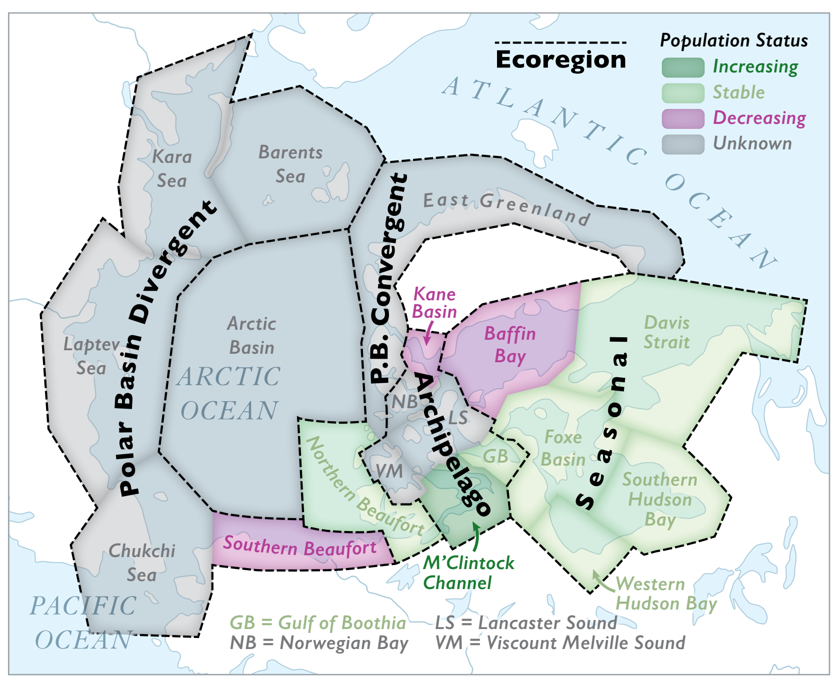

FIGURE 6.1-1. Throughout their circumpolar range, there are 19 subpopulations of polar bear within four distinct ice ecoregions. Each ice ecoregion is characterized by slight, but important, differences in sea-ice habitat. All-white region over inland Greenland has no known polar bears. Figure adapted from Aars et al. (2006), Amstrup et al. (2008), Obbard et al. (2010), Polar Bear Specialist Group (2015), Regehr et al. (2016), Schliebe et al. (2006), and Wiig et al. (2015).

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FIGURE 6.1-2. The US-Russia Bilateral Agreement (2000) and the Inuvialuit-Inupiat Polar Bear Management Agreement (1988, 2000, and 2011) were signed to manage conservation and safeguard cultural access to polar bear for Native peoples of Chukotka and Alaska, and Canada and Alaska, respectively.

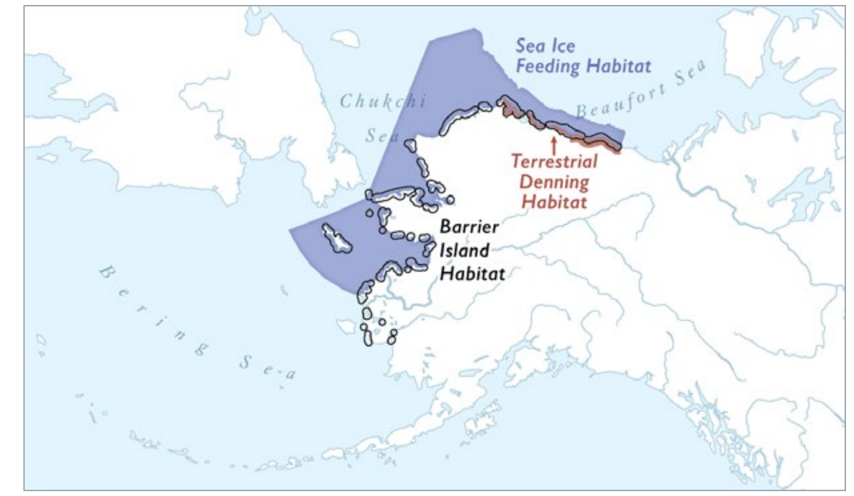

FIGURE 6.1-3. Critical habitat for polar bears, including designations of sea ice feeding, denning, and barrier island habitat. Barrier island habitat includes coastal barrier islands and spits along Alaska's coast as well as a no-disturbance zone that extends 1 mile from these features. Barrier island habitat is buffered for visual clarity—to highlight the areas within which the barrier island critical habitat is located—and extends beyond the official designation. Critical habitat for polar bears was designated by the US Fish and Wildlife Service effective 2011, but the critical habitat final rule was vacated and remanded in 2013 by an order issued by the US District Court for the District of Alaska. In 2016, the 9th Circuit Court Panel reversed the District Court's judgment and the original designation has therefore been reinstated.

1992, Aars et al. 2006) they have since deemed them data deficient and decided a population designation of "unknown" was more appropriate. The Southern Beaufort Sea (SBS) polar bear population was estimated at approximately 1,700 bears from 1978–83 (Amstrup et al. 1986), 1500 in the early 2000s (Regehr et al. 2006), and 900 by 2010 (Bromaghin et al 2015). Rode et al. (2014) suggest that the recent declines in polar bear population where due to changes in sea ice availability.

Sea-Ice Habitat

During winter and into spring, polar bears seek out the highly dynamic boundary between sea ice and water to hunt seals that are using ice holes for breathing or are hauling out after feeding in the highly productive waters at the sea-ice edge. Polar bears very rarely pursue seals on open land or in the water, preferring instead to use leads (systems of stress-induced fissures in sea ice that allow access to open water) (Weeks 2010), and polynyas, (wind or warm-water, upwelling-induced, ice-free areas) (Stringer and Groves 1991). Leads and polynyas play a crucial role in Arctic ecology, creating a zone of productivity and access in a vast seascape. These are important feeding areas for seals, which in turn attract polar bears. Once spring arrives, nearshore leads continue to be integral to polar bear feeding, as do landfast ice zones—ice that is fastened to the coastline or sea floor (Weeks 2010). Landfast and pack ice are crucial habitat components for ringed seals (*Phoca hispida*), as they build their birthing lairs here, under the snow. As newborn polar bear cubs emerge between February and mid-April (Stirling et al. 1988), this food source is critical to the survivability of polar bears (Freitas et al. 2012).

When sea ice recedes in summer, sunlight catalyzes algal blooms that form the basis of highly productive waters found at the ice edge throughout the Arctic (see Biological Setting chapter). Primary production and zooplankton blooms attract pelagic fish and contribute to seafloor food availability. As sea ice recedes, polar bears decide to either follow the productive but tenuous sea ice north, farther and farther away from the coastline and into the less productive waters over the polar basin, or come ashore, where it is very difficult to acquire the calories needed to offset energetic costs associated with terrestrial foraging (Derocher et al. 2004, Whiteman et al. 2015). Once sea-ice concentration drops below a certain threshold, polar bears have been documented to quickly abandon sea ice for land, where their preferred prey (see Diet subsection) are almost entirely absent (Stirling et al. 1999, Cherry et al. 2013).

LIFE CYCLE

Polar bears rely on sea ice as courting and mating habitat. They breed in the spring, generally ending by June (Schliebe et al. 2006, US Fish and Wildlife Service 2016). Males will follow a female as she makes her way to fertile seal-hunting habitat. Eventually, the males in pursuit will engage in intense fighting amongst themselves, often resulting in serious injury (Ramsay and Stirling 1988, Stirling et al. 1988, Derocher and Stirling 1990). The victor will then mate with the female for many days. After fertilization, the egg remains dormant for months as the newly impregnated female consumes large amounts of calories, often nearly doubling her body weight (Rosing-Asvid 2006). The delaying of implantation, and subsequently of birth, is likely dependent upon food availability and timed to coincide with seal pupping. Some females will forgo reproduction in years when food and suitable denning habitat are particularly scarce (Ramsay and Stirling 1988).

Denning

In fall or early winter pregnant polar bears will seek out a location in which to build maternity dens. The CS and SBS subpopulations historically built their maternity dens on the ice. However, denning is now most often terrestrial and constructed in a snowdrift or palsa (an elevated feature of permafrost) when snowfall is not sufficient (Rode et al. 2015a, Olson et al. 2017). The den consists of a narrow entrance tunnel, and one or more chambers. Polar bears reuse the same denning areas from year to year (Ramsay and Stirling 1990).

In the CS subpopulation, the most important denning area is Wrangel Island, Russia. Up to 200 pregnant female bears descend upon Wrangel Island each fall to give birth (Garner et al. 1990, Garner et al. 1994, Rode et al. 2015a). CS polar bears also breed on the northeastern coast of the Chukotka Peninsula, Russia (Stishov 1991) (Ovsyanikov 2005, Ovsyanikov and Menyushina 2008, Ovsyanikov 2009).

For the SBS subpopulation, denning on fast ice is much more prevalent; up to 37% of SBS females den on ice, compared to 5–10% of CS females (Fischbach et al. 2007, Rode et al. 2015a, Olson et al. 2017). Core areas along the coastline, riverbanks, barrier islands, and coastal bluffs of the North Slope of Alaska and the northern coast of Canada are also important denning sites for SBS bears (Durner et al. 2004, Durner et al. 2006).

Pregnant polar bears enter into a state of dormancy when denning (Stirling et al. 1988). Their heart rate slows dramatically but they do not technically hibernate, as their body temperature does not decrease. Polar bear young are born in an altricial state from November to February, requiring constant care. Twinning is by far the most common birth pattern, but litters of one, three, and rarely four have been observed (Stirling et al. 1988). In March or April, the bears will break out of the den, and the family group will emerge (Stirling et al. 1988). Depending on when the ice floe break-up occurs, female polar bears may not have

6.1 POLAR BEAR
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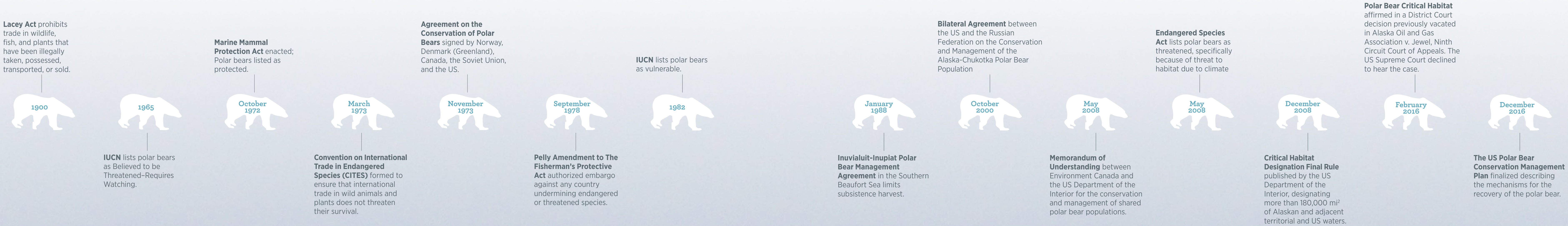


FIGURE 6.1-4. The legal landscape continues to influence human-polar bear interaction in Alaska but has evolved since the turn of the 20th century. The graphic shows some important and impactful legislative highlights.

Specifically adapted to the frigid conditions in the Arctic, polar bears are the most carnivorous of the eight living species of bear, with little to no vegetative food found in most polar bear diets.

Milo Burcham

eaten for eight months, despite expending large amounts of energy birthing and nourishing their offspring (Watts and Hansen 1987).

Diet

The polar bear diet consists mainly of ringed and bearded seals (*Erignathus barbatus*), the bodies of which are 34–76% fat (Stirling and McEwan 1975). Consumption of seal meat, organs, and bone provide a complete set of trace elements, vitamins, and minerals (Derocher 2012). Individuals have been documented to consume up to 70% lipids (Best 1985, Cherry et al. 2011). When on land, bears have been observed consuming more than 60 terrestrial food resources, such as berries, bird eggs, birds, fishes, small mammals, scavenged ungulates, and lichens (Derocher 2012, Iles et al. 2013, Iverson et al. 2014). Subsistence carcass dumps or bonepiles of harvested whales are becoming increasingly important food sources for seasonally terrestrial polar bears (see Conservation Issues). Energy-expenditure modeling (Pritchard and Robbins 1990, Hilderbrand et al. 1999), isotopic analysis (Hobson et al. 2009, McKinney et al. 2009), availability analyses (Wallenius 1999, Rode et al. 2006a), and comparative studies on captive brown bears (Rode et al. 2006b, Rode et al. 2010) strongly indicate that lipid-poor terrestrial foods are calorically insufficient to sustain entire subpopulations over the long term (Rode et al. 2015a), but may occasionally supplement the diets of individual bears and sub-adults (Welch et al. 1997).

CONSERVATION ISSUES

Due to their tenuous habitat and previously unregulated commercial harvest, legislative protections have been necessary to ensure the survival of the polar bear. They are a protected species under the Marine Mammal Protection Act (MMPA) of 1972 along with cetaceans (whales, dolphins, porpoises), pinnipeds (seals, sea lions), and the marine mustelid (sea otter). MMPA protection does not prohibit traditional subsistence harvest by Alaska Native hunters. Since 2008, polar bears in the US Arctic have been listed as a threatened species under the Endangered Species Act (ESA) of 1973, primarily on the basis of future threat of sea-ice habitat decline. As a result of the observed and projected loss of sea-ice habitat due to global climate change, the polar bear is listed as vulnerable on the IUCN Red List of Threatened Species.

The most pressing concern regarding polar bears is sea-ice decline due to Arctic warming and the resulting habitat loss (US Fish and Wildlife Service 2008, 2015). Without stabilization of annual available sea-ice habitat, the CS and SBS populations will likely need to migrate to other, more stable ecoregions (Polar Basin Convergent, Archipelago), or risk severe reduction in numbers (Durner et al. 2009, Durner et al. 2011, Pagano et al. 2012, Atwood et al. 2015a, Ware et al. 2017).

Subsistence harvesting is a time-honored tradition—one that is protected by the MMPA. However, as the population of polar bears declines, so must the take of polar bears. Through agreements such as the Inuvialuit-Inupiat Agreement of 1988 (revised 2011) and the US-Russia Bilateral Agreement of 1988 (revised 2000), Native communities have expressed openness to regulating subsistence harvest to sustainable levels. However, implementation has proven difficult. Polar bear take also happens due to defense-of-life removals, which occur where the habitats for bears and humans overlap.

The discarded bowhead whale carcasses (bonepiles) left by Native subsistence hunting in Alaska, Canada, and Russia are a controversial food source for many CS and SBS bears (Rogers et al. 2015). While the availability of this food source is no doubt welcome to many struggling CS and SBS bears, there are accompanying concerns that warrant consideration. As polar bears increasingly rely on human settlements and activities for food, so too will human-bear interaction increase, potentially resulting in injury or death to humans or polar bears. With the aggregation of an otherwise solitary species, the threats of disease transmission and impact of an oil spill at a population level increase. In order to address some of these concerns, US Fish and Wildlife Service, in cooperation with Native organizations, has plans to remove or disperse bonepiles to reduce bear concentrations (i.e., minimize the risk of harmful impacts from disease transmission, oil spills) (US Fish and Wildlife Service 2016).

As oil-and-gas activity increases in the Arctic, the likelihood of a spill also increases. A large Arctic oil spill without proper prevention and response measures could heavily impact polar bear populations. Also, an increase in shipping, especially along the Northern Sea Route north of Russia, has been noted. It is unclear what impact this might have on CS and SBS bears.

MAPPING METHODS (MAPS 6.1a–6.1d)

Polar bear data are mapped on four seasonal maps, each of which shows polar bear marine habitat selection for the following seasons, as defined by Durner et al. (2009):

Winter: December through May;
Spring: June through July;
Summer: August through September, and;
Fall: October through November.

This analysis was completed by Audubon Alaska (2014) based on seasonal models presented in Durner et al. (2009). On the advice of George Durner, our team mapped polar bear sea-ice habitat selection by applying the seasonal resource selection coefficients presented in Durner et al. (2009) to the most recent five years of available sea-ice data (average sea-ice concentration data acquired as 15.5-mile (25 km) monthly grids from the National Snow and Ice Data Center (2014) for each month from October 2008 through September 2013). The models were run for each of the 60 months; then monthly results were grouped by season, averaged into the four seasonal layers representing mean habitat selection value, and clipped to the maximum extent of sea-ice extent (15% ice concentration or greater) for each season over the 5-year period.

The mapped polar bear range was aggregated by Audubon Alaska based on information provided in several sources: Amstrup et al. (2005), Bromaghin et al. (2015), Durner et al. (2010), Kochnev et al. (2003), National Oceanic and Atmospheric Administration (1988), Rode et al. (2015a, b), US Fish and Wildlife Service (1995), and Community Conservation Plans developed for six communities in the Inuvialuit Settlement Region of Canada (Aklavik, Inuvik, Olokhaktomiut, Paulatuk, Sachs Harbour, and Tuktoyaktuk) in 2008 (Community of Aklavik et al. 2008, Community of Inuvik et al. 2008, Community of Olokhaktomiut et al. 2008, Community of Paulatuk et al. 2008, Community of Sachs Harbour et al. 2008, Community of Tuktoyaktuk et al. 2008).

Annual subpopulation core areas were analyzed by Amstrup et al. (2005), based on positions of radio-collared female polar bears captured over 18 years in coastal areas of the Chukchi and Beaufort Seas near northern Alaska and northwestern Canada.

Denning information is shown on the fall and winter maps, when denning occurs. Denning range data were aggregated by Audubon Alaska based on several sources including Durner et al. (2010), Fischbach et al. (2007), National Oceanic and Atmospheric Administration (1988), Olson et al. (2017), Rode et al. (2015a), US Fish and Wildlife Service (1995), and Community Conservation Plans for the Inuvialuit Settlement Region. The denning concentration area was delineated in National Oceanic and Atmospheric Administration (1988). More recent studies of den locations along the Beaufort Sea coast indicate that there has been a major shift in the distribution of dens in this region, with more now occurring on land than on sea ice; these studies further support the National Oceanic and Atmospheric Administration (1988) identification of the Beaufort coast as an important denning area.

Bonepiles, a food source for some polar bears during the spring and/or fall whaling seasons, are indicated in Dutton et al. (2011) and Schliebe et al. (2008) and are shown on the applicable spring and fall maps. As of 2012, the bonepile at Barrow is no longer in use (T. Atwood pers. comm.).

Sea-ice data on this map include polynyas and approximate median monthly sea-ice extent. The polynya data were compiled from Carmack and MacDonald (2002), Stringer and Groves (1991), and an analysis of the average 1993–1994 extent of recurring leads in the Beaufort and

Chukchi Seas conducted by Audubon Alaska (2009a) and based on data in Eicken et al. (2005). The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016).

Data Quality

Data quality is variable across the map. There is an extensive history of radio and satellite tracking of polar bears, especially in Amundsen Gulf, along Alaska's Beaufort Sea coast and along Alaska's Chukchi Sea coast. Habitat utilization information and data layers for these regions exist from previous studies, for example Amstrup et al. (2006), Durner et al. (2009). US Fish and Wildlife Service and US Geological Survey are also conducting new satellite tracking studies on bears along the Chukchi and Beaufort coasts of Alaska (e.g. http://alaska.usgs.gov/science/biology/polar_bears/tracking.html). Such studies are directly applicable to adult females, but not males, as male polar bears do not retain collars because their necks are bigger than their heads. Russian areas of the map are lacking information from telemetry or mark-recapture studies altogether.

Reviewers

- Todd Atwood
- Ryan Wilson

MAP DATA SOURCES

Marine Habitat Selection (Seasonal): Audubon Alaska (2014) based on Durner et al. (2009)

Extent of Range: Audubon Alaska (2016l) based on Amstrup et al. (2005), Bromaghin et al. (2015), Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Kochnev et al. (2003), National Oceanic and Atmospheric Administration (1988), Rode et al. (2015a, b), and US Fish and Wildlife Service (1995)

Subpopulation Core Areas (Annual): Amstrup et al. (2005)

Denning Range: Audubon Alaska (2016k) based on Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Fischbach et al. (2007), National Oceanic and Atmospheric Administration (1988), Olson et al. (2017), Rode et al. (2015a), and US Fish and Wildlife Service (1995)

Denning Concentration: Fischbach et al. (2007); National Oceanic and Atmospheric Administration (1988); Olson et al. (2017)

Bonepile Locations: Dutton et al. (2011); Schliebe et al. (2008); T. Atwood (pers. comm.)

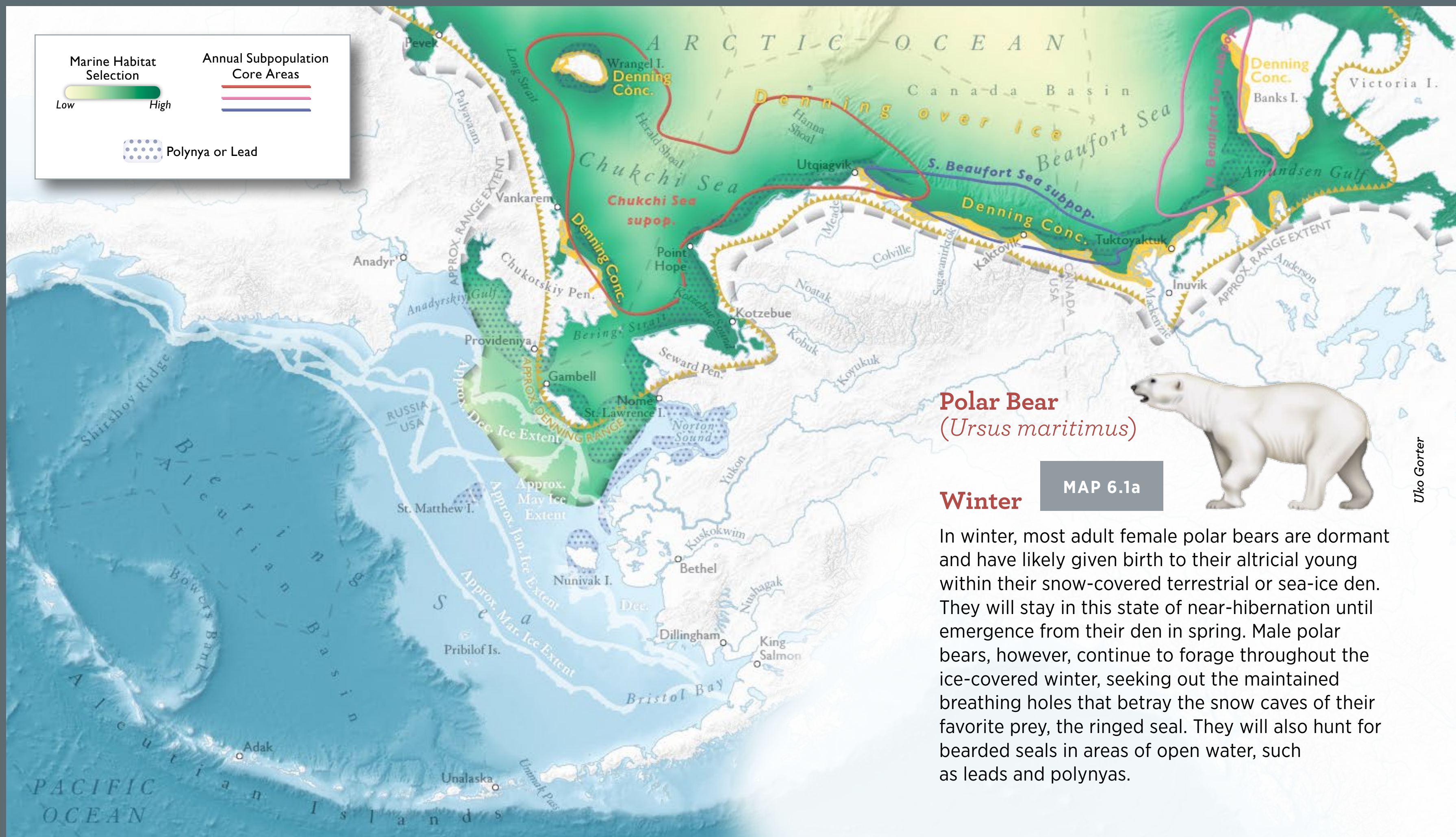
Polynyas: Audubon Alaska (2009a) based on Eicken et al. (2005); Carmack and MacDonald (2002); Stringer and Groves (1991)

Sea Ice Extent: Audubon Alaska (2016j) based on Fetterer et al. (2016)

Patrick Kelley / USCG

Polar Bear

Map Authors: Melanie Smith, Erika Knight, and Max Goldman
Cartographer: Daniel P. Huffman



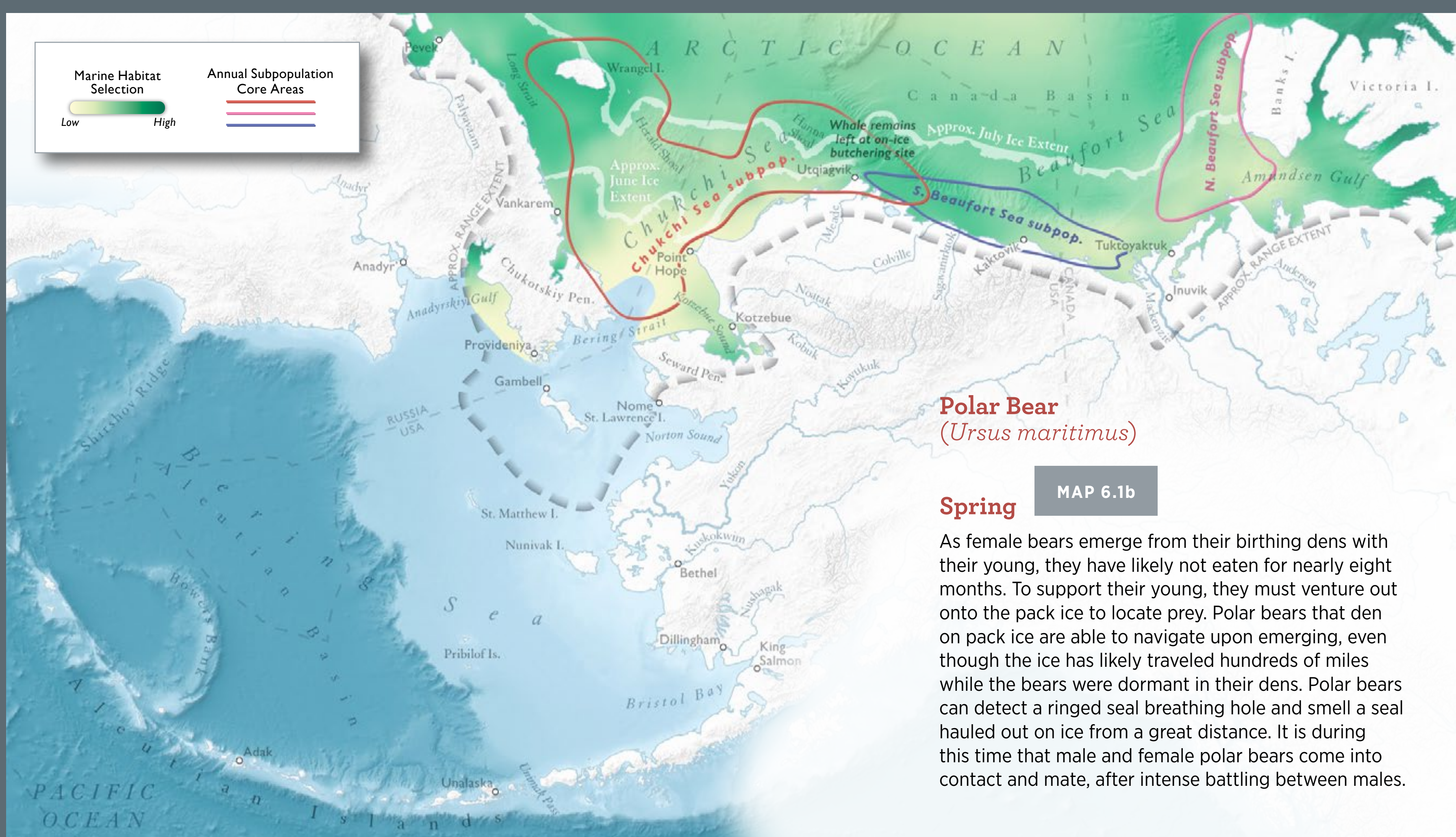
Polar Bear
(Ursus maritimus)

MAP 6.1a

Winter

In winter, most adult female polar bears are dormant and have likely given birth to their altricial young within their snow-covered terrestrial or sea-ice den. They will stay in this state of near-hibernation until emergence from their den in spring. Male polar bears, however, continue to forage throughout the ice-covered winter, seeking out the maintained breathing holes that betray the snow caves of their favorite prey, the ringed seal. They will also hunt for bearded seals in areas of open water, such as leads and polynyas.

Amstrup et al. (2005); Audubon Alaska (2009a) [based on Eicken et al. (2005); Carmack and MacDonald (2002)]; Audubon Alaska (2014) [based on Durner et al. (2009)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016k) [based on Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Fischbach et al. (2007), National Oceanic and Atmospheric Administration (1988), Olson et al. (2017), Rode et al. (2015a), and US Fish and Wildlife Service (1995)]; Audubon Alaska (2016l) [based on Amstrup et al. (2005), Bromaghin et al. (2015), Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Kochnev et al. (2003), National Oceanic and Atmospheric Administration (1988), Rode et al. (2015a, b), and US Fish and Wildlife Service (1995)]; Dutton et al. (2011); Fischbach et al. (2007); National Oceanic and Atmospheric Administration (1988); Olson et al. (2017); Schliebe et al. (2008); Stringer and Groves (1991); T. Atwood (pers. comm.)



Polar Bear
(Ursus maritimus)

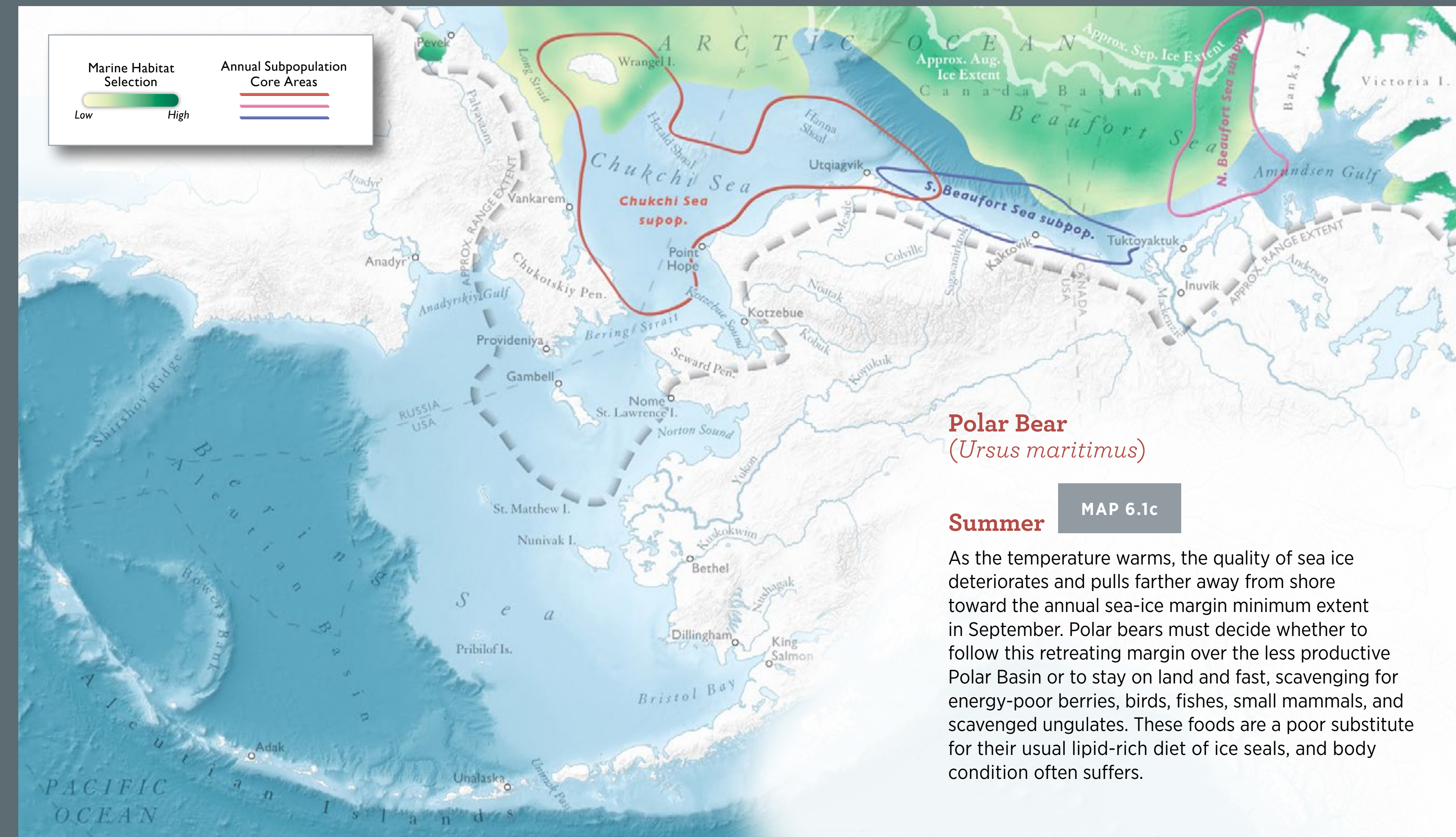
MAP 6.1b

Spring

As female bears emerge from their birthing dens with their young, they have likely not eaten for nearly eight months. To support their young, they must venture out onto the pack ice to locate prey. Polar bears that den on pack ice are able to navigate upon emerging, even though the ice has likely traveled hundreds of miles while the bears were dormant in their dens. Polar bears can detect a ringed seal breathing hole and smell a seal hauled out on ice from a great distance. It is during this time that male and female polar bears come into contact and mate, after intense battling between males.

Amstrup et al. (2005); Audubon Alaska (2009a) [based on Eicken et al. (2005); Carmack and MacDonald (2002)]; Audubon Alaska (2014) [based on Durner et al. (2009)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016k) [based on Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Fischbach et al. (2007), National Oceanic and Atmospheric Administration (1988), Olson et al. (2017), Rode et al. (2015a), and US Fish and Wildlife Service (1995)]; Audubon Alaska (2016l) [based on Amstrup et al. (2005), Bromaghin et al. (2015), Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Kochnev et al. (2003), National Oceanic and Atmospheric Administration (1988), Rode et al. (2015a, b), and US Fish and Wildlife Service (1995)]; Dutton et al. (2011); Fischbach et al. (2007); National Oceanic and Atmospheric Administration (1988); Olson et al. (2017); Schliebe et al. (2008); Stringer and Groves (1991); T. Atwood (pers. comm.)

Audubon ALASKA



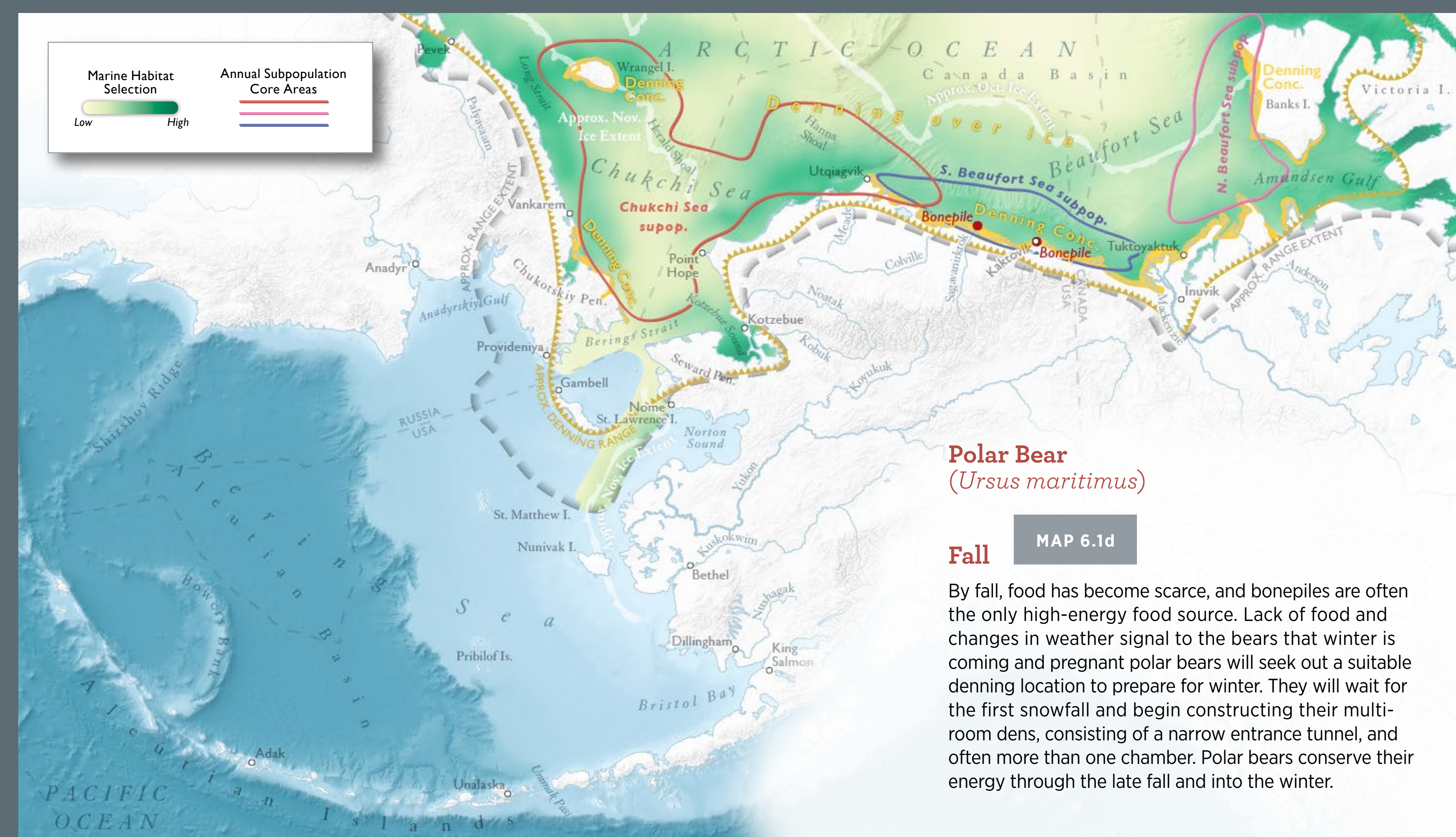
Polar Bear
(Ursus maritimus)

MAP 6.1c

Summer

As the temperature warms, the quality of sea ice deteriorates and pulls farther away from shore toward the annual sea-ice margin minimum extent in September. Polar bears must decide whether to follow this retreating margin over the less productive Polar Basin or to stay on land and fast, scavenging for energy-poor berries, birds, fishes, small mammals, and scavenged ungulates. These foods are a poor substitute for their usual lipid-rich diet of ice seals, and body condition often suffers.

Amstrup et al. (2005); Audubon Alaska (2009a) [based on Eicken et al. (2005); Carmack and MacDonald (2002)]; Audubon Alaska (2014) [based on Durner et al. (2009)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016k) [based on Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Fischbach et al. (2007), National Oceanic and Atmospheric Administration (1988), Olson et al. (2017), Rode et al. (2015a), and US Fish and Wildlife Service (1995)]; Audubon Alaska (2016l) [based on Amstrup et al. (2005), Bromaghin et al. (2015), Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Kochnev et al. (2003), National Oceanic and Atmospheric Administration (1988), Rode et al. (2015a, b), and US Fish and Wildlife Service (1995)]; Dutton et al. (2011); Fischbach et al. (2007); National Oceanic and Atmospheric Administration (1988); Olson et al. (2017); Schliebe et al. (2008); Stringer and Groves (1991); T. Atwood (pers. comm.)



Polar Bear
(Ursus maritimus)

MAP 6.1d

Fall

By fall, food has become scarce, and bonepiles are often the only high-energy food source. Lack of food and changes in weather signal to the bears that winter is coming and pregnant polar bears will seek out a suitable denning location to prepare for winter. They will wait for the first snowfall and begin constructing their multi-room dens, consisting of a narrow entrance tunnel, and often more than one chamber. Polar bears conserve their energy through the late fall and into the winter.

Amstrup et al. (2005); Audubon Alaska (2009a) [based on Eicken et al. (2005); Carmack and MacDonald (2002)]; Audubon Alaska (2014) [based on Durner et al. (2009)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016k) [based on Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Fischbach et al. (2007), National Oceanic and Atmospheric Administration (1988), Olson et al. (2017), Rode et al. (2015a), and US Fish and Wildlife Service (1995)]; Audubon Alaska (2016l) [based on Amstrup et al. (2005), Bromaghin et al. (2015), Community of Aklavik et al. (2008), Community of Inuvik et al. (2008), Community of Olokhaktomiut et al. (2008), Community of Paulatuk et al. (2008), Community of Sachs Harbour et al. (2008), Community of Tuktoyaktuk et al. (2008), Durner et al. (2010), Kochnev et al. (2003), National Oceanic and Atmospheric Administration (1988), Rode et al. (2015a, b), and US Fish and Wildlife Service (1995)]; Dutton et al. (2011); Fischbach et al. (2007); National Oceanic and Atmospheric Administration (1988); Olson et al. (2017); Schliebe et al. (2008); Stringer and Groves (1991); T. Atwood (pers. comm.)

Pacific Walrus

Odobenus rosmarus divergens

Max Goldman and Erika Knight

The walrus (*Odobenus rosmarus*) is the largest of all pagophilic (strong preference for ice) pinnipeds and is the only extant representative of the family *Odobenidae*, which evolved in the North Pacific Ocean over 50 million years ago in the late Miocene and early Pliocene (Kohno 2006, Harington 2008). They dispersed throughout the Arctic Ocean and North Atlantic between 10,000 and 2.5 million years ago (Harington and Beard 1991, Dyke et al. 1999, Harington 2008).

Two subspecies of walruses are recognized: the Atlantic (*O. r. rosmarus*) and Pacific (*O. r. divergens*) (Fay 1982, Wozencraft 2005). A third subspecies, the Laptev (*O. r. laptevi*) is sometimes recognized. They are morphologically similar to the Pacific walrus, and generally considered to be the same subspecies. The Atlantic walrus is substantially smaller and has shorter tusks (Fay 1982).

Walruses are social and gregarious animals. They travel together in groups, hauling out to rest on ice or land in dense groups. Walruses are known to pack together in close physical contact with each other, likely for warmth and to protect their young from predators, such as the polar bear (*Ursus maritimus*) (Fay 1985). The young will often lie on top of adult walruses in groups that can range in size from a few individuals to several thousand animals (Gilbert 1999, Kastelein 2009, Jefferson et al. 2011). When disturbed, stampedes from a haulout can result in injuries and mortalities due to trampling. Calves and young animals are particularly vulnerable to trampling injuries and death.

The Pacific walrus is geographically isolated and ecologically distinct from other walrus populations in the Arctic. Pacific walruses primarily feed on mollusks and marine worms across vast offshore areas of the shallow continental shelf waters of the northern Bering and Chukchi Seas (Fay 1982). The species generally occurs in waters less than 328 feet (100 m) deep, feeding in areas of soft sediments with productive benthic resources, and moving with the ever-changing, extremely productive sea-ice edge. The Pacific walrus tends to occupy first-year ice, favoring areas with broken pack ice, leads, and polynyas (US Fish and Wildlife Service 2002, 2014).

TABLE 6.2-1. Estimates of Pacific walrus population size, 1975–2006.

Year	Population size *	Reference
1975	214,687	Udevitz et al. (2001)
1980	250,000–290,000	Johnson et al. (1982), Fedoseev (1984)
1985	242,366	Udevitz et al. (2001)
1990	201,039	Gilbert et al. (1992)
2006	129,000 (55,000–507,000)	Speckman et al. (2010)

*Due to differences in methods, comparisons of estimates across years (population trends) are subject to several caveats and are not reliable. The 2006 survey was the only one that allowed for a measure of precision (95% confidence interval) (Taylor and Udevitz 2015)

The Pacific walrus population was estimated at over 200,000 animals in both 1985 and 1990 (Gilbert 1989, 1992). However, characteristics of walrus behavior and difficulties associated with conducting surveys resulted in unreliable estimates (Gilbert 1999). Due to these challenges, the current population size is unknown (US Fish and Wildlife Service 2002, 2014). As recently as 1960, the Pacific walrus population was estimated at less than 100,000 individuals due to commercial harvest (Fay 1982).

Historical commercial harvest records indicate that Pacific walruses were hunted along the southern coast of Russia in the Sea of Okhotsk, Unimak Pass, and the Shumigan Islands of Alaska beginning during the 17th century (Elliott 1882). Harvest continued until a moratorium was imposed on commercial walrus harvests in 1972 in the US. Commercial harvests in Russia ended in 1990. Walruses have long been, and continue to be, a subsistence food for Native communities in the Arctic.

Ryan Kingsbery / USGS

Brad Benter / USFWS

Walruses utilize ice floes as platforms for resting and for breeding, with groups of females hauling out together on ice floes as groups of males compete for their attention.

ADAPTATIONS

The word "walrus" began as the Danish word *hvalros*, meaning "sea horse." Walruses use broken annual pack ice as a platform for resting between benthic foraging trips, birthing, and nursing (US Fish and Wildlife Service 2002, Simpkins et al. 2003, Laidre et al. 2008, Minerals Management Service 2010).

They are sexually dimorphic with adult males weighing up to 4,400 pounds (2,000 kg) and measuring 7–12 feet (2.1–3.6 m) long (most between 1,800 and 3,700 pounds [820 and 1680 kg]). Females can weigh up to 2,400 pounds (1,100 kg), generally weighing around 1,800 pounds (820 kg), or two-thirds of a male's size (Fay 1982). Adult walruses annually molt their short, brown pelage during the summer months (Fay 1982). Walruses spend nearly two-thirds of their time in water (Fay 1982). They are capable of diving to depths of more than 820 feet (250 m) (Born et al. 2005). Male walruses regularly forage for extended periods, even up to six days, without hauling out to rest by inflating a pouch on their necks with air, allowing them to rest at the surface (Fay 1960, Jay et al. 2011).

Tusks

Walrus tusks are used as offensive and defensive weapons (Kastelein and Gerrits 1990, Kastelein 2009). Adult male walruses use their tusks to display to other males, establishing dominance during mating (Fay et al. 1984). Both male and female walruses use their tusks to establish and defend positions on land or ice haulouts (Fay 1982). Walruses also use their tusks to anchor themselves to ice floes when resting in the water during inclement weather (Fay 1982, Kastelein 2009). The generic name *Odobenus* (tooth walker) is based on observations of walruses using their tusks to pull themselves out of the water. They may also use their tusks to assist in climbing steep slopes.

Surrounding the tusks is a mat of stiff whiskers called mystacial vibrissae. The vibrissae are an extremely sensitive organ, supplied by blood and nerves, and are used by walruses to locate prey while foraging. They are often worn down to lengths much shorter than their full length of 12 inches (30 cm) (Kastelein et al. 1990, Kastelein and Gerrits 1990).

DISTRIBUTION

In winter, the entire Pacific walrus population concentrates in the Bering Sea to breed, where sea-ice conditions are most favorable for them (US Fish and Wildlife Service 2002). While the exact areas in which walruses congregate in winter to breed vary according to the location and extent of annual sea-ice margins, they are generally found near St. Lawrence Island, Nunivak Island, and in the Gulf of Anadyr (Fay 1982, Mymrin et al. 1990, Burn et al. 2009, Speckman et al. 2011).

In spring, sea ice in the Bering Sea begins to retreat northward, and female and juvenile Pacific walruses move with it, through the Bering Strait and into the productive waters over the continental shelf in the Chukchi Sea. In summer, they concentrate mainly in the northwestern and northeastern Chukchi Sea, along the edge of the ice (Fay 1982, Jay et al. 2012a). Adult male walruses will stay behind as the females and young move north, opting instead to spend the warmer months feeding near the coastal haulouts in the Gulf of Anadyr and Bristol Bay.

In September, when the annual sea-ice margin is at its minimum extent and recedes out over deep, Arctic basin waters, walruses congregate in large numbers at terrestrial haulouts on Wrangel Island, along the northern coast of the Chukotka Peninsula, and increasingly along the Chukchi coast in Alaska, especially near Point Lay (Fay 1982, Belikov et al. 1996, Kochnev 2004, Kavry et al. 2008, Huntington et al. 2012, National Oceanic and Atmospheric Administration 2014). In late September and October, walruses that spent the summer in the Chukchi Sea typically begin moving south in advance of the developing sea ice. Large herds of southbound migrants often congregate for short times to rest at coastal haulout sites in the southern Chukchi Sea along the Russian coast (Fay and Kelly 1980).

Sea-Ice Habitat

Pacific walruses use ice floes to breed, calve, haul out to rest, and as refugia from predators such as killer whales (Fay 1982, Simpkins et al. 2003). Haulouts are an integral component of walrus energy management, allowing them to rest between foraging bouts. Because sea ice is a critical component of their habitat, females and juveniles follow the ice margins as they advance and retreat throughout the year, staying near the ideal thickness and coverage for feeding and hauling out. Walruses prefer ice floes, leads, polynyas, and areas with thinner ice in which they can easily create breathing holes. Conversely, they avoid areas with high concentrations of thick and consolidated pack ice, such as in the Chukchi Sea in winter (Burns et al. 1981, Fay 1982).

LIFE CYCLE

Pacific walruses are identified and managed as a single panmictic (unstructured, random-mating) population (US Fish and Wildlife Service 2014). They ensure their social standing through a series of confrontations decided by body size, tusk size, and aggressiveness. As the individuals that compose a group are constantly changing, they must continually reaffirm their social status with each new group, or group member (Fay 1982).

Leks

Pacific walruses mate primarily in January and February in the Bering Sea. Leks (gatherings of males for the purpose of competing for the attention of nearby females) are formed in the water alongside groups of females hauled out on sea ice. The competition to mate includes vocalizations and visual displays among the dominant males. Subdominant males keep to the edges of the gathering and do not display. When appropriate, a single female will join a male in the water to copulate (Fay et al. 1984). During this time, adult males forage very little (Fay 1982, Fay et al. 1984, Sjare and Stirling 1996, North Atlantic Marine Mammal Commission 2004, Ray et al. 2006)

Calving

Most calving occurs in April–June (following a 15- to 16-month pregnancy), and mothers give birth, care for, and nurse their newborn calves on the ice (Fay 1985). Walrus calves remain with their mothers for at least two years (Fay 1982). Walruses experience much lower rates of mortality among calves than other pinniped species (Fay et al. 1989, Chivers 1999). Calves nurse exclusively into their second year when they are gradually weaned and taught to forage (Fay 1982, Fisher and Stewart 1997). Calves can nurse while in the water after about 14 days.

Diet

Walruses consume a broad diet consisting mostly of benthic invertebrates, such as clams, small crustaceans, snails, and polychaete worms, although fishes and other vertebrates are also occasionally reported including marine birds and seals (Fay 1982, Bowen and Siniff 1999, Dehn et al. 2007, Sheffield and Grebmeier 2009). Walruses require approximately 60–180 pounds (25–70 kg) of food per day and utilize over 100 taxa as potential sources, although clams typically make up over 90% of stomach contents (Fay 1982).

Walruses root with their muzzles in the bottom sediment of waters 300 feet (100 m) deep or less and use their whiskers to locate prey items (Fay and Burns 1988, Kovacs and Lydersen 2008). They use their fore-flippers, noses, and jets of water to extract prey buried up to 12 inches (30 cm) deep (Fay 1982, Levermann et al. 2003, Kastelein 2009). Walruses typically swallow invertebrates without shells in their entirety (Fay 1982). They remove the soft parts of mollusks from their shells by suction and discard the shells (Fay 1982). The foraging behavior of walruses can have a major impact on benthic communities in the Bering and Chukchi Seas, as walrus bioturbation disturbs benthic substrates and impacts benthic structure, nutrient flux, and benthic species composition (Klaus et al. 1990, Ray et al. 2006).

CONSERVATION ISSUES

In 2008, the US Fish and Wildlife Service received a petition filed by the Center for Biological Diversity to list the Pacific walrus under the Endangered Species Act (ESA), citing global warming as a primary concern. As the climate in the Arctic continues to warm and summer sea-ice margins retreat further from the continental shelf, walruses have begun to haulout on land, sometimes prompting longer foraging trips, increasing the likelihood for anthropogenic disturbance, and attracting predators (Tynan and DeMaster 1997, Kelly 2001, Jay and Fischbach 2008, Laidre et al. 2008, Moore and Huntington 2008). In 2011, the US Fish and Wildlife Service found that listing walruses under the ESA was warranted but precluded by higher priority listing actions. That finding resulted in walruses being added to the list of candidate species. A

Bill Hickey / USFWS

Pacific walruses are highly social animals, with intricate herd and subherd social structures and status hierarchies.

final determination of their status under the ESA is due in 2017. Pacific walruses are also protected from take and harassment by the Marine Mammal Protection Act (MMPA) of 1972. Harassment is defined very broadly by the MMPA, and includes any alteration of an animal's behavior.

Many factors determine the health and potential risks affecting the Pacific walrus population. Global climate change continues to severely deplete the sea-ice habitat Pacific walruses use for some important behaviors (Jay et al. 2011), leaving an uncertain future for this species. Increasingly, walruses are utilizing land-based haulouts in late summer when Chukchi Sea ice has receded away from the continental shelf. This puts walruses in the position of potentially depleting nearshore forage resources or making long, foraging trips to areas such as Hanna Shoal (Jay et al. 2012a, Jay et al. 2012b). Other potential stressors, such as impacts to prey species, calf/juvenile mortality, and disease/parasitism/predation rates are also likely to be influenced by environmental changes associated with a warming climate driven by greenhouse gas emissions. An increase in summer shipping due to decreasing sea ice may affect walruses through ship strikes, noise, or spills of freight or fuel. Anthropogenic disturbance at land-based haulouts has resulted in the trampling deaths of thousands of walruses (Jay and Fischbach 2008, Fischbach et al. 2009), but management and protection programs have reduced this threat.

Finally, the Pacific walrus is harvested by Alaskan and Russian Native communities. Harvest levels have been declining since 1990, and the lowest levels on record in the US have occurred in 2013–2016. According to US Fish and Wildlife Service, a total average harvest of 3,960 animals occurred during 2010–2014. Currently, the harvest in Alaska is co-managed by US Fish and Wildlife Service and the Alaska Eskimo Walrus Commission.

Walrus migration information, provided by the Savoonga Tribal Council

Savoonga walrus experts have provided a description of three observed walrus migrations, below. These descriptions include the St. Lawrence Island Yupik terms for the migrations and the characteristics of the migrations, such as timing and relation to ice conditions.

Qavreq
The qavreq migration takes place in spring. It consists of concentrations of walruses headed west. Walrus move in this direction because there is usually thicker ice to the west of St. Lawrence Island in the spring. Bull walrus prefer that ice and can swim against strong currents to it. The walrus have some way of knowing that thicker ice is out there.

Anleghaq
The anleghaq migration takes place in late summer. This is when walruses start to come south in late summer to wait on the ice pack, or where there is food for them. This migration begins in late August and continues until winter sets in.

Ayughaayak
The ayughaayak migration no longer happens because of changed ice conditions near St. Lawrence Island. This migration took place in the spring. Walruses would concentrate on the ice between Gambell and Savoonga in mid to late June. This was a concentration of mainly male walruses.

MAPPING METHODS (MAPS 6.2a–6.2b)

Walrus data are shown on two seasonal maps: one for winter and spring, the other for summer and fall. The maps show the seasonal distribution of walruses throughout the project area, with distribution data categorized into four intensities: extent of range, regular use, concentration, and high concentration.

Walrus range data were digitized from US Fish and Wildlife Service (2014) for both the winter/spring and summer/fall timeframes. The US Fish and Wildlife Service (2014) summer/fall range data were merged with additional range data provided in Audubon Alaska and Oceana (2016), Fischbach et al. (2016), Jay et al. (2012a), and National Oceanic and Atmospheric Administration (1988) by Audubon Alaska (2016o).

The summer/fall regular-use areas in the Chukchi Sea represent the 95% monthly occupancy contours analyzed by Jay et al. (2012a), which were merged across all months (June–November) by Audubon Alaska. In the Bering Sea, summer/fall regular use is shown in US Fish and Wildlife Service (2014). This regular-use area was extended toward St. Matthew Island based on data from a February 2017 workshop with Bering Strait region traditional knowledge experts who reviewed Audubon Alaska's draft walrus maps (Audubon Alaska et al. 2017). The winter/spring regular-use area was combined from Audubon Alaska et al. (2017), Fay and Fedoseev (1984), National Oceanic and Atmospheric Administration (1988), and US Fish and Wildlife Service (2014) by Audubon Alaska (2017d).

Summer/fall concentration areas are shown based on data from three primary sources: Audubon Alaska and Oceana (2016), Jay et al. (2012a), and Oceana and Kawerak (2014). The summer/fall concentration areas from Jay et al. (2012a) represent the merged 50% monthly feeding contours June–November and are labeled as feeding areas. The Audubon Alaska and Oceana (2016) data represent 50% contours (July–October) of data from 2000 through 2014 from the Aerial Survey of Arctic Marine Mammals (ASAMM) (National Oceanic and Atmospheric Administration 2015a). The ASAMM data (formerly Bowhead Whale Aerial Survey Project [BWASP]) were analyzed in consultation with Megan Ferguson and Janet Clarke. Aerial survey methods, data, and metadata for the ASAMM database are available at: http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php. The Audubon Alaska and Oceana analysis used only on-transect data where there were more than 62 miles (100 km) of survey effort in a 12.4-mile x 12.4-mile (20-km by 20-km) grid cell. An observation rate (i.e. relative density) was calculated in each grid cell by dividing the observed number of animals over all years by the measure of total transect length over all years. This observation rate was converted into point data with one point per grid cell (at the centroid), and a kernel density function was run with an anisotropic kernel density function with a 24.8-mile (40-km) north-south search radius and a 49.6-mile (80 km) east-west search radius to smooth the data. The summer/fall concentration areas from Oceana and Kawerak (2014) represent merged concentration polygons specific to the summer and fall seasons; some of these polygons were based on data from National Oceanic and Atmospheric Administration (1988). These polygons were reviewed and modified by Bering Strait region traditional knowledge experts at the February 2017 workshop (Audubon Alaska et al. 2017), and represent areas where people reported regularly seeing groups of walruses in above-average densities.

Similarly, much of the mapped winter/spring concentration data were provided by Kawerak, Inc. (Oceana and Kawerak 2014) as winter- and spring-specific polygons. We merged these season-specific data and the merged polygons were updated based on traditional knowledge from the February Audubon Alaska et al. (2017) workshop. Outside the Bering Strait region, these data were supplemented with data from Fay (1982), Krupnik and Ray (2007), and National Oceanic and Atmospheric Administration (1988). The Krupnik and Ray (2007) and National Oceanic and Atmospheric Administration (1988) winter/spring concentration polygons represent areas where walruses congregate to breed.

The winter/spring and summer/fall high-concentration areas from Oceana and Kawerak (2014), updated based on Audubon Alaska et al. (2017), represent places where walruses were observed in higher densities than in concentration areas, in a particular spot by the dozens, or in a general broad area by the hundreds to thousands. The winter/spring high-concentration area near St. Lawrence Island was identified by Oceana and Kawerak (2014) and Audubon Alaska et al. (2017) as a breeding area and is labeled as such. A winter/spring high concentration area from Noongwook et al. (2007) is incorporated within the Oceana and Kawerak (2014) data. The summer/fall high-concentration areas also incorporate 20% monthly feeding contours

(June–November) from Jay et al. (2012a) and 25% contours (July–October) from Audubon Alaska and Oceana (2016).

The Walrus Islands State Game Sanctuary boundary was produced by Alaska Department of Fish and Game (2016a). The Hanna Shoal Walrus Use Area boundary was provided by US Fish and Wildlife Service (2013).

Haulouts shown on the maps were provided from two sources: 1) Kawerak's 2013 Ice Seal and Walrus Project (Kawerak 2013), and 2) a database compiled by the US Geological Survey in cooperation with the Russian Academy of Sciences and Chukot-TINRO (Fischbach et al. 2016). The latter database incorporates recorded haulout locations from a variety of sources including published reports, state records, and local and traditional knowledge.

Movement information was drawn by Audubon Alaska based on walrus tracking animations from US Geological Survey (US Geological Survey 2016) and personal communication with US Geological Survey biologist Tony Fischbach.

The sea-ice data shown on this map approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See Sea Ice Mapping Methods section for details.

Data Quality

Walrus range, regularly occurring areas, and haulout location information is generally consistent across the project area. Data quality of concentration, high concentration, and activity data varies among regions.

The mapped summer/fall concentration and high-concentration areas from Jay et al. (2012a) and Audubon Alaska and Oceana (2016) were generated from analyses of satellite telemetry data and aerial survey data, respectively. The Jay et al. (2012a) data were generated through a utilization distribution analysis of walrus satellite telemetry data collected from 2008 to 2011 and are specific to female walruses tagged in the Bering Strait, on the north coast of Chukotka, and the northwest coast of Alaska. The Audubon Alaska and Oceana (2016) data, meanwhile, are based only on those animals that were visible from the air at the time of the survey. The Oceana and Kawerak (2014) winter/spring and summer/fall concentration and high-concentration areas were generated through interviews with traditional ecological knowledge experts from nine Bering Strait indigenous communities, and were reviewed and updated by Bering Strait region traditional knowledge experts at the February 2017 workshop (Audubon Alaska et al. 2017). The western biological science and traditional ecological knowledge data were thus collected using different methodologies, and the types of information and concepts embodied in the visual representations of "concentrations" are not necessarily the same. Information regarding concentration and high-concentration areas is lacking across the remainder of the map area.

Feeding and breeding high-concentration areas are labeled where this information is known. This labeling is not intended to indicate that these are the only portions of the project area where these activities occur; additional feeding and breeding high-concentration areas may be present in regions where such information was not available as of our publication date.

Reviewers

- Bering Strait Traditional Knowledge-Holder Map Review Workshop participants
- Jim MacCracken
- Jonathan Snyder

MAP DATA SOURCES

SUMMER/FALL MAP

Extent (Summer/Fall): Audubon Alaska (2016o) based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2017), Fischbach et al. (2016), Jay et al. (2012a), National Oceanic and Atmospheric Administration (1988), Oceana and Kawerak (2014), and US Fish and Wildlife Service (2014)

Extent (Winter/Spring): Audubon Alaska (2016p) based on National Oceanic and Atmospheric Administration (1988) and US Fish and Wildlife Service (2014)

Regular Use (Summer/Fall): Audubon Alaska et al. (2017); Jay et al. (2012a); US Fish and Wildlife Service (2014)

Concentration (Summer/Fall): Audubon Alaska et al. (2017); Audubon Alaska and Oceana (2016); Jay et al. (2012a); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014)

High Concentration (Summer/Fall): Audubon Alaska et al. (2017); Audubon Alaska and Oceana (2016); Jay et al. (2012a); Oceana and Kawerak (2014)

Feeding: Jay et al. (2012a)

Walrus Islands State Game Sanctuary: Alaska Department of Fish and Game (2016a)

Hanna Shoal Walrus Use Area: US Fish and Wildlife Service (2013)

Haulouts: Fischbach et al. (2016); Kawerak (2013)

Movement & Feeding Corridors: A. Fischbach (pers. comm.); US Geological Survey (2016)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

WINTER/SPRING MAP

Extent (Winter/Spring): Audubon Alaska (2016p) based on National Oceanic and Atmospheric Administration (1988) and US Fish and Wildlife Service (2014)

Extent (Summer/Fall): Audubon Alaska (2016o) based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2017), Fischbach et al. (2016), Jay et al. (2012a), National Oceanic and Atmospheric Administration (1988), Oceana and Kawerak (2014), and US Fish and Wildlife Service (2014)

Regular Use (Winter/Spring): Audubon Alaska (2017d) based on Audubon Alaska et al. (2017), Fay and Fedoseev (1984), National Oceanic and Atmospheric Administration (1988), and US Fish and Wildlife Service (2014); Audubon Alaska et al. (2017); US Fish and Wildlife Service (2014)

Concentration (Winter/Spring): Audubon Alaska et al. (2017); Fay (1982); Krupnik and Ray (2007); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014)

High Concentration (Winter/Spring): Audubon Alaska et al. (2017); Noongwook et al. (2007); Oceana and Kawerak (2014)

Breeding: Audubon Alaska et al. (2017); Krupnik and Ray (2007); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014); US Fish and Wildlife Service (2014)

Walrus Islands State Game Sanctuary: Alaska Department of Fish and Game (2016a)

Haulouts: Fischbach et al. (2016); Kawerak (2013)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

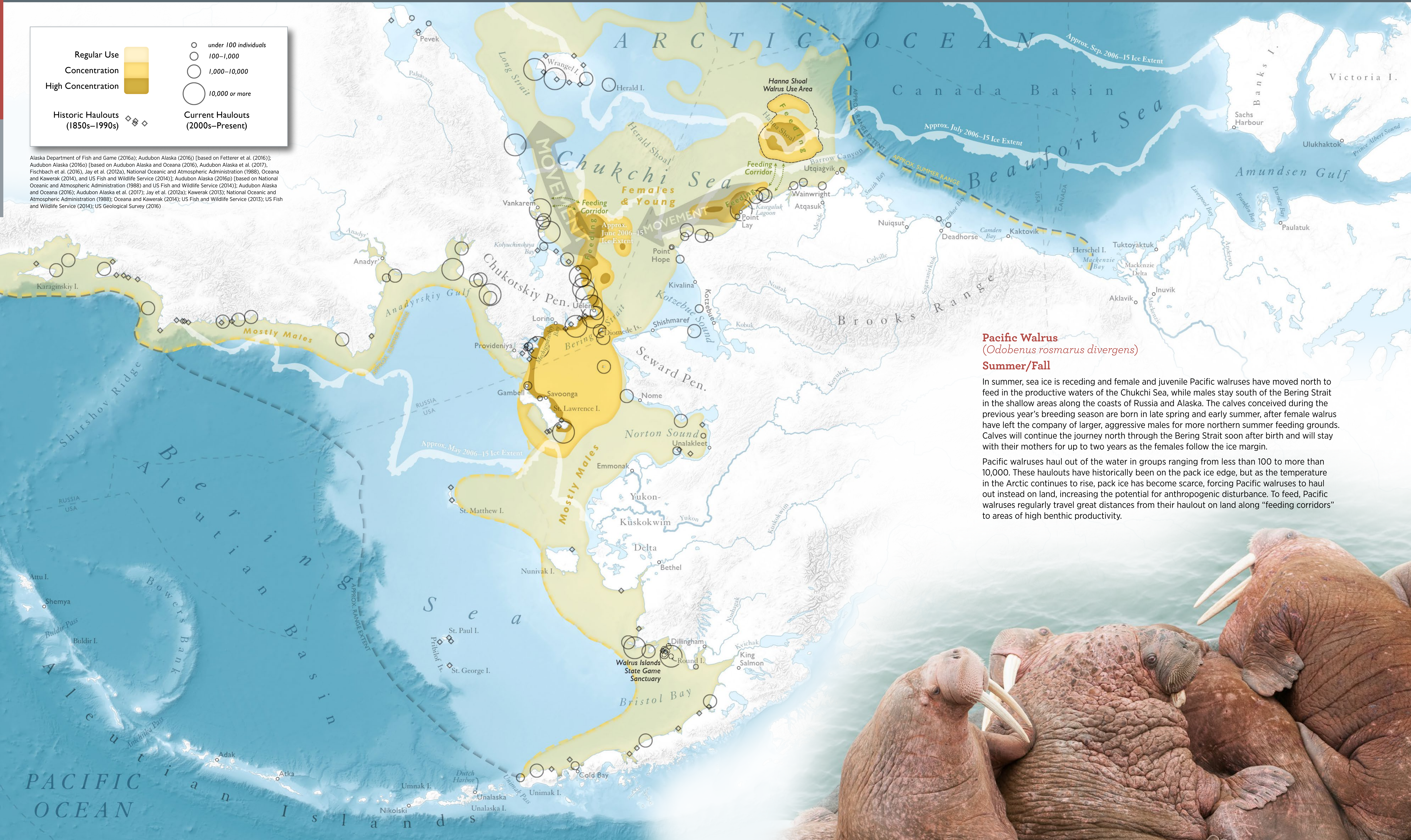
Pacific walruses haul out in groups often numbering more than 10,000 individuals. As temperatures throughout their range continue to rise, altering sea ice conditions, they are forced to use terrestrial haulouts in areas where they have historically used sea ice. With this proximity to land comes an increase in human-caused disturbance.

Terri Stinnett Photography

Pacific Walrus: Summer/Fall

Map Authors: Erika Knight, Melanie Smith, and Max Goldman
Cartographer: Daniel P. Huffman

KAWERAK, INC. OCEANA Audubon ALASKA



Alaska Department of Fish and Game (2016a); Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016o) [based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2017), Fischbach et al. (2016), Jay et al. (2012a), National Oceanic and Atmospheric Administration (1988), Oceana and Kawerak (2014), and US Fish and Wildlife Service (2014)]; Audubon Alaska (2016p) [based on National Oceanic and Atmospheric Administration (1988) and US Fish and Wildlife Service (2014)]; Audubon Alaska and Oceana (2016); Audubon Alaska et al. (2017); Jay et al. (2012a); Kawerak (2013); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014); US Fish and Wildlife Service (2013); US Fish and Wildlife Service (2014); US Geological Survey (2016)

Pacific Walrus
(Odobenus rosmarus divergens)

Summer/Fall

In summer, sea ice is receding and female and juvenile Pacific walruses have moved north to feed in the productive waters of the Chukchi Sea, while males stay south of the Bering Strait in the shallow areas along the coasts of Russia and Alaska. The calves conceived during the previous year's breeding season are born in late spring and early summer, after female walrus have left the company of larger, aggressive males for more northern summer feeding grounds. Calves will continue the journey north through the Bering Strait soon after birth and will stay with their mothers for up to two years as the females follow the ice margin.

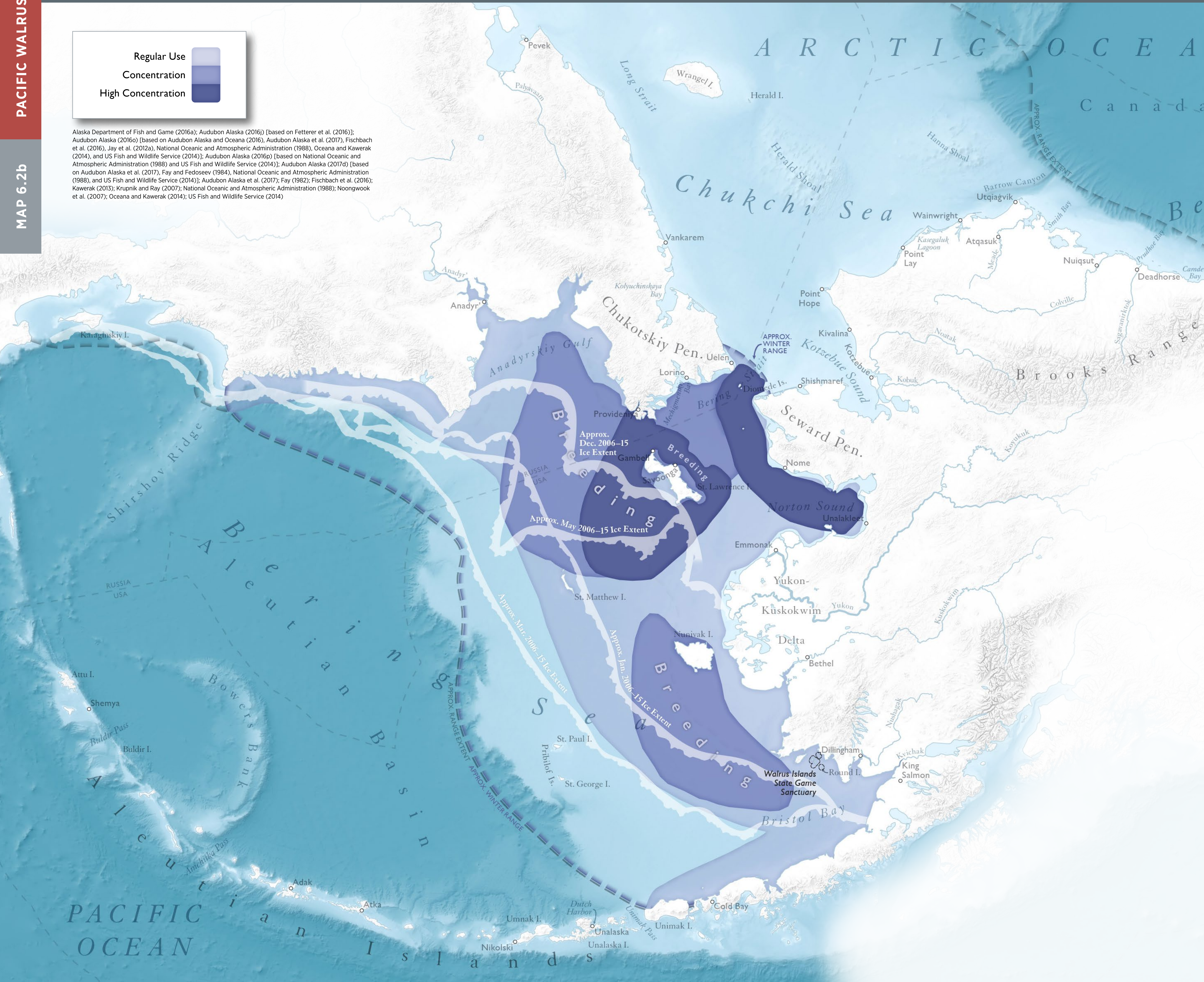
Pacific walruses haul out of the water in groups ranging from less than 100 to more than 10,000. These haulouts have historically been on the pack ice edge, but as the temperature in the Arctic continues to rise, pack ice has become scarce, forcing Pacific walruses to haul out instead on land, increasing the potential for anthropogenic disturbance. To feed, Pacific walruses regularly travel great distances from their haulout on land along "feeding corridors" to areas of high benthic productivity.

Terri Stinnett Photography

Pacific Walrus: Winter/Spring

Map Authors: Erika Knight, Melanie Smith, and Max Goldman
Cartographer: Daniel P. Huffman

KAWERAK, INC. OCEANA Audubon ALASKA



Alaska Department of Fish and Game (2016a); Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016o) [based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2017), Fischbach et al. (2016), Jay et al. (2012a), National Oceanic and Atmospheric Administration (1988), Oceana and Kawerak (2014), and US Fish and Wildlife Service (2014)]; Audubon Alaska (2016p) [based on National Oceanic and Atmospheric Administration (1988) and US Fish and Wildlife Service (2014)]; Audubon Alaska (2017d) [based on Audubon Alaska et al. (2017), Fay and Fedoseev (1984), National Oceanic and Atmospheric Administration (1988), and US Fish and Wildlife Service (2014)]; Audubon Alaska et al. (2017); Fay (1982); Fischbach et al. (2016); Kawerak (2013); Krupnik and Ray (2007); National Oceanic and Atmospheric Administration (1988); Noongwook et al. (2007); Oceana and Kawerak (2014); US Fish and Wildlife Service (2014)

Kim Sheldon / NOAA

Pacific Walrus
(Odobenus rosmarus divergens)

Winter/Spring

This map shows the distribution of the Pacific walrus throughout the Bering Sea during the winter and spring seasons. As temperatures begin to cool in fall and early winter and ice margins begin to push southward, female and juvenile walruses also move south, reuniting with male walruses to breed and overwinter in the Bering Sea. During January and February, breeding bull walruses will follow groups of females as they haul out on large ice flows, their preferred breeding habitat.

Pacific walruses haul out of the water in groups ranging from less than 100 to more than 10,000. They tend to congregate around areas of thin ice, and are closely associated with polynyas and leads. In the winter and spring, these haulouts are usually on nearshore pack ice along the coast. Walruses use haulouts to rest after strenuous foraging bouts, to evade predation, and to breed. Throughout the rest of the winter, walruses are pushed farther south as the pack ice margin continues to march toward its maximum extent. Calving happens after 15 or 16 months of pregnancy, in April, May, or June.

6.3
ICE SEALS
MAPS ON PAGES 230–231

Ice Seals

Benjamin Sullender and Erika Knight

Bearded Seal *Erignathus barbatus* | **Ribbon Seal** *Histriophoca fasciata* | **Ringed Seal** *Phoca hispida* | **Spotted Seal** *P. largha*

Ice seals are a group of marine mammals adapted to life primarily on ice. Within the Bering, Chukchi, and Beaufort Seas, there are four species of ice seal: bearded (*Erignatus barbatus*), ribbon (*Histriophoca fasciata*), ringed (*Phoca hispida*), and spotted (*P. largha*). All Arctic ice seals belong to the family *Phocidae* (earless seals) within the seal clade Pinnipedia. Bearded and ringed seals are the most common and widespread of the seals, while ribbon and spotted seals are more locally distributed, particularly along the sea-ice margins.

ADAPTATIONS

Seal pups have a natal or fetal layer of hair called lanugo. Lanugo is white in all seals except for the bearded seal, where it is brown (Árnason et al. 2006). Lanugo is important for thermoregulation, although it is quickly shed as the pup gains a layer of insulating blubber during nursing (Burns 1970, Lydersen and Hammill 1993). Bearded seals often shed lanugo in utero and, to compensate, are born with a thicker layer of subcutaneous fat (Kovacs et al. 1996).

Pelage in sub-adults and adults is mainly useful for protection, streamlining while swimming, and traction on ice, rather than for thermoregulation (Ling 1970, 1972). Hair must be annually shed and regrown to maintain its function, a process called molting (Ling 1970).

DISTRIBUTION

The bearded seal is distributed widely across the circumpolar Arctic. The ribbon seal breeds and molts in the Bering Sea and the Sea of Okhotsk, seasonally ranging into the Chukchi Sea and occasionally south of the Aleutian Islands. Ringed seals are very broadly distributed through the Arctic. Subspecies inhabit smaller areas and even some inland lakes. The spotted seal is distributed from the Bering Sea through the Sea of Okhotsk and Sea of Japan to the Yellow Sea, with discrete breeding areas in each of these seas.

Sea-Ice Habitat

Ice seals rely on a balance of sufficient ice conditions for haulout platforms and sufficient access to open water for foraging and escape from predators. Pack ice is particularly important for whelping, so that young have a place to rest while mothers have access to foraging habitats (Kovacs et al. 2011).

LIFE CYCLE

Ice seal life history tracks the seasonal nature of sea-ice extent, balancing suitable marine foraging conditions with the presence of ice for use as haulouts (Lydersen and Kovacs 1999). Most of the key events in seal life histories are condensed into the months between spring and summer (generally, March–June). Whelping (birth) typically peaks in March and April, followed by nursing, when seal pups rapidly gain mass, up to 7.3 pounds (3.3 kg) per day for bearded seals (Lydersen et al. 1996). Immediately after nursing, seals begin to breed. Implantation of the blastocyst is usually delayed a few months, followed by a seven- to nine-month pregnancy, ensuring that pups are born in the spring, when food is most available (Sandell 1990).

After whelping and breeding have been completed, ice seals undertake an annual molt. Seals haul out of the water more during molting, likely because the resulting elevated skin temperatures promote hair shedding and regrowth (Cameron et al. 2010).

Generally, ice seals are highly mobile and follow the distribution of sea ice (MacIntyre et al. 2015), although ribbon seals adapt to a seasonally pelagic life during the open-water season (Boveng et al. 2013).

Diet

Although Arctic ice seal ranges overlap, dietary niches are somewhat partitioned (Dehn et al. 2007). Ringed, ribbon, and spotted seals are pelagic foragers, whereas bearded seals eat benthic prey, typically crustaceans, cephalopods, and occasionally fish (Dehn et al. 2007, Cooper et al. 2009). Bearded seals eat both infaunal and epifaunal benthic prey, although they shift their diets according to seasonal availability and will consume pelagic prey opportunistically (Antonelis et al. 1994, Quakenbush et al. 2011).

Species Description

Bearded Seal

The bearded seal is characterized by the distinctive vibrissae (whiskers) that it uses to detect prey (Dehn et al. 2007). The vibrissae, combined with an ability to use hydraulic jetting and suction to acquire prey (Marshall et al. 2008), make the bearded seal well adapted to benthic foraging (Marshall et al. 2006). Bearded seals also consume pelagic fishes, which suggests opportunistic feeding or diet plasticity (Antonelis et al. 1994, Quakenbush et al. 2011).

TABLE 6.3-1. Ice seal life history characteristics and conservation status. Sources: Conn et al. (2014), Muto et al. (2016).

	Bearded Seal *Erignathus barbatus*	Ribbon Seal *Histriophoca fasciata*	Ringed Seal *Phoca hispida*	Spotted Seal *P. largha*
Body Size Mass Length	**M** 475 pounds (220 kg) **L** 6.5 feet (2 m)	**M** 175 pounds (80 kg) **L** 5 feet (1.5 m)	**M** 150 pounds (70 kg) **L** 5 feet (1.5 m)	**M** 200 pounds (90 kg) **L** 5 feet (1.5 m)
Maximum Life Span (wild)	30 years	30 years	40 years	35 years
Conservation Status ESA IUCN	**ESA:** Threatened Beringia and Okhotsk DPS **IUCN:** Least Concern	**ESA:** Species of Concern **IUCN:** Least Concern	**ESA:** Endangered–Ladoga and Saimaa subspecies **ESA:** Threatened–Okhotsk and Baltic subspecies **ESA:** Not Listed–Arctic subspecies as of 2017 **IUCN:** Least Concern	**ESA:** Threatened Southern DPS **ESA:** Not Listed–Sea of Okhotsk and Bering Sea DPS **IUCN:** Least Concern
Population US Bering Sea Global	**U** 300,000 **G** Unknown	**U** 184,000 **G** Unknown	**U** 170,000 **G** 3,000,000	**U** 460,000 **G** Unknown

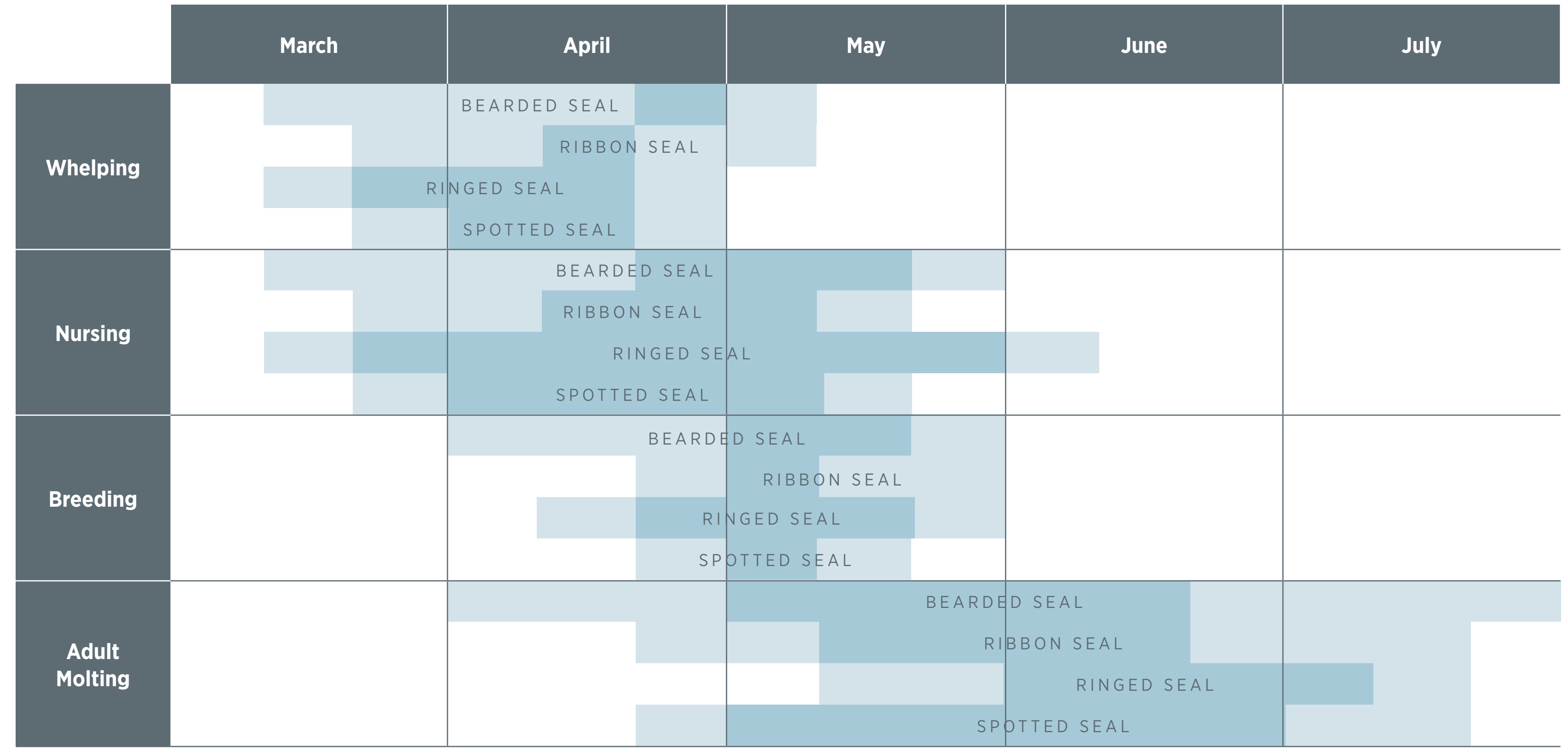


FIGURE 6.3-1 . Comparative phenology for ice seals. Modified from Cameron et al. (2010), Kelly et al. (2010b), Boveng et al. (2013) and Boveng et al. (2009). Darker blue indicates peak activity; lighter blue indicates known extent of activity within study area.

There are two main subspecies of bearded seals, *E. b. barbatus* and *E. b. nauticus*, although there is no geographic gap between their ranges. *E. b. nauticus* lives in the Bering, Beaufort, and Chukchi Seas and is migratory (Rice 1998). Bearded seals in this subspecies employ a roaming (rather than territorial) strategy during the breeding season (Van Parijs and Clark 2006), and very rarely haul out on land (Smith 1981).

Although bearded seals have some capacity to create breathing holes in shallow ice, they prefer sea ice with existing access to water (Burns and Frost 1979). Generally, bearded seals prefer dense ice (70–90% coverage) in motion and with natural openings like leads or polynyas, and tend to avoid shorefast or unbroken, multi-year ice (Kingsley et al. 1985, Simpkins et al. 2003). Young bearded seals feed upriver (sometimes many miles) in the summer and fall (Audubon Alaska et al. 2017).

Ribbon Seal

Ribbon seals are named for their distinctive coloration, with four light-colored ribbons on top of dark pelage. This unusual pattern may help disguise the shape of the ribbon seal's body, reducing the risk of detection by predators searching for seals (Naito and Oshima 1976). Ribbon seals are less wary while hauled out than other ice seals, suggesting that they are less vulnerable to predation (Boveng et al. 2013).

Ribbon seals were formerly classified as belonging to the genus *Phoca*, but recent phylogenetic analyses have confirmed that ribbons seals are more appropriately classified as a separate genus *Histriophoca* (Higdon et al. 2007, Fulton and Strobeck 2010).

Ribbon seals dive deeper than other ice seals (Deguchi et al. 2004) and exhibit several adaptations to their cardiovascular system—higher oxygen storage capacity and higher hemoglobin concentrations—that befit deep dives (Lenfant et al. 1970). Ribbon seals regularly forage at depths up to 1,600 feet (500 m), but shift to shallower foraging bouts when ice coverage precludes presence in deeper waters. This suggests that sea ice is more important than access to preferred deeper waters along the continental shelf slope (Boveng et al. 2013).

Ringed Seal

Ringed seals are the only ice seal that create and maintain breathing holes in the ice; they do so using their foreflipper claws. They often excavate snow above their breathing holes to create lairs (Smith and Stirling 1975). These subnivean lairs provide refuge from cold temperatures, particularly for pups, and hide seals from predators (Smith et al. 1991). Multiple lairs are used, most likely as a way to mitigate risk of predation, and ringed seals demonstrate inter-annual site fidelity to subnivean lairs (Kelly et al. 2010a).

There are five subspecies of ringed seals: Arctic ringed seal (*P. h. hispida*), Baltic ringed seal (*P. h. botnica*), Okhotsk ringed seal (*P. h. ochotensis*), Ladoga ringed seal (*P. h. ladogensis*), and Saimaa ringed seal (*P. h. saimensis*). The Arctic subspecies, found across the circumpolar Arctic, has the broadest geographic distribution. Other subspecies are believed to have been derived from this original geographic extent, but became isolated through the years (Amano et al. 2002). These isolated populations have been listed as threatened or endangered under the Endangered Species Act (ESA), but the main circumpolar subspecies is not currently listed (Table 6.3-1, Figure 6.3-2).

Ringed seals have diverse diets, eating mainly gadid (cod family) fishes in the winter months and switching to a more invertebrate-based diet during the open-water months (Dehn et al. 2007, Kovacs 2007).

Spotted Seal

Morphologically and genetically, spotted seals are similar to harbor seals (*P. vitulina*), and these species overlap in the Aleutian Islands. However, spotted seals usually haul out on sea ice during the breeding season, whereas harbor seals haul out on land (Bishop 1967).

Based on breeding area delineations, spotted seals can be divided into three distinct population segments (DPSs): the Bering DPS, the Okhotsk DPS, and the Southern DPS (Boveng et al. 2009). The Southern DPS breeds in the Yellow Sea and the Sea of Japan.

Spotted seals are closely associated with sea ice when sea ice is present. Spotted seals follow the ice front, preferring ice floes less than 70 feet (<20 m) in diameter for hauling out and avoiding areas of dense ice (Lowry et al. 2000). In the summer, spotted seals haul out on shore for extended periods of time, a behavior unusual for the other species of ice seal, and make multiple-day foraging trips (Lowry et al. 1998).

Spotted seals are pelagic foragers, eating primarily fish and favoring higher trophic levels than other ice seals (Dehn et al. 2007).

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FIGURE 6.3-2. Ringed seal subspecies and ESA status as of 2017.

Of the five subspecies of ringed seal, the Arctic ringed seal (pup pictured) is the most numerous and widely distributed.

CONSERVATION ISSUES

Due to rising concern about the impacts of reduced sea ice on ice-obligate and ice-associated wildlife, the National Oceanic and Atmospheric Administration (NOAA) recently assessed ice seal conservation status according to the ESA (Boveng et al. 2009, Cameron et al. 2010, Kelly et al. 2010b, Boveng et al. 2013). The resulting decisions are the subject of ongoing litigation.

For bearded seals, the original 2012 decision to list Pacific subspecies as threatened was challenged, vacated, and has since been appealed and reinstated in October 2016, with the appellate court denying any future rehearings in May of 2017. (DeMarban 2016, Muto et al. 2016). Currently, both of the DPSs of the bearded seals in the Bering, Chukchi, Beaufort, and Okhotsk Seas (*E. b. nauticus* subspecies) are listed as threatened. The range of the Beringia DPS spans the entire Bering, Chukchi, and Beaufort Seas; the Okhotsk DPS is restricted to the Sea of Okhotsk.

Ribbon seal status was reviewed under the ESA in 2013, and although listing was not warranted, ribbon seals were determined to be a species of concern.

Although Arctic ringed seals were listed as threatened under the ESA in 2010, a subsequent lawsuit vacated the decision in 2016 and ringed seals are no longer listed under the ESA (Muto et al. 2016).

One of three DPSs of spotted seals is listed as threatened. This population breeds in the Yellow Sea and Peter the Great Bay and does not typically reach into the Arctic. The spotted seals that inhabit the project area—the Bering Sea DPS—are not warranted for listing under the ESA.

The most severe threat facing ice seals is the reduction and loss of sea ice (Moore and Huntington 2008). Changes are already reducing breeding habitat for ice seals (Meier et al. 2014), and years with poor ice conditions have been shown to increase pup mortality for ice-breeding seals (Stenson and Hammill 2014). Extreme ice fluctuations depress body conditions and female ovulation rates for ringed seals (Harwood et al. 2012). Although some studies do not anticipate significant negative responses to a reduction in ice extent (Laidre et al. 2008), shifts in habitat and/or diet may occur. Changes in prey abundance and distribution may indirectly affect ice seals (MacIntyre et al. 2015). Some experts predict an overall shift to more pelagic-based productivity in the Arctic marine ecosystem, with negative impacts for benthic-reliant taxa such as bearded seals (Bluhm and Gradinger 2008). However, because ice seals are opportunistic or even generalists in diet, bearded seals may be able to switch diet along with prey abundance (Bluhm and Gradinger 2008).

Industrial development and shipping pose concerns, as noise, ship strikes, oil spills, and other discharges may disturb, displace, or directly harm ice seals (Boveng et al. 2009, Cameron et al. 2010, Kelly et al. 2010b, Boveng et al. 2013). Predation, hunting, and bycatch from commercial fishing are not anticipated to be major threats to ice seal populations (Huntington 2009).

Seal populations have been affected by diseases or infections, although it is difficult to predict future trajectories or occurrences. An unusual mortality event (UME) was declared by the NOAA and the US Fish and Wildlife Service (USFWS) for ice seals in 2011. Over 100 ice seals were reported stranded, with hair loss, lesions, and/or weakness (National Oceanic and Atmospheric Administration and US Fish and Wildlife Service 2012). No cause has been identified, and the UME is still an open investigation for ice seals, although few if any new causes have been reported since 2014 (National Oceanic and Atmospheric Administration 2016).

MAPPING METHODS (MAPS 6.3.1–6.3.4)

The ice seal maps show seasonal distribution of each species throughout the project area. Seasonal data are generally grouped into two seasons, winter/spring and summer/fall, with the exception of data that are applicable year-round. Distribution data are also categorized by four intensities: extent of range, regular use, concentration, and high concentration. Areas where winter/spring and summer/fall data of the same intensity level overlap are shown as year-round at that intensity. General methods for mapping each data layer are described below, with specific sources listed by intensity and seasonal grouping in Table 6.3-2. Due to polygon overlap between data sources, some data listed below may be depicted as year-round but listed as winter/spring or summer/fall; see "Map Data Sources" for a list of citations by display layer. Also see *A Closer Look:* Kawerak's Contribution of Traditional Knowledge.

The mapped ice seal range data were provided in the most recent NOAA status reviews for each species. Seasonal range data were not available for ice seals, with the exception of winter/spring range for spotted seals.

Regular-use data for each ice seal species were composited from a variety of sources.

- Bearded seal regular-use data were composited from several sources. Bearded seals regularly use large portions of the map area throughout the year and regularly use other portions of the map area in only the winter/spring season. The year-round data were from National Oceanic and Atmospheric Administration (1988) and three traditional knowledge sources, including data from a February 2017 workshop with Bering Strait region traditional knowledge experts who reviewed Audubon Alaska's draft ice seal maps (Audubon Alaska et al. 2017). The winter/spring data came from two sources: an Audubon Alaska (2016a) GIS file (based on publications by Bengtson et al. (2005), Cameron et al. (2010), and National Oceanic and Atmospheric Administration (1988)) and traditional knowledge from Oceana and Kawerak (2014).

TABLE 6.3-2. Spatial data sources used on ice seal maps, listed by intensity and seasonal grouping. Due to polygon overlap among data sources, some data described as winter/spring or summer/fall below are depicted as year-round on the ice seal maps. For a list of data sources compiled by map display layer, see the Map Data Sources section.

	Bearded Seal *Erignathus barbatus*	Ribbon Seal *Histriophoca fasciata*	Ringed Seal *Phoca hispida*	Spotted Seal *P. largha*
Range	• Cameron et al. (2010)	• Boveng et al. (2013)	• Kelly et al. (2010b)	• Boveng et al. (2009)
Winter/Spring Range	Not available	Not available	Not available	• Audubon Alaska (2016n) based on: > Boveng et al. (2009) > Lowry et al. (1998) > National Oceanic and Atmospheric Administration (1988) > Oceana and Kawerak (2014)
Winter/Spring Regular Use	• Audubon Alaska (2017) based on: > Bengtson et al. (2005) > Cameron et al. (2010) > National Oceanic and Atmospheric Administration (1988) • Oceana and Kawerak (2014)	• Audubon Alaska et al. (2017) • Boveng et al. (2013)	• Audubon Alaska (2017c) based on: > Bogoslovskaya et al. (2016) > Kelly et al. (2010b) > National Oceanic and Atmospheric Administration (1988)	• Boveng et al. (2009) • Lowry et al. (1998) • National Oceanic and Atmospheric Administration (1988)
Summer/Fall Regular Use	• Audubon Alaska et al. (2017)	• Audubon Alaska et al. (2017) • National Oceanic and Atmospheric Administration (1988)	• Audubon Alaska (2009b) • Huntington et al. (2015b) • Stephenson and Hartwig (2010)	• Audubon Alaska (2009d) based on: > Lowry et al. (1998) • Huntington et al. (2015b) • Huntington et al. (2016a) • Lowry et al. (1998) • National Oceanic and Atmospheric Administration (1988)
Year-round Regular Use	• Audubon Alaska et al. (2017) • Huntington et al. (2015b) • National Oceanic and Atmospheric Administration (1988) • Stephenson and Hartwig (2010)	Not available	• Audubon Alaska et al. (2017) • National Oceanic and Atmospheric Administration (1988) • Stephenson and Hartwig (2010)	• Audubon Alaska et al. (2017)
Winter/Spring Concentration	• Oceana and Kawerak (2014) • Oceana (2013) based on: > Bengtson et al. (2005) > National Oceanic and Atmospheric Administration (1988)	• National Oceanic and Atmospheric Administration (1988)	• Audubon Alaska (2017b) based on: > Audubon Alaska (2009c) > Eicken et al. (2009) > Hartwig (2009) > Kelly et al. (2010b) > National Snow and Ice Data Center and Konig Beatty (2012) > National Oceanic and Atmospheric Administration (1988) > Oceana and Kawerak (2014) > Satterthwaite-Phillips et al. (2016) > Stephenson and Hartwig (2010) • National Oceanic and Atmospheric Administration (1988) • Oceana and Kawerak (2014)	• Audubon Alaska et al. (2017) • Boveng et al. (2009) • National Oceanic and Atmospheric Administration (1988) • Oceana and Kawerak (2014)
Summer/Fall Concentration	• Oceana and Kawerak (2014)	• National Oceanic and Atmospheric Administration (1988)	• Hartwig (2009) • Harwood and Stirling (1992) • National Oceanic and Atmospheric Administration (1988) • Oceana and Kawerak (2014) • Satterthwaite-Phillips et al. (2016)	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014)
Year-round Concentration	• Audubon Alaska et al. (2017)	Not available	• Audubon Alaska et al. (2017) • Hartwig (2009)	• Audubon Alaska et al. (2017)
Winter/Spring High Concentration	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014)	• National Oceanic and Atmospheric Administration (1988)	• Audubon Alaska et al. (2017) • Huntington et al. (2015a) • Oceana and Kawerak (2014) • Satterthwaite-Phillips et al. (2016)	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014)
Summer/Fall High Concentration	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014)	Not available	• Oceana and Kawerak (2014)	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014) • Satterthwaite-Phillips et al. (2016)
Year-round High Concentration	Not available	Not available	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014)	• Audubon Alaska et al. (2017) • Oceana and Kawerak (2014)
Haulouts	• Huntington et al. (2012)	Not applicable	Not available	• Huntington and Quakenbush (2013) • Huntington et al. (2012) • Kawerak (2013) • Lowry et al. (1998) • National Oceanic and Atmospheric Administration (1988) • National Oceanic and Atmospheric Administration (2005)

- Ribbon seal regular-use data were shown based on three data sources, including traditional knowledge and data from NOAA.
- The year-round, regular-use data for ringed seals were from traditional knowledge (Stephenson and Hartwig 2010, Audubon Alaska et al. 2017), and also incorporate summer/fall data (Audubon Alaska 2009b, Huntington et al. 2015b, Stephenson and Hartwig 2010).
- Spotted seal data are shown for winter/spring and summer/fall seasons as well as year-round data, and were acquired from several data sources.

As with regular use, concentration data for the four ice seal species also came from a number of sources.

- Bearded seal summer/fall concentration data (displayed as year-round concentration due to seasonal concentration data overlaps) were available from traditional knowledge, while winter/spring data are shown based on traditional knowledge and several other sources.
- Both winter/spring and summer/fall concentration data for ribbon seals were available only from National Oceanic and Atmospheric Administration (1988).
- The ringed seal winter/spring concentration is represented by the maximum extent of shorefast ice (compiled by Audubon Alaska (2016m)) where they are known to congregate while denning, as well as information from National Oceanic and Atmospheric Administration (1988) and Oceana and Kawerak (2014). Summer/fall concentration areas are based on several traditional knowledge publications and National Oceanic and Atmospheric Administration (1988).
- Spotted seal concentration information are from traditional knowledge data and National Oceanic and Atmospheric Administration (1988).

In the Bering Strait region, concentration areas provided by Oceana and Kawerak (2014) (reviewed and updated by Audubon Alaska et al. (2017)) represent areas where people regularly saw groups of seals in above-average densities. Note that the Oceana and Kawerak (2014) bearded and spotted seal spring/early summer data were treated as spring data on our maps; thus, they are shown using our winter/spring symbology.

Winter/spring and summer/fall high-concentration areas for all species are generally based on traditional and/or local knowledge sources, with the exception of ribbon seals for which the only available data are documented by National Oceanic and Atmospheric Administration (1988).

The mapped bearded seal haulouts are shown based on traditional knowledge documented by Huntington et al. (2012). Spotted seal haulout locations were compiled from several data sources.

The sea-ice data shown on this map approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See Sea Ice Mapping Methods section for details.

Data Quality

Knowledge of ice seals varies from species to species. While the overall range extent data are comprehensive and consistent for all four species, the quantity of information regarding more detailed habitat use varies across the maps. The available spatial data for ribbon seals, for example, comes from just three data sources while ringed seal data were gathered from over a dozen sources. Much of the habitat use information shown on these maps comes from traditional knowledge and varies in collection method from data source to data source. Lack of concentration and high-concentration areas across these maps does not indicate that these regions are unimportant, rather, that the use or non-use of these areas is unknown. Areas where a specific activity occurs, such as breeding or denning, are labeled where this information is known. This labeling is not intended to indicate that these are the only portions of the project area where these activities occur. Little is known about ice seal distributions in Russian waters.

Reviewers
- Bering Strait Traditional Knowledge-Holder Map Review Workshop participants
- Michael Cameron

Josh London / NOAA Fisheries, Alaska Fisheries Science Center

Ribbon seals are listed as a species of concern under the Endangered Species Act due to their reliance on diminishing sea ice.

MAP DATA SOURCES

BEARDED SEAL MAP

Extent of Range: Cameron et al. (2010)

Regular Use (Winter/Spring): Audubon Alaska (2016a) based on Cameron et al. (2010), Bengtson et al. (2005), and National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014)

Regular Use (Year-round): Audubon Alaska et al. (2017); Huntington et al. (2015b); National Oceanic and Atmospheric Administration (1988); Stephenson and Hartwig (2010)

Concentration Area (Winter/Spring): Oceana (2013) based on Bengtson et al. (2005) and National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014)

Concentration Area (Year-round): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

High Concentration Area (Winter/Spring): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

High Concentration Area (Summer/Fall): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

High Concentration Area (Year-round): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

Haulouts: Huntington et al. (2012)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

RIBBON SEAL MAP

Extent of Range: Boveng et al. (2013)

Regular Use (Winter/Spring): Audubon Alaska et al. (2017); Boveng et al. (2013)

Regular Use (Summer/Fall): National Oceanic and Atmospheric Administration (1988)

Regular Use (Year-round): Audubon Alaska et al. (2017); Boveng et al. (2013b)

Concentration (Winter/Spring): National Oceanic and Atmospheric Administration (1988)

Concentration (Summer/Fall): National Oceanic and Atmospheric Administration (1988)

High Concentration (Winter/Spring): National Oceanic and Atmospheric Administration (1988)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

RINGED SEAL MAP

Extent of Range: Kelly et al. (2010b)

Regular Use (Winter/Spring): Audubon Alaska (2017c) based on Bogoslovskaya et al. (2016), Kelly et al. (2010b), and National Oceanic and Atmospheric Administration (1988)

Regular Use (Year-round): Audubon Alaska (2009b); Audubon Alaska et al. (2017); Huntington et al. (2015b); Huntington et al. (2016a); National Oceanic and Atmospheric Administration (1988); Stephenson and Hartwig (2010)

Concentration (Winter/Spring): Audubon Alaska (2017b) based on Audubon Alaska (2009c), Eicken et al. (2009), Hartwig (2009), Kelly et al. (2010b), National Oceanic and Atmospheric Administration (1988), National Snow and Ice Data Center and Konig Beatty (2012), Oceana and Kawerak (2014), Satterthwaite-Phillips et al. (2016), and Stephenson and Hartwig (2010); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014)

Concentration (Summer/Fall): Hartwig (2009); Harwood and Stirling (1992); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014); Satterthwaite-Phillips et al. (2016)

Concentration (Year-round): Audubon Alaska et al. (2017); Hartwig (2009)

High Concentration (Winter/Spring): Audubon Alaska et al. (2017); Huntington et al. (2015a); Oceana and Kawerak (2014); Satterthwaite-Phillips et al. (2016)

High Concentration (Year-round): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

SPOTTED SEAL MAP

Extent of Range: Boveng et al. (2009)

Winter/Spring Range: Audubon Alaska (2016n) based on Boveng et al. (2009), Lowry et al. (1998), National Oceanic and Atmospheric Administration (1988), and Oceana and Kawerak (2014)

Regular Use (Winter/Spring): Boveng et al. (2009); Lowry et al. (1998); National Oceanic and Atmospheric Administration (1988)

Regular Use (Summer/Fall): Audubon Alaska (2009d) based on Lowry et al. (1998); Huntington et al. (2015b); Lowry et al. (1998); National Oceanic and Atmospheric Administration (1988)

Regular Use (Year-round): Audubon Alaska et al. (2017); Lowry et al. (1998); National Oceanic and Atmospheric Administration (1988)

Concentration (Winter/Spring): Audubon Alaska et al. (2017); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014)

Concentration (Summer/Fall): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

Concentration (Year-round): Audubon Alaska et al. (2017)

High Concentration (Winter/Spring): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

High Concentration (Summer/Fall): Audubon Alaska et al. (2017); Oceana and Kawerak (2014); Satterthwaite-Phillips et al. (2016)

High Concentration (Year-round): Audubon Alaska et al. (2017); Oceana and Kawerak (2014)

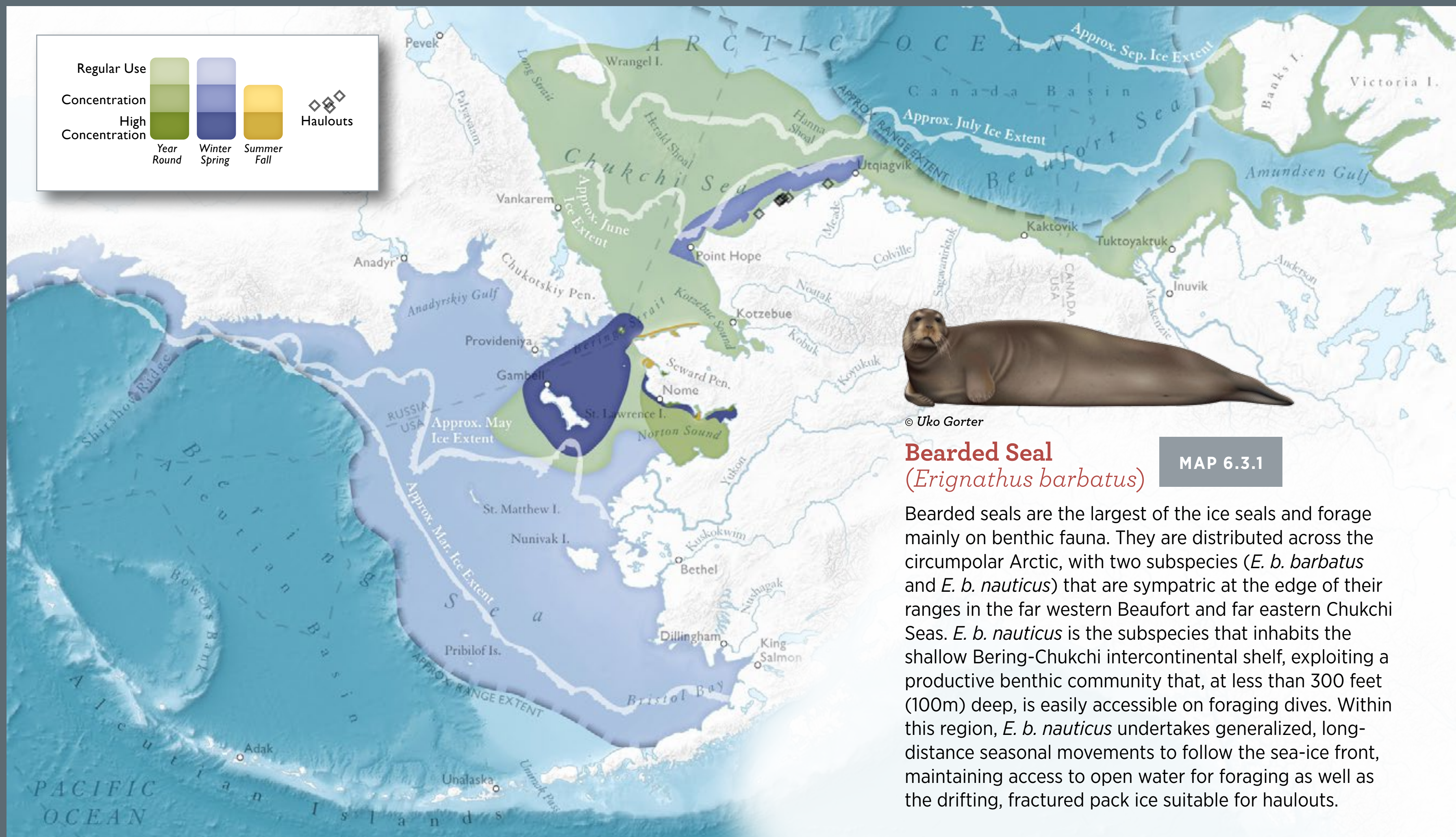
Haulouts: Huntington and Quakenbush (2013); Huntington et al. (2012); Kawerak (2013); Lowry et al. (1998); National Oceanic and Atmospheric Administration (1988); National Oceanic and Atmospheric Administration (2005)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

KAWERAK, INC. OCEANA Audubon ALASKA

Ice Seals

Map Authors: Erika Knight, Melanie Smith, and Max Goldman
Cartographer: Daniel P. Huffman

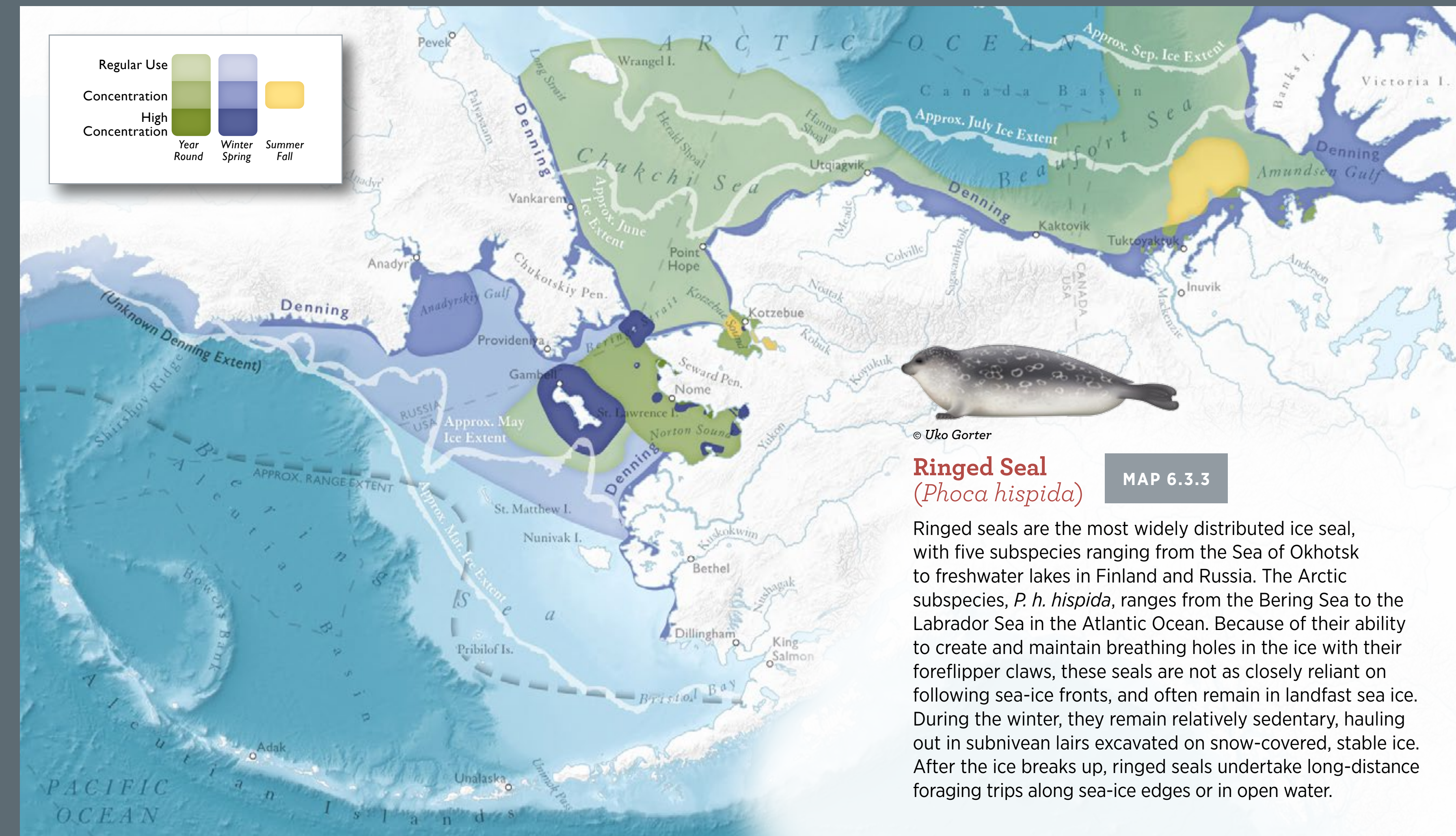


Bearded Seal
(Erignathus barbatus)

MAP 6.3.1

Bearded seals are the largest of the ice seals and forage mainly on benthic fauna. They are distributed across the circumpolar Arctic, with two subspecies (*E. b. barbatus* and *E. b. nauticus*) that are sympatric at the edge of their ranges in the far western Beaufort and far eastern Chukchi Seas. *E. b. nauticus* is the subspecies that inhabits the shallow Bering-Chukchi intercontinental shelf, exploiting a productive benthic community that, at less than 300 feet (100m) deep, is easily accessible on foraging dives. Within this region, *E. b. nauticus* undertakes generalized, long-distance seasonal movements to follow the sea-ice front, maintaining access to open water for foraging as well as the drifting, fractured pack ice suitable for haulouts.

Audubon Alaska (2016a) [based on Cameron et al. (2010), Bengtson et al. (2005), and National Oceanic and Atmospheric Administration (1988)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska et al. (2017); Cameron et al. (2010); Huntington et al. (2012); Huntington et al. (2015b); National Oceanic and Atmospheric Administration (1988); Oceana (2013) [based on Bengtson et al. (2005) and National Oceanic and Atmospheric Administration (1988)]; Oceana and Kawerak (2014); Stephenson and Hartwig (2010)

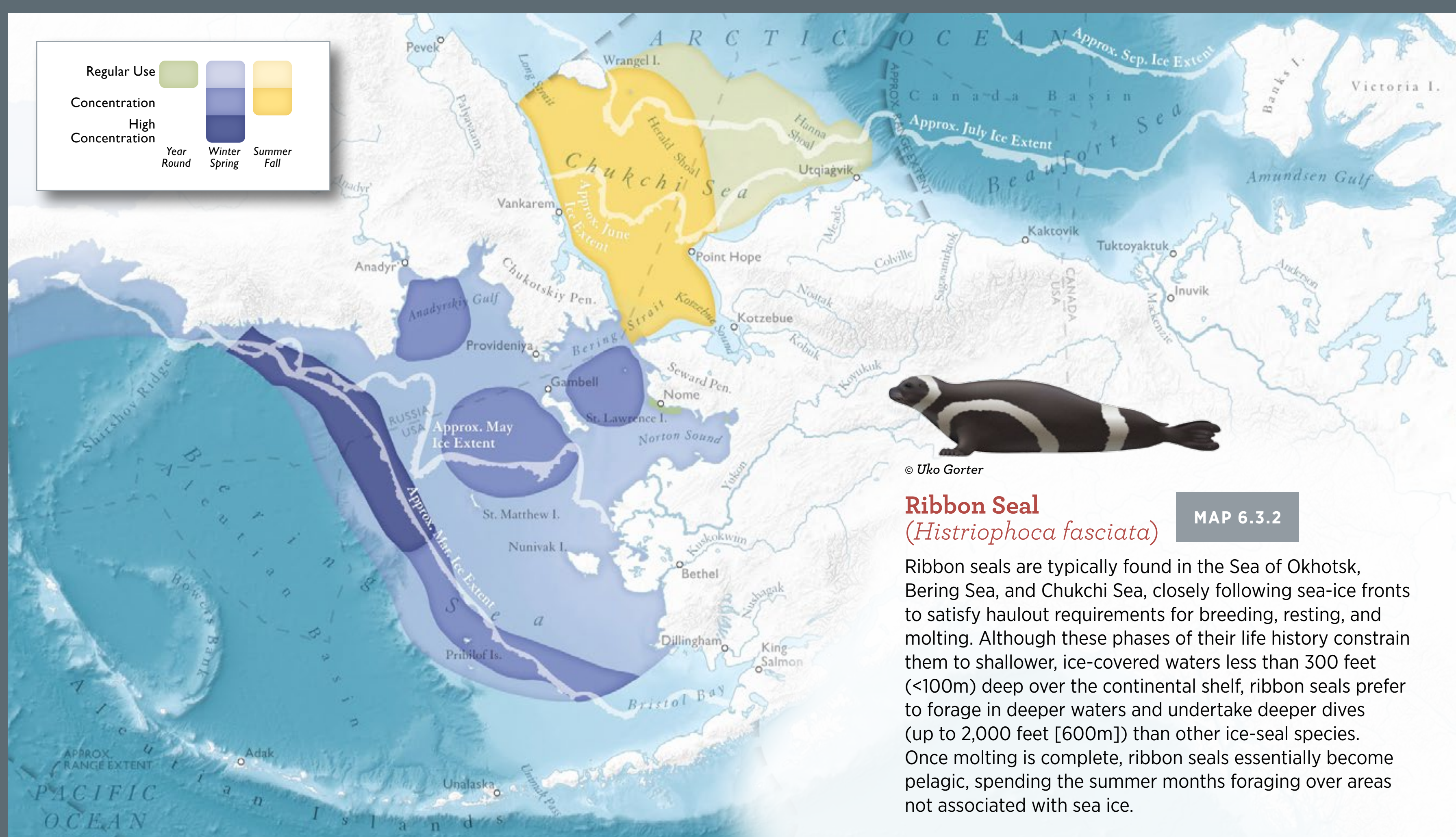


Ringed Seal
(Phoca hispida)

MAP 6.3.3

Ringed seals are the most widely distributed ice seal, with five subspecies ranging from the Sea of Okhotsk to freshwater lakes in Finland and Russia. The Arctic subspecies, *P. h. hispida*, ranges from the Bering Sea to the Labrador Sea in the Atlantic Ocean. Because of their ability to create and maintain breathing holes in the ice with their foreflipper claws, these seals are not as closely reliant on following sea-ice fronts, and often remain in landfast sea ice. During the winter, they remain relatively sedentary, hauling out in subnivean lairs excavated on snow-covered, stable ice. After the ice breaks up, ringed seals undertake long-distance foraging trips along sea-ice edges or in open water.

Audubon Alaska (2009b); Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2017b) [based on Audubon Alaska (2009c), Eicken et al. (2009), Hartwig (2009), Kelly et al. (2010b), National Oceanic and Atmospheric Administration (1988), National Snow and Ice Data Center and Konig Beatty (2012), Oceana and Kawerak (2014), Satterthwaite-Phillips et al. (2016), and Stephenson and Hartwig (2010)]; Audubon Alaska (2017c) [based on Bogoslovskaya et al. (2016), Kelly et al. (2010b), and National Oceanic and Atmospheric Administration (1988)]; Audubon Alaska et al. (2017); Hartwig (2009); Harwood and Stirling (1992); Huntington et al. (2015a); Huntington et al. (2015b); Kelly et al. (2010b); National Oceanic and Atmospheric Administration (1988); Oceana and Kawerak (2014); Satterthwaite-Phillips et al. (2016); Stephenson and Hartwig (2010)

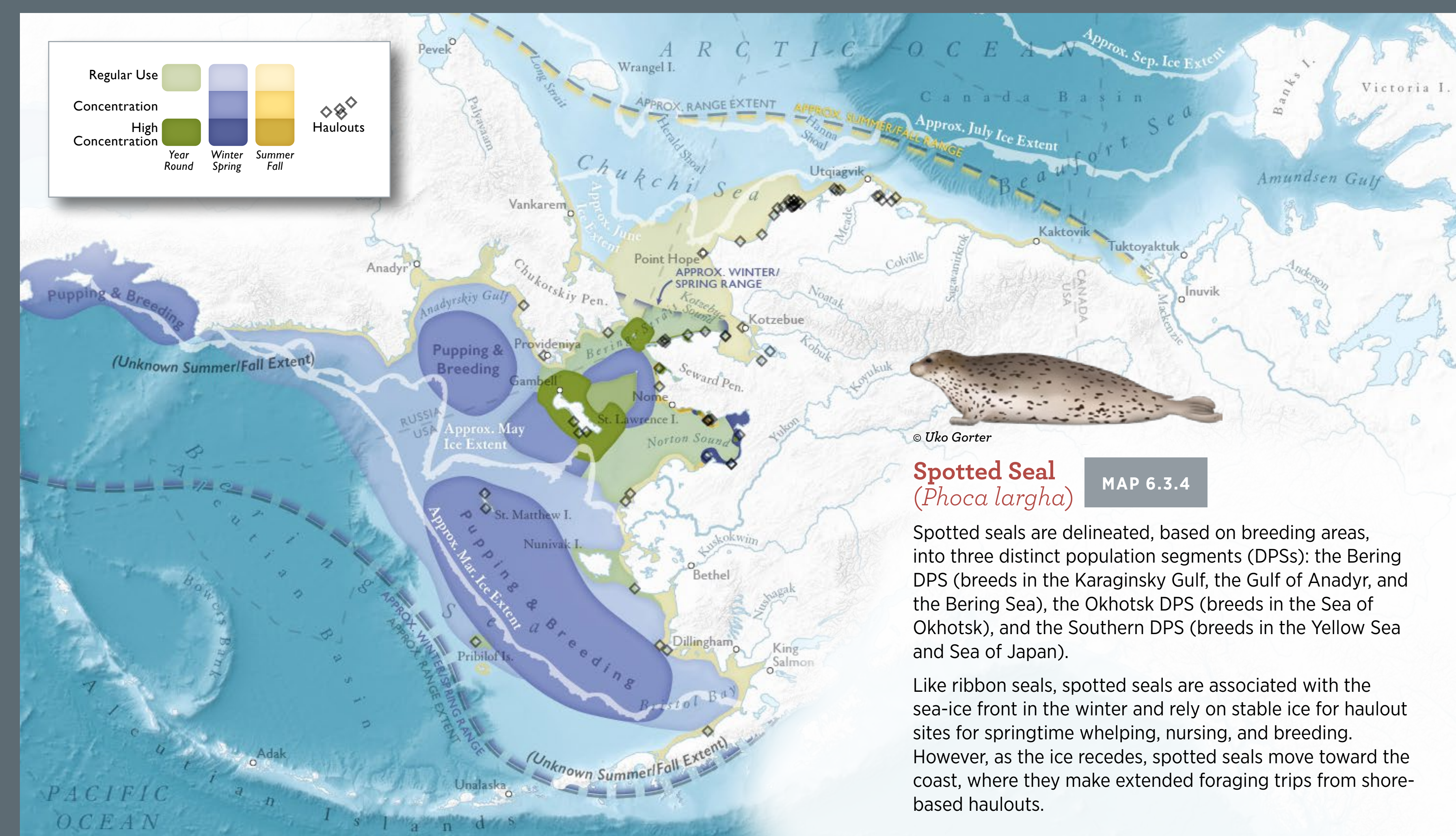


Ribbon Seal
(Histriophoca fasciata)

MAP 6.3.2

Ribbon seals are typically found in the Sea of Okhotsk, Bering Sea, and Chukchi Sea, closely following sea-ice fronts to satisfy haulout requirements for breeding, resting, and molting. Although these phases of their life history constrain them to shallower, ice-covered waters less than 300 feet (<100m) deep over the continental shelf, ribbon seals prefer to forage in deeper waters and undertake deeper dives (up to 2,000 feet [600m]) than other ice-seal species. Once molting is complete, ribbon seals essentially become pelagic, spending the summer months foraging over areas not associated with sea ice.

Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska et al. (2017); Boveng et al. (2013); National Oceanic and Atmospheric Administration (1988)



Spotted Seal
(Phoca largha)

MAP 6.3.4

Spotted seals are delineated, based on breeding areas, into three distinct population segments (DPSs): the Bering DPS (breeds in the Karaginsky Gulf, the Gulf of Anadyr, and the Bering Sea), the Okhotsk DPS (breeds in the Sea of Okhotsk), and the Southern DPS (breeds in the Yellow Sea and Sea of Japan).

Like ribbon seals, spotted seals are associated with the sea-ice front in the winter and rely on stable ice for haulout sites for springtime whelping, nursing, and breeding. However, as the ice recedes, spotted seals move toward the coast, where they make extended foraging trips from shore-based haulouts.

Audubon Alaska (2009d) [based on Lowry et al. (1998)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2016n) [based on Boveng et al. (2009), Lowry et al. (1998), National Oceanic and Atmospheric Administration (1988), and Oceana and Kawerak (2014)]; Audubon Alaska et al. (2017); Boveng et al. (2009); Huntington and Quakenbush (2013); Huntington et al. (2012); Huntington et al. (2015b); Huntington et al. (2016a); Kawerak (2013); Lowry et al. (1998); National Oceanic and Atmospheric Administration (1988); National Oceanic and Atmospheric Administration (2005); Oceana and Kawerak (2014); Satterthwaite-Phillips et al. (2016)

MAP ON PAGES 234–235

Steller Sea Lion

Eumetopias jubatus

Jon Warrenchuk, Brianne Mecum, and Marilyn Zaleski

The Steller sea lion (*Eumetopias jubatus*) is the third largest of the pinnipeds, after the walrus (*Odobenus rosmarus*) and the elephant seal (*Mirounga* spp.), and is a top fish predator. Georg Steller, for whom the Steller sea lion was named, described the species in 1741 after being shipwrecked with them on Bering Island. He called the animals "sea lions" because the males' tawny mane and bellowing roar reminded him of African lions. However, the native Unangan people of the Aleutian Islands had long been intimately familiar with "Steller's" sea lions. They called them qawan, and for thousands of years relied on them as a source of food, clothing, and even transportation, inventing kayaks made from the sea lions' waterproof skins.

The habitat of Steller sea lions extends around the North Pacific Ocean from eastern Japan and Russia through the Aleutian Islands, Bering Sea, Gulf of Alaska (GOA), and down the west coast of North America to Central California. Steller sea lions are gregarious, and during the breeding season they concentrate at traditional terrestrial haulout sites called rookeries to give birth and mate. There are 10 Steller sea lion rookeries in Russia, 50 in Alaska, 7 in British Columbia, 1 in Washington, 2 in Oregon, and 3 in California (Kenyon and Rice 1961; Loughlin et al. 1984, 1987, 1992).

ADAPTATIONS

Steller sea lions are the largest member of the family of eared seals (*Otariidae*) and have external ears and rear flippers that can turn forward, allowing them to "walk" with a gait similar to land mammals. They swim using their strong fore flippers and steer with their rear flippers (unlike true seals, which propel themselves with their rear flippers and by undulating their bodies). Steller sea lions are quick and agile swimmers and reach bursts of speed by porpoising at the surface. They can live for 20 or 30 years, with females weighing up to 770 pounds (350 kg) and males up to 2,500 pounds (1,130 kg). Most females reach maximum size by age 7, and males reach adult size by age 12 (Muto et al. 2016).

At birth, a sea lion pup's chocolate brown coat has a frosty appearance because of the colorless tips of their hair. Color gradually lightens as the animal ages and it periodically molts. Most adult females are a yellowish-cream color on the back, although some remain darker. Nearly all males stay darker on the front of the neck and chest; although some are even a reddish color (Loughlin et al. 1987, Hoover 1988).

Steller sea lions have a thinner blubber layer than seals and tend to be larger and leaner (Mellish et al. 2007). Their likely strategy for survival is to eat voraciously; they have relatively large stomachs and can consume up to 16% of their body weight per day (Rosen and Trites 2004).

Vocalizations

Steller sea lions are amongst the most vocal of marine mammals. Their low-pitched "roars" are distinct from the higher pitched "barking" sounds of the smaller California sea lions where they co-occur. Pups make sounds that could be described as mewling, bleating, or yowling. Females with pups have individually distinct calls, which aid in reuniting mothers and pups on crowded rookeries (Campbell et al. 2002). Roars of territorial males can be "threat calls" that help establish dominance without physical confrontation (Gisiner 1985, Insley et al. 2003). Underwater, Steller sea lions can hear a range of frequencies. Their hearing sensitivity overlaps with the frequencies that orcas use for social calls and echolocation, which may help them avoid these predators (Kastelein et al. 2005).

DISTRIBUTION

The range of Steller sea lions extends around the North Pacific Ocean Rim from northern Japan, the Kuril Islands and Okhotsk Sea, through the Aleutian Islands and the Bering Sea, along Alaska's southern coast, and south to California (Kenyon and Rice 1961; Loughlin et al. 1984, 1987, 1992). The northernmost rookery is in Prince William Sound in the Gulf of Alaska (60°10'N, 146°50'W) and Walrus Island off St. Paul Island in the Pribilofs is the northernmost rookery in the Bering Sea. Currently, Año Nuevo Island off central California is the southernmost rookery (37°06'N), although until 1981, some pups were born farther south at San Miguel Island (34°05'N).

Steller sea lions used to be more abundant in different parts of their range. In the 1980s, the population declined rapidly. Prior to the decline, most large rookeries were in the Gulf of Alaska and Aleutian Islands (Kenyon and Rice 1961; Calkins et al. 1982; Loughlin et al. 1984, 1992; Merrick and Loughlin 1997). However, as the decline continued, rookeries in the west became smaller. The largest rookeries are now in Southeast Alaska and British Columbia.

As many as 15,000 Steller sea lions may have inhabited the Pribilof Islands in the late 19th century, but culling reduced the population to a few hundred by 1914, before regulations were enacted to reduce takes (Kenyon 1962, Loughlin et al. 1984). Now only a few dozen pups are born each year at the last remaining Pribilof rookery at Walrus Island (L. Fritz pers. comm.).

Genetic research has identified three stocks of Steller sea lions (Baker et al. 2005, O'Corry-Crowe et al. 2006), two of which are recognized as distinct population segments (DPSs) under the Endangered Species Act (ESA): the Eastern stock, which breeds on rookeries located east of 144°W in Southeast Alaska, British Columbia, Washington, Oregon, and California; and the Western stock, which breeds on rookeries located primarily west of 144°W in Alaska and Russia. The third, or Asian stock, has not been formally recognized by the National Marine Fisheries Service (NMFS), and breeds on all rookeries in Asia except for the Commander Islands.

Migration

In winter, Steller sea lions may move from their rookeries on the exposed coast to areas more protected from the weather or to the lee sides of islands. They can move over long distances, and adult males, in particular, may disperse widely after the breeding season (Kenyon and Rice 1961, Jemison et al. 2013). During fall and winter, many Steller sea lions disperse from rookeries and increase their use of haulouts, even hauling out on sea ice in the Bering Sea. They also gather at sea in protected bays and channels in tightly packed groups, or "rafts," near haulouts in winter.

LIFE CYCLE

Steller sea lions gather on habitually used rookeries on exposed, remote islands to give birth and breed. Dominant males defend individual territories on their rookery from approximately mid-May through mid-July (Pitcher and Calkins 1981). Females mate with males who can hold the most preferred territory (Parker and Maniscalco 2014). Georg Steller observed that the males "hold the females in great respect" in contrast to northern fur seals (*Callorhinus ursinus*) that treat their females "harshly" (Steller 1899). During the breeding season, males typically do not leave their territory and will not eat for two months.

Females give birth to a single pup from mid-May through July, after 11.5 months of gestation (Pitcher and Calkins 1981). They breed shortly after giving birth, but the fertilized egg does not implant in the uterus and begin growing until October. Some females first breed at the age of three, but by their sixth year, nearly all are breeding and producing pups. They generally return to their rookery of birth to breed (Calkins et al. 1982), but may disperse to a nearby rookery (Raum-Suryan et al. 2002). Males are able to breed at three to six years of age, but they must do so sneakily until they are older than nine, when they are large enough to compete for territories with dominant males (Pitcher and Calkins 1981).

Steller sea lion mothers nurse their pups for up to three years, and pups are weaned just prior to the next breeding season (Pitcher and Calkins 1981, Trites et al. 2006). Pups are left onshore for 7 to 62 hours while the mother goes to sea to feed, depending on how long it takes her to find food (Hood and Ono 1997). A pup's early growth is key to its survival. Steller sea lion milk is energy-rich and contains 20–30% fat and a variety of essential fatty acids (Higgins et al. 1988, Miller 2014). The pups are nursed at the rookery for two to three months before dispersing with the mothers to haulouts (Trites and Porter 2002). Pups as young as three months old can start catching their own fish to supplement their milk diet (Raum-Suryan et al. 2002).

Diet

Steller sea lions eat a wide variety of fishes, such as walleye pollock (*Gadus chalcogrammus*), Atka mackerel (*Pleurogrammus monopterygius*), Pacific herring (*Clupea pallasii*), Pacific sand lance (*Ammodytes hexapterus*), capelin (*Mallotus villosus*), Pacific cod (*Gadus macrocephalus*), salmon (*Onchorhynchus spp.*), rockfish, sculpins, flatfish, and invertebrates such as squid and octopus. Most of their top-ranked prey are off-bottom, schooling species. Feeding occurs from the intertidal zone to the continental shelf, and Steller sea lions are considered top-level consumers. They have regionally specific diets (Sinclair et al. 2005) and seem to remember when and where predictable concentrations of prey occur (Sigler et al. 2009). In the Gulf of Alaska, their diets include pollock, salmon, and arrowtooth flounder (*Atheresthes stomias*); in the western GOA and eastern Aleutian Islands their most important prey are pollock, salmon, Atka mackerel, sand lance, and herring; while those in the western Aleutians eat Atka mackerel, Pacific cod and cephalopods (Sinclair et al. 2005).

Transient killer whales (*Orcinus orca*), and possibly sleeper sharks (*Somniosus pacificus*) prey on Steller sea lions (Maniscalco et al. 2007, Horning and Mellish 2014). Pups can die from drowning, or starvation if separated from the mother, as well as disease, parasitism, predation, crushing by adults, bites from other Steller sea lions, and complications during birth (Orr and Poulter 1967, Edie 1977, Maniscalco et al. 2002, Maniscalco et al. 2007). Older animals may die from starvation, injuries, disease, predation, subsistence harvests, intentional shooting by humans, entanglement in marine debris, and fishery interactions (Merrick et al. 1987).

CONSERVATION ISSUES

Steller sea lions were listed as a threatened species under the ESA in 1990. In 1997, it was determined that they actually comprised two DPSs: an Eastern stock from California through Southeast Alaska to Cape Suckling, and a Western stock from Cape Suckling through the Aleutian Islands to the Sea of Okhotsk in Russia. The Western DPS (WDPS) was re-classified as endangered, while the Eastern DPS (EDPS) retained the threatened classification (National Marine Fisheries Service 1997). The EDPS is now considered recovered and has been de-listed from the ESA.

Steller sea lions were historically a crucial source of food and tools for inhabitants of the Aleutian Islands. Clothing, boots, and kayaks were made from skins. The blubber and meat is described as "sweet" and "well flavored" and the gelatinous flippers are considered a prime delicacy (Steller 1899). Steller sea lions are still a culturally significant subsistence food source today.

In contrast, the modern era has seen attempts to deliberately exterminate Steller sea lions and reduce their population. During the early development of commercial fisheries in Alaska, they were often shot on sight by fishermen, who perceived them as competitors (Turek et al. 2008). Anecdotal reports told of military planes using sea lions as target practice in the 1940s (National Research Council 2003). The federal Bureau of Commercial Fisheries even instituted a predator control program for seals and sea lions in 1951 (Turek et al. 2008). Between 1964 and 1972, Steller sea lion pups were commercially harvested for their fur (Merrick et al. 1987). A commercial Steller sea lion meat harvest was encouraged for fox farmers to use as fox food (Thorsteinson et al. 1961, Merrick et al. 1987).

Competition between commercial groundfish fisheries that target Steller sea lion prey (pollock, Pacific cod, and Atka mackerel) likely continues to affect the sea lion population, particularly in the western Aleutians where populations declined at 7% per year between 2003 and 2016 (Sweeney et al. 2016). Fishery management measures have been put into place to reduce possible interactions with boats and competition for resources, including area closures and seasonal fishery limits in Steller sea lion critical habitat (National Marine Fisheries Service 2014).

From the 1950s through the 1970s, the worldwide abundance of Steller sea lions was estimated at 240,000 to 300,000 animals (Kenyon and Rice 1961, Loughlin et al. 1984). In the 1980s, the population decreased rapidly, mostly in the range of what is now recognized as the western population and by 1990, the US portion of the population had declined by about 80% (Loughlin et al. 1992). The worldwide population likely reached its smallest size (~105,000 animals) in 2000 when the overall decline of the WDPS stopped.

In 2015, the worldwide population of Steller sea lions was estimated to be around 137,000 animals, which includes about 60,000 animals in the Eastern stock and 50,000 animals in the Western stock, including the Russian population (Muto et al. 2016).

MAPPING METHODS (MAP 6.4)

Steller sea lion general range distribution is from the map figure displayed in the Steller sea lion stock assessment in Muto et al. (2016).

Steller sea lion haulout and rookery locations are from Fritz et al. (2015b) and were joined to non-pup and pup count data also from Fritz et al. (2015a) and Fritz et al. (2015c). Rookeries and haulout locations in Russian waters are from L. Fritz (pers. comm.).

Female foraging areas were created from text descriptions in Merrick and Loughlin (1997), which describe seasonal foraging distance based on satellite telemetry locations of tagged female Steller sea lions. Buffers of described distances were drawn from known haulouts and rookeries. Both maximum and minimum distances are displayed to show the general range of seasonal foraging areas.

The migration of male Steller sea lions in their western range was documented by Kenyon and Rice (1961) and was based on aerial surveys and at-sea observations. The migration arrow was drawn based on text descriptions that describe seasonal movement from the Aleutian and Pribilof Islands in the summer northward past St. Matthew and Hall Islands toward the northern Bering Sea as far as the Bering Strait at 65°45'N.

The sea-ice data shown on this map approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See Sea Ice Mapping Methods section for details.

Data Quality

Foraging ranges and movement patterns of Steller sea lions are estimated from field observations and telemetry-tagged animals and may not necessarily be indicative of the population as a whole.

Reviewer

- Lowell Fritz

MAP DATA SOURCES

Range Extent: Muto et al. (2016)

Haulouts: Fritz et al. (2015a, b, c); L. Fritz (pers. comm.)

Adult Female Foraging (Average–Winter): Merrick and Loughlin (1997)

Seasonal Migration: Kenyon and Rice (1961)

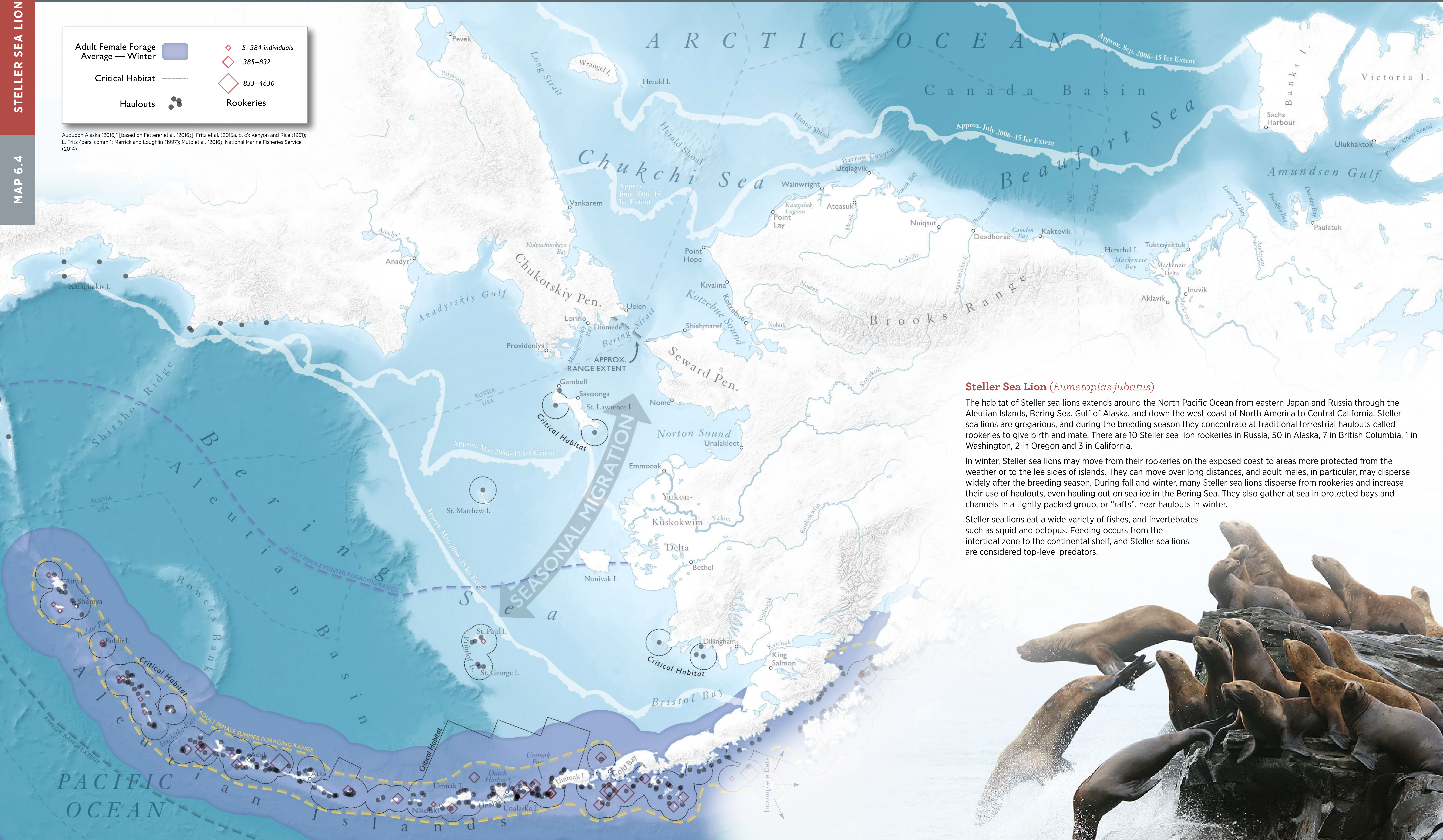
Critical Habitat: National Marine Fisheries Service (2014)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

Steller Sea Lion

Map Authors: Brianne Mecum, Marilyn Zaleski, and Jon Warrenchuk
Cartographer: Daniel P. Huffman

OCEANA Audubon ALASKA



Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Fritz et al. (2015a, b, c); Kenyon and Rice (1961); L. Fritz (pers. comm.); Merrick and Loughlin (1997); Muto et al. (2016); National Marine Fisheries Service (2014)

Steller Sea Lion (*Eumetopias jubatus*)

The habitat of Steller sea lions extends around the North Pacific Ocean from eastern Japan and Russia through the Aleutian Islands, Bering Sea, Gulf of Alaska, and down the west coast of North America to Central California. Steller sea lions are gregarious, and during the breeding season they concentrate at traditional terrestrial haulouts called rookeries to give birth and mate. There are 10 Steller sea lion rookeries in Russia, 50 in Alaska, 7 in British Columbia, 1 in Washington, 2 in Oregon and 3 in California.

In winter, Steller sea lions may move from their rookeries on the exposed coast to areas more protected from the weather or to the lee sides of islands. They can move over long distances, and adult males, in particular, may disperse widely after the breeding season. During fall and winter, many Steller sea lions disperse from rookeries and increase their use of haulouts, even hauling out on sea ice in the Bering Sea. They also gather at sea in protected bays and channels in a tightly packed group, or "rafts", near haulouts in winter.

Steller sea lions eat a wide variety of fishes, and invertebrates such as squid and octopus. Feeding occurs from the intertidal zone to the continental shelf, and Steller sea lions are considered top-level predators.

MAP ON PAGE 238

Northern Fur Seal

Callorhinus ursinus

Jon Warrenchuk and Brianne Mecum

The northern fur seal (*Callorhinus ursinus*) is a pinniped, and spends most of its life at sea. It comes ashore in the spring and gathers at colonial breeding sites, or rookeries, on only a few islands in the world. The home range of the northern fur seal covers a vast area—from the Bering Strait to the California Current ecosystem. Despite its expansive range, 50% of the northern fur seal population returns to the Pribilof Island rookeries in the Bering Sea to breed and give birth to their young. Northern fur seals were subject to a major commercial harvest for their fur, first starting when Russian explorers discovered the Pribilof Island rookeries in 1796, and continued by the US after the purchase of Alaska until 1984.

ADAPTATIONS

Northern fur seals are members of the family *Otariidae* (the eared seals) and have external ears and rear flippers that can turn forward, allowing them to "walk" with a gait similar to land mammals. They are likely "visual" predators, and their large eyes aid them in hunting at night or in deep waters. They have a short snout and a stocky body, and were first described as "sea bears" (Steller 1899).

In the animal kingdom, only the sea otter (*Enhydra lutris*) has thicker fur than the northern fur seal (Irving et al. 1962). That thick fur subjected the fur seals to intense historical commercial harvest (Roppel and Davey 1965). Their long flippers, however, are bare, and aid in regulating their body temperature (Irving et al. 1962). Fur seals spend most of their lives at sea, and only come onshore to breed and give birth. They do not regularly haul out on land or ice like Steller sea lions (*Eumetopias jubatus*) or ice seals. Females weigh up to 120 pounds (55 kg) and males up to 600 pounds (275 kg) (Gentry 1998). Females can live for 25–30 years, but males only live 9–12 years as the rigors of defending breeding territory result in a diminished lifespan (Gentry 1998).

Vocalizations

Early biologists believed fur seals to have three different kinds of speech (Steller 1899). A "lowing of cows" when lazing about, a roar or growl of a bear when battling, and a sharp and repeated note like crickets when victorious in battle (Steller 1899). The roars and growls of territorial males can be interpreted as threat calls by other individuals and may help establish dominance without physical confrontation (Insley et al. 2003). Females and their pups find each other on crowded rookeries through vocalization, and pups can remember their mothers' unique calls for at least four years (Insley 2000).

DISTRIBUTION

Five stocks of northern fur seals are identified for management purposes: the Eastern Pacific stock which comprises the northern fur seal population of the Pribilof Islands and Bogoslof Island; the Commander Islands, Kuril Islands, and Robben Island stocks in Russia; and the California stock off southern California (Dizon et al. 1992). The Pribilof Islands used to support most of the world's northern fur seals but now account for about half of the global population. There are 15 rookeries on St. Paul Island and 6 rookeries on St. George Island. Bogoslof Island is a geologically young island; it was an underwater volcano and first emerged from the sea in 1796. Northern fur seals discovered the island and were noticed using it as a rookery in 1980 (Lloyd et al. 1981). Since then, pup production on Bogoslof Island increased exponentially but now may be stabilizing (Kuhn et al. 2014). The Bogoslof volcano erupted multiple times in 2016 and 2017.

Northern fur seals spend most of their life at sea and concentrate at major oceanographic frontal features formed by offshore seamounts, canyons, and the continental shelf break (Loughlin et al. 1999, Ream et al. 2005, Pelland et al. 2014, Sterling et al. 2014). In the winter, males spend more time in the Bering Sea and along the Aleutian Islands, while the females forage further south in the central North Pacific, Gulf of Alaska, and within the California Current ecosystem.

In the 1870s, a US government agent estimated the Pribilof Islands northern fur sea population at 4.7 million animals (Coues 1877, Elliott 1882) although some scientists believe this was an overestimate. In the 1950s, the Eastern Pacific stock of northern fur seals comprised an estimated 1.8–2.1 million animals (National Marine Fisheries Service 2007).

The most recent population estimate for the Eastern Pacific stock of northern fur seals is based on counts of the pups at rookeries from 2008 to 2012 and is estimated at 648,534 animals (Muto et al. 2016). It is likely that the current population is lower given the declining number of pups born at the main breeding rookeries in the Pribilof Islands.

Migration

Northern fur seals disperse widely through the Pacific when they leave their summer breeding rookeries. After the pups are weaned, females leave the rookeries and migrate south, traveling through the passes in the Aleutian Islands and into the central North Pacific, Gulf of Alaska, and California Current (Ream et al. 2005). Older males remain in the Bering Sea longer and do not migrate as far south as the females (Loughlin et al. 1999, Sterling et al. 2014). Unimak Pass is a primary migration corridor, used twice per year as the animals leave and return to the Bering Sea (Ragen et al. 1995). In the winter, the females can be found dispersed from southern California to the Sea of Okhotsk and southern Japan off Asia (Kajimura and Loughlin 1988, Ream et al. 2005, Pelland et al. 2014).

LIFE CYCLE

Northern fur seals are territorial and most return to the rookeries where they were born to breed (Gentry 1998). Reproductive males begin to compete for territories on the rookeries when about seven to nine years old (Johnson 1968). Females become sexually mature between 4 and 7 years old (York 1983) but can remain reproductive up to at least the age of 23 (Lander 1981).

Males arrive on rookeries in mid-May and pregnant females begin to arrive in mid-June (Gentry 1998). The males do not eat while defending their territories and lose a quarter of their body mass over this time period (Gentry 1998). Females give birth to a single pup within two days of arrival on shore, and then mate with the dominant male of the territory three to eight days later (Gentry 1998). Females experience delayed implantation, and the fertilized egg implants later in early winter while the females are at sea (York and Scheffer 1997).

Mothers leave the rookery to forage at sea and return to the rookery to nurse their pups. They spend three to ten days at sea foraging, depending upon how long it takes to find enough food, then return to the rookery for one to two days to nurse. The length of the females' foraging trip, and hence the frequency of pup nursing, can influence the rate of pup growth, as seen in the related Antarctic fur seal (Lunn et al. 1993). Pups are weaned after about four months and then must forage on their own. Pups spend 22 months at sea before returning to their natal rookeries as 2-year olds.

Diet

Northern fur seals rely on schooling forage fish, walleye pollock (*Gadus chalcogrammus*), and squid species, which varies by location and season (Sinclair et al. 1994, Robson et al. 2004, Ream et al. 2005, Gudmundson et al. 2006, Kuhn et al. 2014). The Bogoslof fur seals feed predominantly on deep-sea smelt (bathylagids), northern smoothtongue (*Leruoglossus schmidti*), and armhook (gonatid) squid (Kuhn et al. 2014) at night when the prey field migrates nearer the surface. The Pribilof fur seals feed primarily on walleye pollock and gonatid squid while foraging from their rookeries in the summer (Sinclair et al. 1994, Robson et al. 2004, Gudmundson et al. 2006). In the winter and spring, female fur seals feed on Pacific herring (*Clupea pallasi*), capelin (*Mallotus villosus*), sablefish (*Anoplopoma fimbria*), Pacific sand lance (*Ammodytes hexapterus*), walleye pollock, and squid in the Gulf of Alaska and off British Columbia, and Pacific hake (*Merluccius productus*), northern anchovy (*Engraulis mordax*), market squid (*Doryteuthis opalescens*), Pacific herring, and rockfish off the coasts of Washington, Oregon, and California (Antonelis and Perez 1984, Ream et al. 2005).

CONSERVATION ISSUES

In the early 20th century, after noting a declining and greatly reduced fur seal population, countries agreed to ban pelagic sealing and reduce commercial harvest in the Pribilofs. This Treaty for the Preservation and Protection of Fur Seals and Sea Otters was ratified by Canada, Japan, Russia, and the US in 1911 and was one of the first international wildlife management agreements (National Marine Fisheries Service 2007). The Fur Seal Act was passed in 1966, which further regulated the commercial harvest and also provided for the subsistence use of fur seals on the Pribilof Islands (National Marine Fisheries Service 2007).

After passage of the Marine Mammal Protection Act (MMPA), a commercial harvest moratorium and research sanctuary was established on St. George Island, while commercial harvest continued on St. Paul Island. The commercial harvest there ended in 1984. Northern fur seals were listed as depleted under the MMPA in 1988, when it was observed the population had declined to less than 50% of the levels observed in the 1950s (National Marine Fisheries Service 2007). In 1994, the MMPA was amended to include cooperative co-management of marine mammals by Alaska Native Organizations. The tribal governments of St. Paul and St. George signed fur seal co-management agreements with NMFS in 2000 and 2001 to manage the subsistence harvest.

The northern fur seals in the Pribilof Islands were subject to periods of intense commercial exploitation for their fur, first by Russia and then by the US Government after Alaska was purchased (National Marine Fisheries Service 2007). Seals were also taken at sea, and this practice of commercial pelagic sealing killed the lactating females that were on foraging trips when they were away from their pups on the rookeries (Roppel and Davey 1965, York and Hartley 1981). This at-sea harvest of the mothers also resulted in the deaths of the dependent pups back at the rookeries.

Northern fur seals have also been subject to past culling and predator control programs. From 1958 to 1964, the US Fisheries Service killed hundreds of thousands of breeding female fur seals at their rookeries in response to a request by Japan to reduce the fur seal population (York and Hartley 1981). Japan was concerned the fur seals were eating too much fish (York and Hartley 1981). The fur seal population subsequently plummeted.

Northern fur seals seem to be particularly vulnerable to entanglement in marine debris and fishing gear. Death through entanglement in debris and derelict gear has been thought to have population-level impacts in the past (Trites and Larkin 1989, Fowler et al. 1992). Thousands of northern fur seals were also incidentally killed each year by drift gillnet fisheries for squid in the high seas until the fishing practice was banned (National Marine Fisheries Service 2007).

Commercial fisheries have a potentially significant adverse effect on fur seals through competition for prey resources (National Marine Fisheries Service 2004). The Pribilof northern fur seals rely on walleye pollock for a large part of their diet and there is a high degree of overlap between age classes of pollock consumed by northern fur seals and pollock caught by the commercial fishery (Gudmundson et al. 2006). A great deal of commercial pollock fishing occurs where the fur seals forage around the Pribilof Islands.

The Eastern Pacific stock of northern fur seals is declining, and fewer pups are being produced on their main breeding rookeries of the Pribilof Islands (Muto et al. 2016). Pup production from the newer colony on Bogoslof Island now makes up 21% of the pups born in Alaska each year (Muto et al. 2016). Bogoslof Island was actively erupting in 2016 and 2017 and it is unknown how that will affect the pregnant females when they return in the spring.

MAPPING METHODS (MAP 6.5)

The summer feeding area polygon for Bogoslof Island fur seals was digitized from Figure 1 in Benoit-Bird et al. (2013). The feeding area polygon for St. George Island fur seals was digitized from Figure 3 in Robson et al. (2004). The feeding area for St. Paul Island fur seals was created by combining the digitized feeding areas from Figure 2 in Robson et al. (2004) and Figure 1 in Benoit-Bird et al. (2013). All feeding areas from both studies describe the feeding range from breeding sites for lactating females. Feeding areas from Benoit-Bird et al. (2013) are described by density kernels with the highest use occurring closer to the breeding sites (Bogoslof Island colony or St. Paul Island colony). For the purposes of this map, these areas were digitized to show only areas of either presence or absence.

Colony locations on St. Paul Island, St. George Island, and Bogoslof Island were obtained from National Oceanic and Atmospheric Administration (2015c).

Female fur seal migration data were based on satellite telemetry data from Sterling et al. (2014), who assessed the contrasting wintertime migration strategies of male and female fur seals. Females exhibited a typical migration pattern by leaving the Bering Sea generally through Unimak Pass and traveling southward toward the Gulf of Alaska and California Current. This same migration route has been documented by other studies. In contrast, male fur seals displayed a wide variety of migratory behaviors, so it was not possible to delineate a distinct migration route.

Data Quality

Data and information for northern fur seals were limited to the Eastern Pacific stock only. Because of their behavior and locations on only three islands in the Bering Sea, female northern fur seal foraging areas in the summer, and winter migration behavior for this stock is fairly well documented. Males, however, exhibit less predictable behavior so data for male northern fur seals are lacking.

Reviewers

- Jeremy Sterling

MAP DATA SOURCES

Summer Feeding Areas, Bogoslof Island Fur Seals: Benoit-Bird et al. (2013)

Summer Feeding Areas, St. Paul Island Fur Seals: Benoit-Bird et al. (2013); Robson et al. (2004)

Summer Feeding Areas, St. George Island Fur Seals: Robson et al. (2004)

Rookeries: National Oceanic and Atmospheric Administration (2015c)

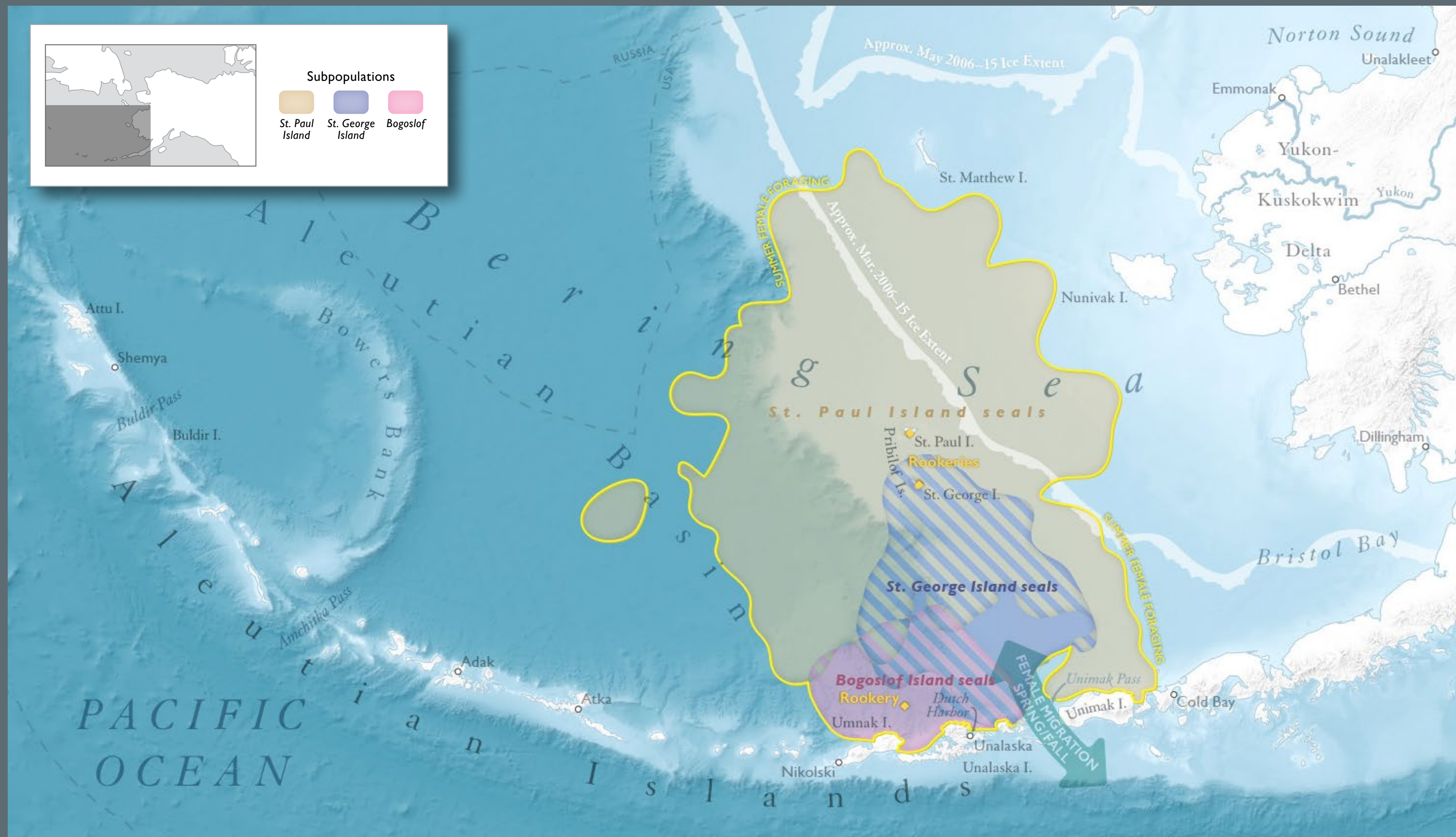
Female Migration: Sterling et al. (2014)

6.5 NORTHERN FUR SEAL

MAP ON PAGE 238

Northern Fur Seal

OCEANA Audubon ALASKA



Benoit-Bird et al. (2013); National Oceanic and Atmospheric Administration (2015); Robson et al. (2004); Sterling et al. (2014)

Map Authors: Brianne Mecum, Marilyn Zaleski, and Jon Warrenchuk
Cartographer: Daniel P. Huffman

Northern Fur Seal (*Callorhinus ursinus*)

This map shows summer foraging areas and spring rookeries of three subpopulations of northern fur seals in Alaska. The northern fur seal is a pinniped, and spends most of its life at sea. It comes ashore in the spring and gathers at colonial breeding sites, or rookeries, on only a few islands in the world. The home range of the northern fur seal covers a vast area, from the Bering Strait to the California Current. Despite its expansive range, 50% of the northern fur seal population returns to the Pribilof Islands rookeries in the Bering Sea to breed and give birth to their young. When foraging offshore, they concentrate at major oceanographic frontal features formed by offshore seamounts, canyons, and the continental shelf break. After the pups are weaned, females leave the rookeries and migrate south, traveling through the passes in the Aleutian Islands and into the offshore Pacific, Gulf of Alaska, and California Current. Older males remain in the Bering Sea longer and do not migrate as far south as the females. Unimak Pass serves as the primary migration corridor twice per year as the animals leave and return to the Bering Sea.

Northern fur seals were subject to a major commercial harvest for their fur, first starting when Russian explorers discovered the Pribilof Island rookeries in 1796, and continued by the US after purchase of Alaska until 1984.

Dave Withrow / NOAA Fisheries, Alaska Fisheries Science Center

MAP ON PAGE 238

Northern fur seal bull.

John Schoen

Beluga Whale

Delphinapterus leucas

Max Goldman and Erika Knight

Beluga whales (*Delphinapterus leucas*) are unmistakable Arctic specialists broadly distributed throughout the circumpolar northern latitudes. With at least 19 global stocks, or distinct population segments (DPSs), of which 5 use the Bering, Chukchi, or Beaufort Seas, beluga whales are among the very few entirely Arctic marine mammals on the planet (Braham et al. 1984, Solovyev et al. 2012, Laidre et al. 2015). A sixth stock, the critically endangered Cook Inlet DPS, never travels outside of the sheltered waters of Cook Inlet in Alaska.

Beluga whales are extremely social animals, feeding and traveling in and between their distinct wintering and summering grounds in groups that often number in the hundreds. The five DPSs that use the Bering, Chukchi, and Beaufort Seas are the Bristol Bay stock, the Eastern Bering Sea stock, the Anadyr stock, the Eastern Chukchi stock, and the Beaufort stock (Map 6.6.1).

ADAPTATIONS

Known in many regions as the "white whale" due to the white skin color of the adults, beluga whales are small relative to other whales, with an average adult weight and length of 3,150 pounds (1,430 kg) and 13 feet (4 m) (Brodie 1989; Doidge 1990a, b). Female beluga whales are measurably smaller than their male counterparts, usually by 300 hundred pounds (140 kg) and 2–3 feet (less than 1 m). Beluga calves are born weighing more than 150 pounds (50 kg) and measuring around 5 feet long (less than 2 m). As a toothed whale, the beluga's dentition lends insight into their longevity, with the rings of their teeth suggesting typical lifespans of 35–50 years, extending to 70 years in some cases (Luque et al. 2007, Suydam 2009). Unlike most other cetaceans, beluga whales lack true dorsal fins and do not produce a typical mist when surfacing to breathe. Belugas are also unique in that they can move their heads up, down, left and right—a possible benefit while hunting (Brodie 1989; Doidge 1990a, b). Most whales have fused cervical vertebrae that keep them from moving their heads this way. Like all other Arctic marine mammals, the beluga's thick layer of blubber insulates them from the frigid and often ice-covered waters of their Arctic range.

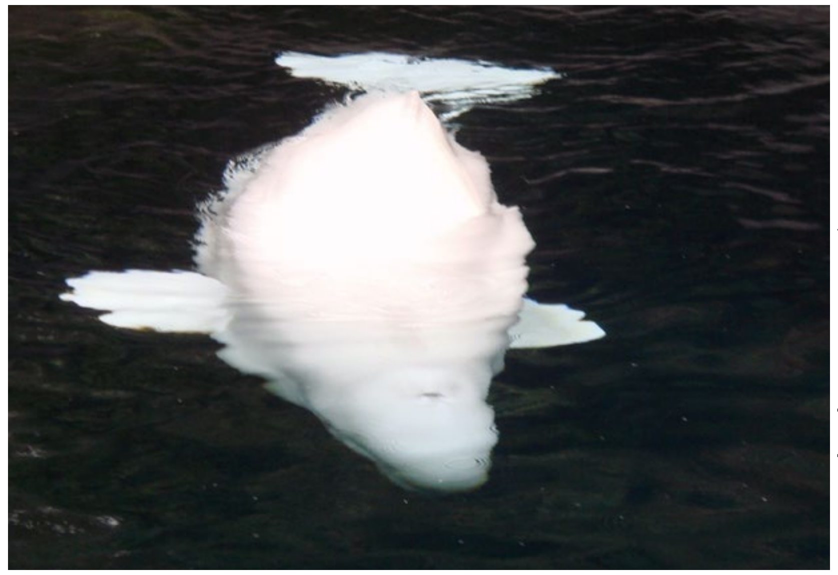
Vocalizations

Beluga whales are highly vocal and are often referred to as the "canaries of the sea," in reference to the vast array of sounds they produce, including whistles, squeals, moos, chirps, and clicks (Sjare and Smith 1986). The need for such a repertoire may stem from their highly social tendencies and their often dark, ice-covered habitat with poor visibility, which necessitates vocal communication. Belugas also have highly developed senses of hearing and vision, and possess a unique organ called a melon, which is a malleable, cranial mass used for echolocation (Mooney et al. 2008). Their closest relative, the narwhal, is of similar size, lives in the same habitat, and also has the melon organ. Like those of other toothed whales, the brains of belugas show no evidence of olfactory bulbs or nerves, which suggests they do not have a sense of smell. Instead, areas of their mouths act as sensitive chemoreceptors, effectively allowing them to "smell" the water (O'Corry-Crow 2002).

DISTRIBUTION

Belugas live throughout the Arctic, from Greenland to North America to Russia, including in the Sea of Okhotsk, the Bering Sea, Cook Inlet, Gulf of Alaska, Beaufort Sea, Baffin Bay, Hudson Bay, and the Gulf of St. Lawrence (Hauser et al. 2014). They prefer coastal or continental shelf waters, although belugas also use the much deeper water of the Canada Basin (Hauser et al. 2017b, Stafford et al. in press).

Five separate stocks of beluga whales winter in the Bering Sea, including the Bristol Bay, Eastern Bering Sea, Anadyr, Eastern Chukchi Sea, and Beaufort Sea populations. Each stock winters in a different portion of the Bering Sea, and exhibits site fidelity from year to year,



Dr. Kristin Laidre, Polar Science Center, UW / NOAA

The unique, white skin of the beluga whale makes them one of the most familiar and easily recognized cetaceans.

suggesting that belugas from different populations have population-specific winter ranges (Citta et al. 2016).

In summer, the Eastern Chukchi Sea and Beaufort Sea beluga stock ranges overlap in the Arctic, while the Bristol Bay, Eastern Bering Sea, and Anadyr stocks are restricted to their respective ranges (Suydam et al. 2001, Harwood et al. 2014, Hauser et al. 2017b). During certain times of the year, belugas are also known to travel far upstream to feed in large, freshwater rivers, and seem to be unaffected by salinity changes (Watts and Draper 1988, Hobbs et al. 2005, Harwood et al. 2014).

Sea-Ice Habitat

During the winter, beluga whales are found in offshore waters near the pack ice margin, and are closely associated with polynyas and leads. Belugas swim in the marginal ice zone of Arctic and subarctic waters, where water temperatures may be lower than 32° F (0° C), (Moore et al. 2000, Laidre et al. 2008). The role of sea ice in the life of Arctic whales is still unclear. Evidence suggests that factors such as bathymetry and hydrography play larger roles in beluga whale habitat selection than sea ice. It is clear, however, that sea ice plays a large role in beluga natural history, informing the seasonal movements through their range (Hauser et al. 2017b). These whales are clearly adaptable to a wide range of conditions, and show elasticity in their behavior as new conditions present themselves (Hauser et al. 2017a, O'Corry-Crowe et al. 2016).

LIFE CYCLE

In the Bering, Chukchi, and Beaufort Seas, beluga whales mate in the spring, usually in March or April. Gestation lasts about 14–15 months, and in the northernmost portions of their respective ranges, most calves are born between May and July, when the water is warmest, as newborn calves lack a thick blubber layer. The calves are born toothless and nurse exclusively for 12–18 months. When their teeth emerge, they begin to supplement their diets with shrimp and small fishes, although they will often continue to nurse. Females are old enough to reproduce at around four to seven years, and give birth to single calves every two to three years. Males reach sexual maturity between ages seven and nine (Doidge 1990a, b).

Molting

Belugas shed their outer layer of skin, or molt, each summer around July. They concentrate in shallow water and rub against coarse gravel, removing the top layer of old skin to reveal the new skin (St. Aubin et al. 1990).

Diet

Opportunistic feeders, the belugas of the Bering, Chukchi, and Beaufort Seas move between seasonally disparate habitats and consume equally diverse prey. They concentrate their hunting efforts on calorically beneficial prey, such as cephalopods, bivalves, gastropods, arthropods, annelids, and a variety of fishes, including salmon, eulachon, cod, and flounder (Loseto et al. 2009, Marcoux et al. 2012, Quakenbush et al. 2015). The unique movements of water through Barrow Canyon in the far eastern Chukchi Sea results in high concentrations of Arctic cod (*Arctogadus glacialis*) during the summer months, a resource the belugas of the Chukchi and Beaufort Seas exploit each year (Hauser et al. 2015, Stafford et al. in press).

CONSERVATION ISSUES

The critically endangered Cook Inlet DPS is the only population of belugas listed under the Endangered Species Act (ESA). Genetically isolated for millennia, the population has been reduced in the last 40 years from 1,300 individuals in the late 1970s to approximately 280 whales in 2015 (Allen and Angliss 2014, Muto et al. 2016). In 2011, 3,016 square miles (7,809 square km) of marine habitat were designated as Critical Habitat for the Cook Inlet beluga whale DPS (76 FR 20180; 50 CFR part 226.220). As of 2012, the International Union for the Conservation of Nature (IUCN) lists the entire species as near-threatened (Jefferson et al. 2012). They are protected under the Marine Mammal Protection Act (MMPA), and were listed as depleted in the late 1990s.

The Arctic climate continues to change significantly, requiring adaptation by the species that rely upon this unique ecosystem. Changes in sea-ice extent, quality, and timing directly and indirectly impact the life history of beluga whales (Johannessen et al. 2004, Hauser et al. 2017a, O'Corry-Crowe et al. 2016). Ice-associated and ice-obligated species will be forced to adapt to shifts and changes in water temperatures, habitat availability, prey species quantities and composition, and weather patterns, although there is evidence that the beluga whale may be less susceptible to the potentially drastic changes they face, owing to their broad distribution and exhibited adaptability (Laidre et al. 2008, Moore and Huntington 2008, Heide-Jørgensen et al. 2010).

Hydrocarbon exploration may affect whales due to noise, especially seismic activities. Offshore energy development may result in pollution or oil spills. A large oil spill could be catastrophic due to sea-ice conditions that make a spill difficult to clean up, coupled with very little localized response infrastructure or capability (Miles et al. 1987, LGL and Greeneridge 1995, LGL 1996, Suydam et al. 2005).

In far northern latitudes, such as the Bering and Chukchi Seas, large fluctuations in lower trophic recruitment have been observed as a result of a changing climate (Bakun et al. 2015). Beluga whales, along with all other life in the Arctic, will be impacted by those changes (O'Corry-Crowe et al. 2016).

Beluga whales are an important subsistence species as their meat and blubber are a traditional food source for indigenous Arctic communities. Additionally, beluga whales are the only cetacean with skin thick enough to be used as leather when tanned, and are coveted among subsistence hunters. While the Bering, Chukchi, and Beaufort Sea populations are harvested in sustainable numbers, the reported annual subsistence harvest of Cook Inlet belugas by Alaska Natives during 1995–1998 was unsustainable, averaging 77 belugas per year and likely resulted in substantial population decline from 1994 to 1998. This decline prompted the depleted designation under the MMPA (Frost and Suydam 2005). Today, subsistence harvest of belugas by native populations in the US, Canada, and Russia is ongoing and at current levels is not likely to have any noticeable impact on the health of beluga stocks (Huntington 2002, Muto et al. 2016). Between 1999 and 2015, five Cook Inlet beluga whales were taken through subsistence harvest.

MAPPING METHODS (MAPS 6.6.1–6.6.2)

The beluga whale map shows migration and species distribution broken into groups of "winter" and "non-winter" data to show seasonality, and is categorized into four levels of intensity: extent of range, regular use, concentration, and high concentration.

Beluga whale range information was compiled by Audubon Alaska (2016c) based on figures published in the 2007 Alaska Marine Mammal

Vicki Beaver / NOAA Fisheries, Alaska Fisheries Science Center

A highly social species, beluga whales have been referred to as the "canaries of the sea" because of their vocal nature, employing a complex language of clicks, whistles, and clangs to communicate among pod members.

Stock Assessment (Angliss and Outlaw 2008), papers by Citta et al. (2016) and Hauser et al. (2014), and data provided in an assessment of Biologically Important Areas (BIAs) for Cetaceans in US waters (Clarke et al. 2015, Ferguson et al. 2015).

Areas that belugas regularly use in winter are represented by wintering areas defined in a satellite telemetry study by Citta et al. (2016). These areas are specific to each beluga stock; we have merged and smoothed these stock-specific areas to show the general area regularly used by all beluga stocks in winter. Regular use, non-winter areas are also shown, based on analyses of satellite telemetry data by both Citta et al. (2016) and Hauser et al. (2014). Citta et al. (2016) delineated summer locations of each beluga stock; Hauser et al. (2014) analyzed 95% kernel density contours for males and females from the Beaufort and Chukchi stocks. The regular use, non-winter areas shown on our map represent the merged output of these data.

Concentration areas are shown for the non-winter season. These concentration areas come from several publications: Citta et al. (2016), Clarke et al. (2015), Ferguson et al. (2015), Hauser et al. (2014), Muto et al. (2016), Suydam and Alaska Department of Fish and Game (2004); and an Audubon Alaska and Oceana analysis of data from the Aerial Survey of Arctic Marine Mammals (ASAMM) (National Oceanic and Atmospheric Administration 2015a), which were collected between 2000 and 2015 (Audubon Alaska and Oceana 2016). The ASAMM data (formerly Bowhead Whale Aerial Survey Project [BWASP]) were analyzed in consultation with Megan Ferguson and Janet Clarke, the points of contact for this database and associated reports, who provided valuable advice and feedback. Aerial survey methods, data, and metadata for the ASAMM database are available at: http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php. The Audubon Alaska and Oceana analysis used only on-transect data where there were more than 62 miles (100 km) of survey effort in a 12.4-mile by 12.4-mile (20-km by 20-km) grid cell. An observation rate (i.e. relative density) was calculated in each grid cell by dividing the observed number of animals over all years by the measure of total transect length over all years. This observation rate was converted into point data with one point per grid cell (at the centroid), and a kernel density function was run with a 24.8-mile (40-km) search radius (two grid-cell radius in all directions) to smooth the data.

High-concentration areas are also shown for the non-winter season. In the eastern Chukchi and western Beaufort, these data were compiled by Audubon Alaska (2017a) based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2015), Daniel et al. (2015), and Stafford et al. (in press). High-concentration areas also incorporate traditional knowledge published in Stephenson and Hartwig (2010) and Huntington and the Communities of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik (1999); as well as data published in Paulic et al. (2012), Harwood et al. (2014), and in the 2004 North Slope Borough Area Wide Comprehensive Plan (Suydam and Alaska Department of Fish and Game 2004). Where such information is known (based on traditional knowledge by Huntington et al. (1999) and/or analysis conducted as part of the BIA assessment (Clarke et al. 2015)), high-concentration (and concentration) areas are labeled with information on how belugas use these areas (i.e., for molting or calving).

Migration information was derived from a combination of sources, including governmental studies by Muto et al. (2016), and National Oceanic and Atmospheric Administration (1988), and peer-reviewed papers by Citta et al. (2016), Richard et al. (2001), Suydam et al. (2005), and Hauser et al. (2014).

The sea-ice data shown on this map approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See Sea Ice Mapping Methods section for details.

Data Quality
Data quality of beluga range and regular use areas, as well as migration data, is generally good across the project area. Range information is based primarily on one assessment that was consistent throughout the map area (Angliss and Outlaw 2008), which we modified based on more recent studies. Regular use areas are based on two satellite telemetry studies of tagged belugas from each of the five stocks encompassed in our map area (Citta et al. 2016, Hauser et al. 2014). Similarly, migration information is based on many data sources, including telemetry data of whales tagged in each of these five stocks (Citta et al. 2016).

By contrast, concentration and high-concentration data are primarily available for US and Canadian waters. The mapped concentration areas extend into the Russian portion of the Chukchi Sea, but these data are based on telemetry data for belugas tagged in the US and in Canada (see Map Data Sources below). High-concentration area information is available for US waters only. Additional concentration and high-concentration areas may be present in regions where such information was not available as of our publication date.

Reviewers
- Bering Strait Traditional Knowledge-Holder Map Review Workshop participants
- Donna Hauser
- Megan Ferguson

MAP DATA SOURCES

BELUGA WHALE MAP

Extent of Range: Audubon Alaska (2016c) based on Angliss and Outlaw (2008), Citta et al. (2016), Clarke et al. (2015), Hauser et al. (2014)

Regular Use (Winter): Audubon Alaska et al. (2017); Citta et al. (2016)

Regular Use (Non-winter): Citta et al. (2016); Hauser et al. (2014)

Concentration (Non-winter): Audubon Alaska and Oceana (2016); Citta et al. (2016); Clarke et al. (2015); Ferguson et al. (2015); Hauser et al. (2014); Muto et al. (2016); Suydam and Alaska Department of Fish and Game (2004)

High Concentration (Non-winter): Audubon Alaska (2017a) based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2015), Daniel et al. (2015), Stafford et al. (in press); Harwood et al. (2014); Huntington and the Communities of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik (1999); Paulic et al. (2012); Stephenson and Hartwig (2010); Suydam and Alaska Department of Fish and Game (2004)

Reproduction: Audubon Alaska et al. (2017); Clarke et al. (2015); Huntington and the Communities of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik (1999)

Migration: Audubon Alaska (2016b) based on Audubon Alaska et al. (2017), Citta et al. (2016), and Muto et al. (2016); Hauser et al. (2014); National Oceanic and Atmospheric Administration (1988); Richard et al. (2001); Suydam et al. (2005)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

BELUGA STOCKS MAP

Anadyr Stock: Summer and winter—Citta et al. (2016)

Bristol Bay Stock: Summer and winter—Citta et al. (2016)

Cook Inlet Stock: Year-round—Muto et al. (2016)

Beaufort Sea Stock: Summer—Hauser (2017a); Winter—Citta et al. (2016)

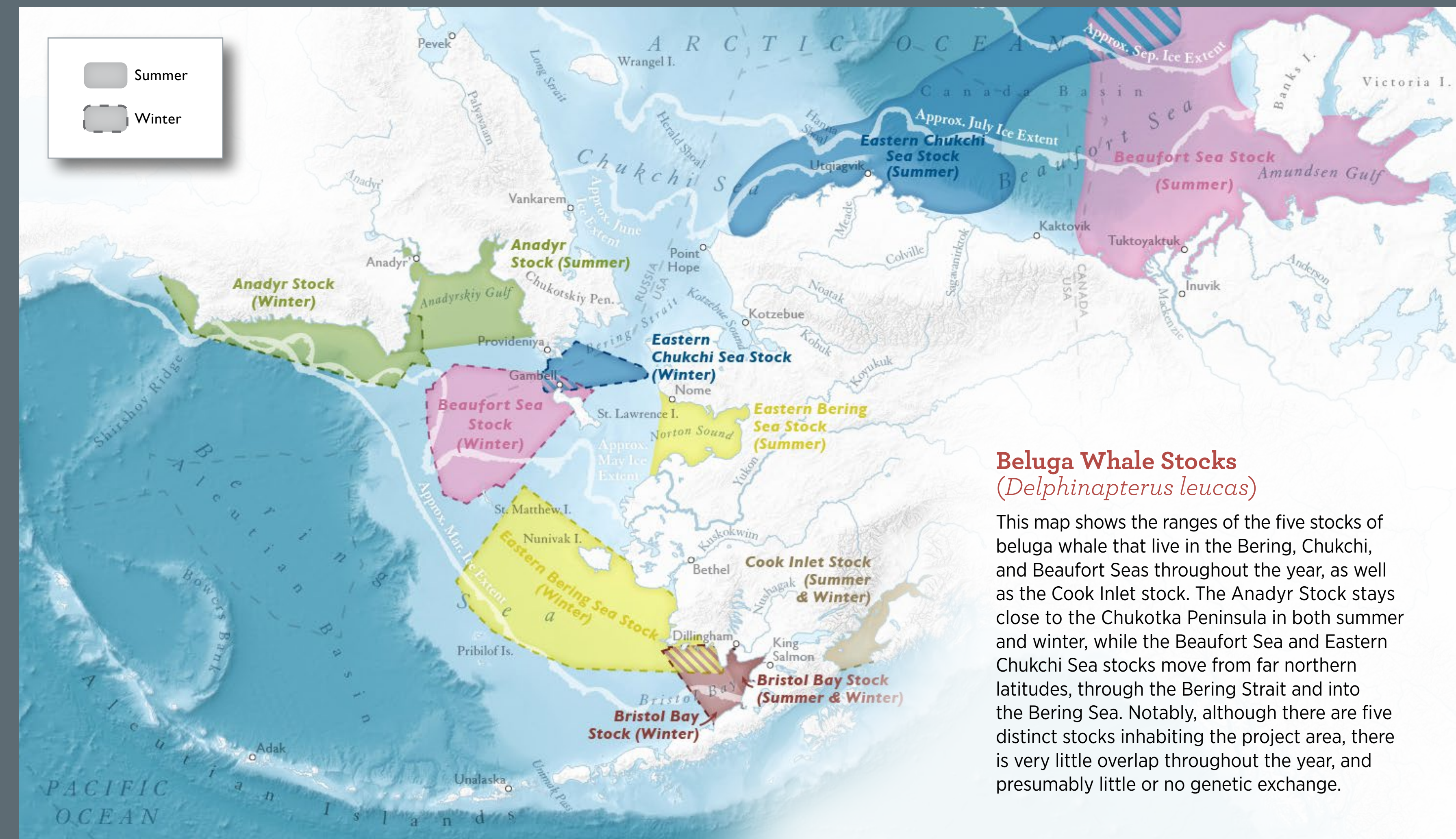
Eastern Bering Sea Stock: Summer and winter—Citta et al. (2016)

Eastern Chukchi Sea Stock: Summer—Hauser (2017a); Winter—Citta et al. (2016)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

Beluga Whale Stocks

Audubon ALASKA



Beluga Whale Stocks
(Delphinapterus leucas)

This map shows the ranges of the five stocks of beluga whale that live in the Bering, Chukchi, and Beaufort Seas throughout the year, as well as the Cook Inlet stock. The Anadyr Stock stays close to the Chukotka Peninsula in both summer and winter, while the Beaufort Sea and Eastern Chukchi Sea stocks move from far northern latitudes, through the Bering Strait and into the Bering Sea. Notably, although there are five distinct stocks inhabiting the project area, there is very little overlap throughout the year, and presumably little or no genetic exchange.

Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Citta et al. (2016); Hauser (2017a); Muto et al. (2016)

Map Authors: Erika Knight and Max Goldman
Cartographer: Daniel P. Huffman

Laura Morse / NOAA Fisheries, Alaska Fisheries Science Center

Beluga Whale

Map Authors: Erika Knight, Max Goldman, and Melanie Smith
Cartographer: Daniel P. Huffman

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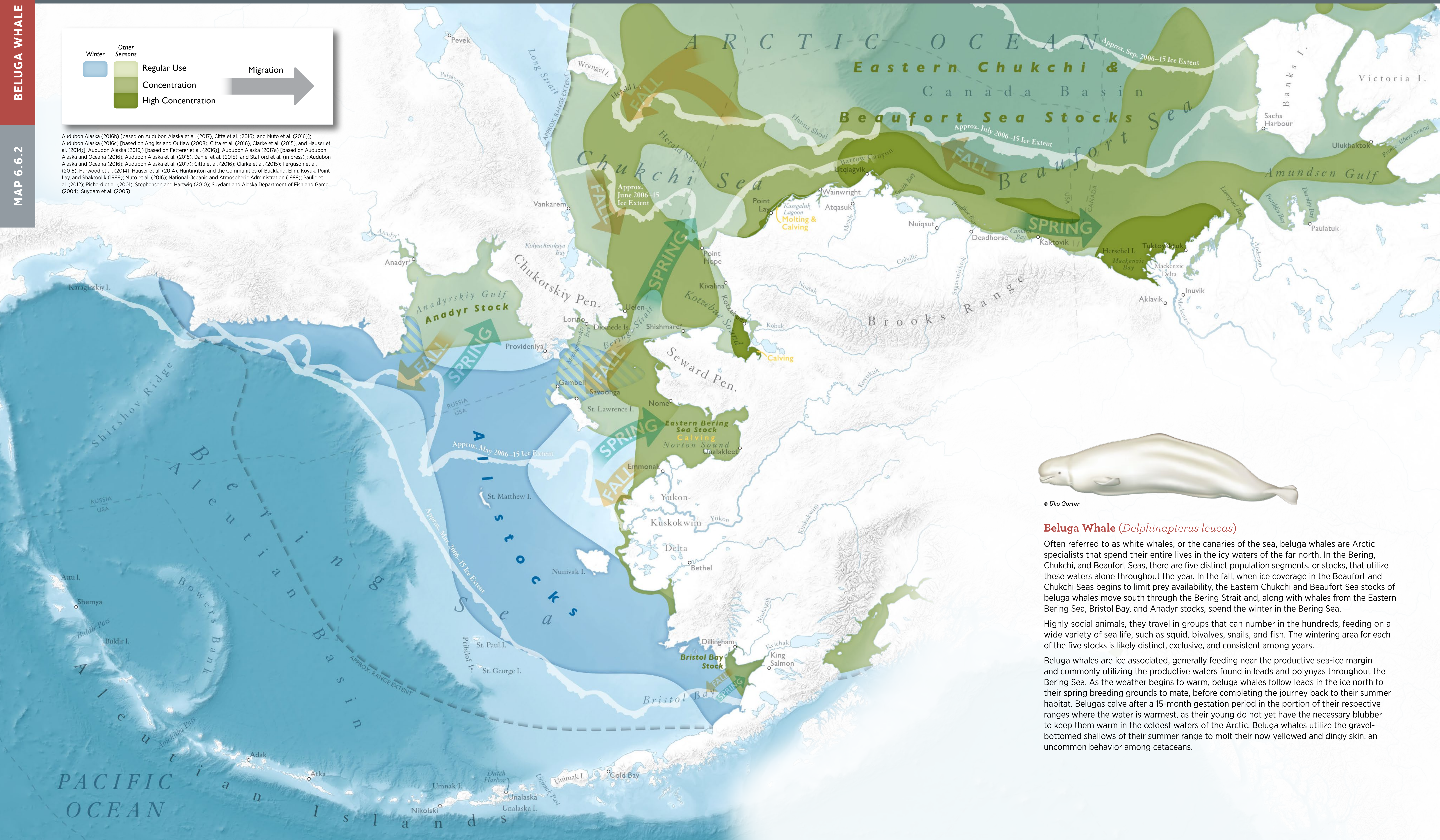
Audubon ALASKA



Audubon Alaska (2016b) [based on Audubon Alaska et al. (2017), Citta et al. (2016), and Muto et al. (2016)]; Audubon Alaska (2016c) [based on Angliss and Outlaw (2008), Citta et al. (2016), Clarke et al. (2015), and Hauser et al. (2014)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska (2017a) [based on Audubon Alaska and Oceana (2016), Audubon Alaska et al. (2015), Daniel et al. (2015), and Stafford et al. (in press)]; Audubon Alaska and Oceana (2016); Audubon Alaska et al. (2017); Citta et al. (2016); Clarke et al. (2015); Ferguson et al. (2015); Harwood et al. (2014); Hauser et al. (2014); Huntington and the Communities of Buckland, Elim, Koyuk, Point Lay, and Shaktoolik (1999); Muto et al. (2016); National Oceanic and Atmospheric Administration (1988); Paulic et al. (2012); Richard et al. (2001); Stephenson and Hartwig (2010); Suydam and Alaska Department of Fish and Game (2004); Suydam et al. (2005)

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Beluga Whale (*Delphinapterus leucas*)

Often referred to as white whales, or the canaries of the sea, beluga whales are Arctic specialists that spend their entire lives in the icy waters of the far north. In the Bering, Chukchi, and Beaufort Seas, there are five distinct population segments, or stocks, that utilize these waters alone throughout the year. In the fall, when ice coverage in the Beaufort and Chukchi Seas begins to limit prey availability, the Eastern Chukchi and Beaufort Sea stocks of beluga whales move south through the Bering Strait and, along with whales from the Eastern Bering Sea, Bristol Bay, and Anadyr stocks, spend the winter in the Bering Sea.

Highly social animals, they travel in groups that can number in the hundreds, feeding on a wide variety of sea life, such as squid, bivalves, snails, and fish. The wintering area for each of the five stocks is likely distinct, exclusive, and consistent among years.

Beluga whales are ice associated, generally feeding near the productive sea-ice margin and commonly utilizing the productive waters found in leads and polynyas throughout the Bering Sea. As the weather begins to warm, beluga whales follow leads in the ice north to their spring breeding grounds to mate, before completing the journey back to their summer habitat. Belugas calve after a 15-month gestation period in the portion of their respective ranges where the water is warmest, as their young do not yet have the necessary blubber to keep them warm in the coldest waters of the Arctic. Beluga whales utilize the gravel-bottomed shallows of their summer range to molt their now yellowed and dingy skin, an uncommon behavior among cetaceans.

Bowhead Whale

Balaena mysticetus

Max Goldman and Erika Knight

Bowhead whales (*Balaena mysticetus*) are endemic to northern latitudes, living out their entire lives in Arctic or subarctic waters (Niebauer and Schell 1993). Closely related and similar in appearance to right whales of the genus *Eubalaena*, the bowhead whale is the sole extant species in the genus *Balaena*. While bowheads came under enormous hunting pressure in the late 19th and 20th centuries, environmental protection and moratoria on commercial whaling have secured a future for this unique animal, and population numbers have rebounded significantly. Scientists classify the bowhead whale into five subpopulations or stocks: The Hudson Bay-Foxe Basin stock, the Baffin Bay-Davis Strait stock, the Okhotsk Sea stock, the Spitsbergen stock, and the Western Arctic or Bering Chukchi Beaufort stock (International Whaling Commission 2010). For management purposes, four bowhead whale stocks are currently recognized by the International Whaling Commission, with the Hudson Bay-Foxe Basin and Baffin Bay-Davis Strait stocks combined into the eastern Arctic-West Greenland stock (International Whaling Commission 2010).

ADAPTATIONS

Bowhead whales are mysticetes, meaning they have baleen plates instead of teeth for filtering food out of the ocean. They have the largest mouths of any animal on the planet, containing enormous baleen plates up to 14 feet (4.3 m) long (Quakenbush et al. 2008). Distinctively, bowheads have a dark body, a white chin, and lack a dorsal fin. Their 17–19 inch (43–50 cm) thick blubber layer is thicker than that of any other living animal, allowing them to thrive in the frigid waters of the high Arctic (Quakenbush et al. 2008; Quakenbush et al. 2010a, b). Their paired blowholes are positioned at the elevated peak of their massive heads, presumably allowing them to breathe through small openings in the frozen surface of the Arctic Ocean (Burns et al. 1993, Quakenbush et al. 2008).

The huge, 16-foot (5-m) long skull of the bowhead whale makes up nearly a third of their overall body length and is used to break through or lift thick ice sheets to breathe, granting the bowhead whale access to otherwise unattainable food sources. At about 45–60 feet (14–18 m) long and weighing 150,000–200,000 pounds (68,000–90,000 kg), bowheads are among the largest animals on the planet (Burns et al. 1993).

Vocalizations

Bowhead whales spend their entire lives in the often icy waters of the far north. For a substantial portion of the year, this habitat is shrouded in darkness and crusted with ice, making communication between individuals and groups using visual stimuli difficult or impossible. Bowhead calls add to the varied arctic soundscape that includes sounds produced by animals, wind, ice, and people (Blackwell et al. 2007, Hildebrand 2009). Bowhead whales have evolved to communicate by producing both simple calls and elaborate songs based in part on external stimuli in the aural environment (Clarke et al. 2015).

DISTRIBUTION

Bowhead whales are distributed in seasonally ice-covered waters of the Arctic and subarctic (Moore and Reeves 1993). Bowhead stocks occur in the Sea of Okhotsk (Russian waters), Baffin Bay-Davis Strait and Hudson Bay-Foxe Basin (western Greenland and eastern Canadian waters, sometimes split into two separate stocks), in the eastern North Atlantic (the Spitsbergen stock near Svalbard), and in the Bering-Chukchi-Beaufort Seas (the Western Arctic stock), which is the largest subpopulation and only stock found within US waters (Rugh et al. 2003).

The Western Arctic stock occurs from Chaunskaya Bay (Russia) in the western Chukchi Sea east to the Canadian Arctic Archipelago, and the northern Bering Sea south from near Cape Navarin (Russian Federation) along the Bering slope and St. Matthew Island (Rice 1998, Quakenbush et al. 2013). Despite the geographical proximity of wintering bowhead whales from the Western Arctic stock in the northern Bering Sea to those from the Sea of Okhotsk stock, there is no evidence of any geographical or temporal overlap of these stocks (Ivashchenko and Clapham 2010).

Sea-Ice Habitat

Bowhead whales are found only in Arctic and subarctic regions. Western Arctic bowheads spend much of their lives in, near, and even under the pack ice, migrating north to the Beaufort shelf and northeastern Chukotkan coast in summer, and retreating south through the Bering Strait with the advancing ice edge in winter (Moore and Reeves 1993). During winter, bowhead whales frequent areas near the sea-ice margin, utilizing leads (large cracks in ice) and polynyas (areas of open water in ice caused by wind or warm-water upwelling), and in areas of unconsolidated pack ice, though recent evidence suggests they are not as closely tied to these areas as previously understood (Nerini et a. 1984). During the spring these whales use leads to penetrate areas that were inaccessible during the winter due to heavy ice coverage. If no open water is available, they will locate a thin portion of the ice cover and use their massive heads to push up or break the ice sheet so they can breathe. Bowheads can break ice up to 2 feet (0.6 meters) thick (Quakenbush et al. 2008).

Migration

Bowhead whales of the Western Arctic stock migrate each spring from the Bering Sea through the Chukchi Sea to the eastern Beaufort Sea where they spend most of the summer (Moore and Reeves 1993). By early September bowheads begin their fall migration, leaving the eastern Beaufort Sea during September and October. The bowheads move past Barrow before heading west across the Chukchi Sea toward Russian waters (Moore and Reeves 1993, Clarke and Ferguson 2010, Clarke et al. 2016), where many feed in late fall off the northern coast of Chukotka before returning to the Bering Sea.

During the spring migration, bowhead whales typically begin arriving in the Utqiagvik area (formerly Barrow) area in early April and continue migrating past Utqiagvik until well into June. Most of this migration appears to be a fairly steady flow of whales traveling from the Chukchi Sea to the Beaufort Sea, but in late spring some whales have been seen making frequent turns in a small area, and are presumably feeding (Carroll et al. 1987). Although bowheads are more commonly seen off the coast of Utqiagvik during the spring and fall migrations, there have also been reports of whales feeding near Utqiagvik from late July to early September (Moore 1992, George et al. 2004, Moore et al. 2010). A smaller portion of the population follows an atypical migration path, instead migrating west along the northern Chukotka coast in spring and milling about during summer and fall, before returning to the Bering Sea in winter.

LIFE CYCLE

Bowhead whales reach sexual maturity at approximately 20 years of age. During northward spring migration in April, displays of breaching and fluke slapping ensue prior to mating. It is not clear if this activity is competitive in nature or a part of a cooperative mating strategy (Foote 1964, Everitt and Krogman 1979, Würsig et al. 1993, Audubon Alaska et al. 2017).

After a gestation period of 13–14 months, females give birth to a calf about 13 feet (4 m) long and weighing about 2,000 pounds (900 kg) (Nerini et al. 1984). Calves are born able to swim during the spring migration between April and June (Burns et al. 1993, Quakenbush et al. 2008). They form close bonds with their mothers, staying together for 9–12 months. Females give birth every three to four years (Nerini et al. 1984).

Bowhead whales are very long-lived, as suggested by biochemical methods and the discovery of stone, slate, and ivory harpoon heads in contemporary, hunter-killed animals, indicating a failed hunt from over 100 years ago (George et al. 1999). Biochemical age determination methods estimated the age of one male bowhead's tissue sample to be from 177 to 245 years old, indicating a possible lifespan of over 200 years, which makes bowhead whales the longest-lived mammal on earth (George et al. 1999, George and Bockstoce 2008).

Diet

Bowhead whales use their huge keratin baleen plates to filter-feed almost exclusively on zooplankton, including over 60 species of small to moderately sized (most 1 inch [2.5 cm] or less) crustaceans such as copepods, euphausiids, and mysids, as well as other invertebrates and fishes (Hoekstra et al. 2002, Lowry et al. 2004, Lee et al. 2005, Citta et al. 2015).

Bowheads feed from the surface to the bottom, under the ice, and in open water (Quakenbush et al. 2008). Bowheads with mud on their dorsal surfaces have been reported during the spring migration, indicating that they were near the sea bottom, presumably feeding on epibenthic prey. However, there is no evidence from the stomach contents of harvested whales that they, like gray whales (*Eschrichtius robustus*), ingest sediments. (Angliss and Outlaw 2008, Mocklin et al. 2012).

CONSERVATION ISSUES

The International Whaling Commission has attempted to protect bowhead whales from commercial whaling since its inception in 1946. The Aboriginal Whaling and Management Procedure has successfully managed subsistence hunting of bowhead whales, with take numbers consistently below the thresholds for impact to the overall population (Givens and Thomas 1997).

The Marine Mammal Protection Act of 1972 (MMPA) ensures protection against "take," which means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA does this by enacting a moratorium on the import, export, and sale of any marine mammal or marine mammal product within the US. Subsistence hunting is exempted from this legislation, and currently up to 67 bowhead whales are harvested via subsistence hunts annually to feed and to preserve the cultural heritage of the communities of the US Arctic coasts (Alaska Eskimo Whaling Commission 2007, 2013; Huntington et al. 2016b).

All bowhead whale stocks are currently listed as endangered under the US Endangered Species Act (ESA) and have been since the inception of the ESA in 1973. They were initially designated as endangered as a result of depletion by commercial whaling during the late 19th and 20th centuries. Due to the efforts put forth under these protections, the population has recovered considerably.

The International Union for Conservation of Nature (IUCN) has recognized the need for conservation efforts directed toward the bowhead whale since they first listed it as very rare in 1965. Their subsequent designations are shown in Table 6.7-1

TABLE 6.7-1. IUCN RedList Assessments for Bowhead Whales

Year	IUCN RedList Assessment
2008	Least concern (LC)
1996	Lower risk/conservation dependent (LR/CD)
1994	Vulnerable (V)
1990	Vulnerable (V)
1988	Endangered (E)
1986	Endangered (E)
1965	Very rare but believed to be stable or increasing

Corey Accardo / NOAA Fisheries, Alaska Fisheries Science Center

Among the largest animals on the planet, bowhead whales give birth every three to four years. A bowhead whale calf (pictured next to its mother) spends the first year of its life with its mother. For perspective, the adult beluga whales pictured are approximately 13 feet (4 m) long.

Commercial whaling in the north Pacific began in the mid-19th century, escalating and continuing into the 20th century before a near-global moratorium was agreed upon in 1982 (International Whaling Commission 2017). Minimum pre-whaling subpopulation sizes are estimated to have been 3,000 for the Okhotsk Sea stock; 12,000 for the Hudson Bay-Foxe Basin and Baffin Bay-Davis Strait stocks; and 24,000 for the Spitsbergen stock (Woodby and Botkin 1993). The Western Arctic stock was estimated to be 10,000–20,000 animals (Brandon and Wade 2006).

The current range-wide abundance of all five stocks of bowhead whales is not known. Estimates of the Western Arctic stock suggest a population of nearly 17,000 (George et al. 2004, Givens et al. 2013). Estimates of portions of the ranges of the Hudson Bay-Foxe Basin and Baffin Bay-Davis Strait stocks suggest populations of 3,500 and 7,300 respectively (Cosens and Blouw 2003, Koski et al. 2006b).

The Western Arctic stock has been increasing at a rate of approximately 3.4% per year over 30 years (Zeh and Punt 2005). Interviews with Native elders and subsistence hunters also suggest that bowhead whales have expanded their distribution in recent years (Koski et al. 2006a, Noongwook et al. 2007).

There are many areas of concern regarding the health of bowhead populations. While the biggest threat of the past was overharvest from commercial whaling activities, bowhead harvest for subsistence is currently well managed (National Oceanic and Atmospheric Administration 2013). However, broad-scale habitat degradation from human activities could affect bowhead behavior and/or abundance, which should be carefully considered for stock management in the future (Richardson 1995, Croll et al. 2001). Climate change and loss of sea ice affects productivity and availability of food resources—a yet unknown effect on the future of bowhead whale populations (George et al. 2015). Bowheads may be sensitive to noise disturbance from ships and are vulnerable to ship strikes, which will likely increase along with an increase in vessel traffic (Reeves et al. 2012). Hydrocarbon exploration may affect bowheads due to noise, especially from seismic activities (Ljungblad et al. 1988, Richardson 1995). Offshore energy development may result in pollution or oil spills. A large oil spill could be catastrophic due to sea ice conditions that make a spill hard to clean up, coupled with very little localized response infrastructure or capability. Commercial fishing gear entanglement is another issue of concern (Reeves et al. 2012, Reeves et al. 2014). Although commercial fisheries are not currently estimated to have a significant impact on bowheads, Native subsistence hunters have reported entanglement of bowheads (National Oceanic and Atmospheric Administration 2013).

MAPPING METHODS (MAPS 6.7a–6.7d)

Bowhead whale data are mapped on four season-specific maps (spring, summer, fall, and winter). Each map shows the overall (year-round) range extent of bowhead whales, as well as the season-specific range extent. Bowhead whale distribution for each season was further categorized into areas where there are known concentrations of bowheads and areas where there are known high concentrations of bowheads. Migration arrows and reproduction areas are shown where this information is available.

Bowhead whale year-round range was compiled from seasonal range data, which was primarily based on figures published in Quakenbush et al. (2013). The spring seasonal range extent from Quakenbush et al. (2013) was expanded based on Bogoslovskaya et al. (2016), spring Biologically Important Areas (BIAs) for bowhead whales published in Clarke et al. (2015), and data from a February 2017 workshop with Bering Strait region traditional knowledge experts who reviewed Audubon Alaska's draft bowhead maps (Audubon Alaska et al. 2017). The summer and winter ranges were based on Quakenbush et al. (2013) and expanded based on Bogoslovskaya et al. (2016) and Audubon Alaska et al. (2017). No modifications were made to the fall range from Quakenbush et al. (2013).

Seasonal concentration areas were merged by Audubon Alaska (2016d) based on BIAs (Clarke et al. 2015), density information from satellite telemetry from Citta et al. (2015), and seasonal information from Quakenbush et al. (2013). Data regarding summer feeding aggregations (Paulic et al. 2012) were included in the summer concentration area. Summer and fall concentration areas also incorporate the 95% isopleth from an Audubon Alaska and Oceana analysis (Audubon Alaska and Oceana 2016) of data from 2000 through 2014 from the Aerial Survey of Arctic Marine Mammals (ASAMM) (National Oceanic and Atmospheric Administration 2015a). The ASAMM data (formerly Bowhead Whale Aerial Survey Project [BWASP]) were analyzed in consultation with Megan Ferguson and Janet Clarke. Aerial survey methods, data, and metadata for the ASAMM database are available at: http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php. The Audubon Alaska and Oceana analysis used only on-transect data where there were more than 62 miles (100 km) of survey effort in a 12.4-mile by 12.4-mile (20-km by 20-km) grid cell. An observation rate (i.e. relative density) was calculated in each grid cell by dividing the observed number of animals over all years by the measure of total transect length over all years. This observation rate was converted into point data with one point per grid cell (at the centroid), and a kernel density function was run with an anisotropic kernel density function with a 24.8 mile (40 km) north-south search radius and a 49.6 mile (80 km) east-west search radius to smooth the data.

Seasonal high-concentration areas were also compiled by Audubon Alaska (2016e), largely based on density information from satellite telemetry (Citta et al. 2015) and seasonal information from Quakenbush et al. (2013), as described for concentration areas. The summer and fall high-concentration areas incorporate the 50% isopleth from the Audubon Alaska and Oceana analysis (Audubon Alaska and Oceana 2016) of 2000 through 2014 ASAMM data described above. Each seasonal high-concentration area also includes traditional knowledge information from Huntington and Quakenbush (2009) (spring, summer, and fall) and/or Noongwook et al. (2007) (winter and spring).

Reproduction information is labeled where such information is known based on traditional knowledge (Huntington and Quakenbush (2009) and Noongwook et al. (2007)) and/or the BIA assessment (Clarke et al. 2015).

Migration information was derived from a combination of sources, including National Oceanic and Atmospheric Administration (1988), Alaska Department of Fish and Game (1986), Alaska Department of Fish and Game (2009), Audubon Alaska et al. (2017), and the North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003).

Bowhead whaling communities shown in a NOAA environmental impact statement are also mapped (National Oceanic and Atmospheric Administration 2013). Shaktoolik was removed from this dataset based on draft map review by Bering Strait region traditional knowledge experts (Audubon Alaska et al. 2017).

The sea-ice data shown on these maps approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See "Sea Ice Mapping Methods" section for details.

Data Quality

Data quality for the maps is good. The data come from a variety of sources, including satellite telemetry studies, traditional knowledge, and long-term aerial surveys, which have delineated seasonal usage and densities of bowheads across the map area. The high-concentration and reproduction information shown may be an incomplete representation, especially in the Russian portions of the map area.

Reviewers

- Bering Strait Traditional Knowledge-Holder Map Review Workshop participants
- Sue Moore
- Lori Quakenbush

MAP DATA SOURCES

WINTER MAP

Overall Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)

Winter Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)

Concentration: Audubon Alaska (2016d) based on Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)

High Concentration: Audubon Alaska (2016e) based on Citta et al. (2015), Clarke et al. (2015), Noongwook et al. (2007), and Quakenbush et al. (2013)

Reproduction: Noongwook et al. (2007)

Migration: Alaska Department of Fish and Game (1986); Audubon Alaska (2016g) based on Alaska Department of Fish and Game (2016b); National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003)

Whaling Communities: National Oceanic and Atmospheric Administration (2013) (revised based on Audubon Alaska et al. (2017))

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

SPRING MAP

Overall Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)

Spring Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), Clarke et al. (2015), and Quakenbush et al. (2013)

Concentration: Audubon Alaska (2016d) based on Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)

High Concentration: Audubon Alaska (2016e) based on Citta et al. (2015), Huntington and Quakenbush (2009), Noongwook et al. (2007), and Quakenbush et al. (2013)

Reproduction: Clarke et al. (2015), Huntington and Quakenbush (2009), and Noongwook et al. (2007)

Migration: Alaska Department of Fish and Game (1986); Audubon Alaska (2016g) based on Alaska Department of Fish and Game (2016b); National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003)

Whaling Communities: National Oceanic and Atmospheric Administration (2013) (revised based on Audubon Alaska et al. (2017))

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

MAP DATA SOURCES (CONTINUED)

SUMMER MAP

Overall Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)

Summer Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)

Concentration: Audubon Alaska (2016d) based on Audubon Alaska and Oceana (2016), Citta et al. (2015), Clarke et al. (2015), Paulic et al. (2012), and Quakenbush et al. (2013)

High Concentration: Audubon Alaska (2016e) based on Audubon Alaska and Oceana (2016), Citta et al. (2015), Huntington and Quakenbush (2009), and Quakenbush et al. (2013)

Reproduction: Clarke et al. (2015)

Migration: Alaska Department of Fish and Game (1986); Audubon Alaska (2016g) based on Alaska Department of Fish and Game (2016b); National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003)

Whaling Communities: National Oceanic and Atmospheric Administration (2013) (revised based on Audubon Alaska et al. (2017))

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

FALL MAP

Overall Range: Audubon Alaska (2016f) based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)

Fall Range: Quakenbush et al. (2013)

Concentration: Audubon Alaska (2016d) based on Audubon Alaska and Oceana (2016), Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)

High Concentration: Audubon Alaska (2016e) based on Audubon Alaska and Oceana (2016), Citta et al. (2015), Huntington and Quakenbush (2009), and Quakenbush et al. (2013)

Reproduction: Clarke et al. (2015)

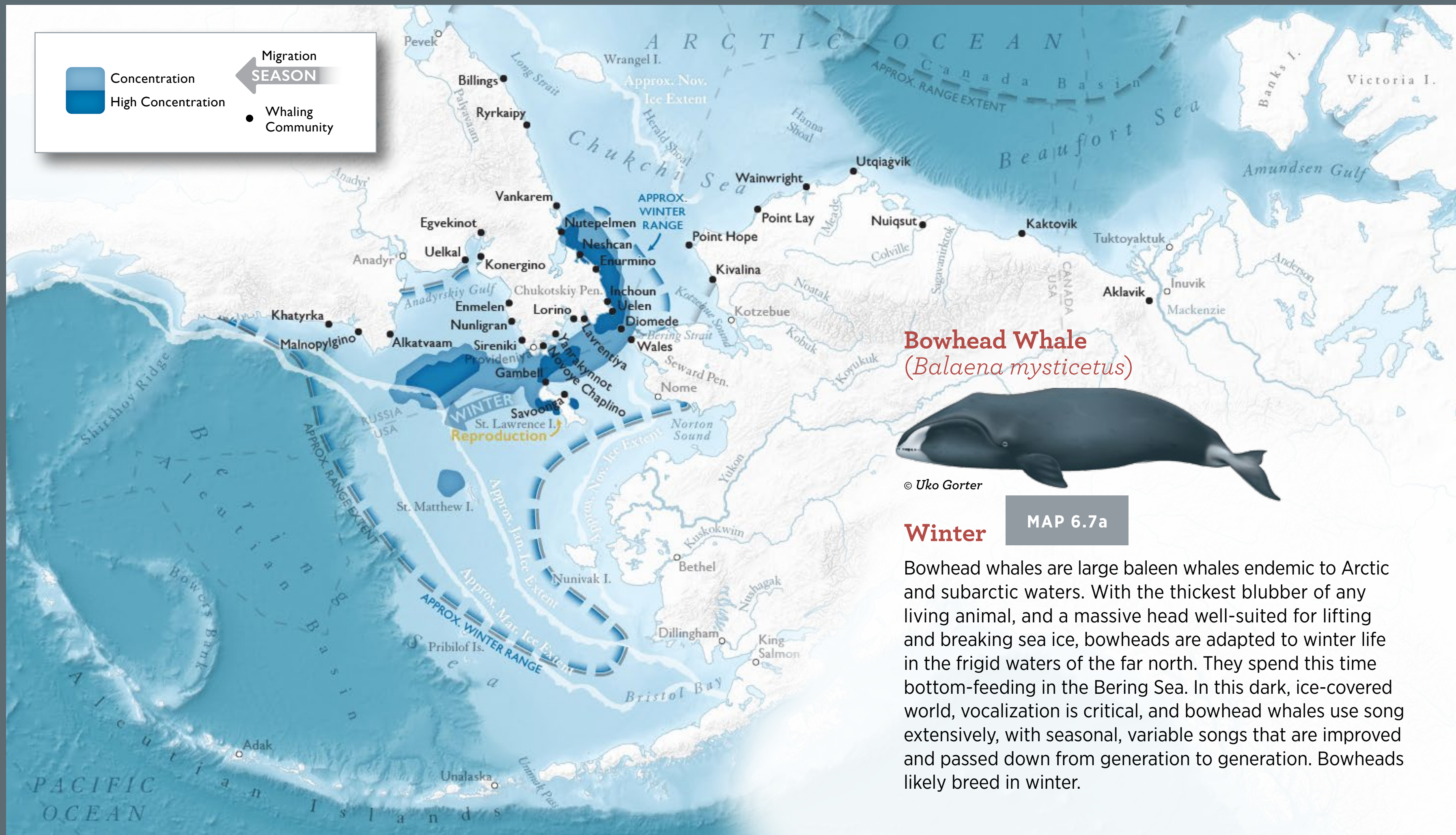
Migration: Alaska Department of Fish and Game (1986); Alaska Department of Fish and Game (2009); Audubon Alaska (2016g) based on Alaska Department of Fish and Game (2016b); Audubon Alaska et al. (2017); National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003)

Whaling Communities: National Oceanic and Atmospheric Administration (2013) (revised based on Audubon Alaska et al. (2017))

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

Bowhead Whale

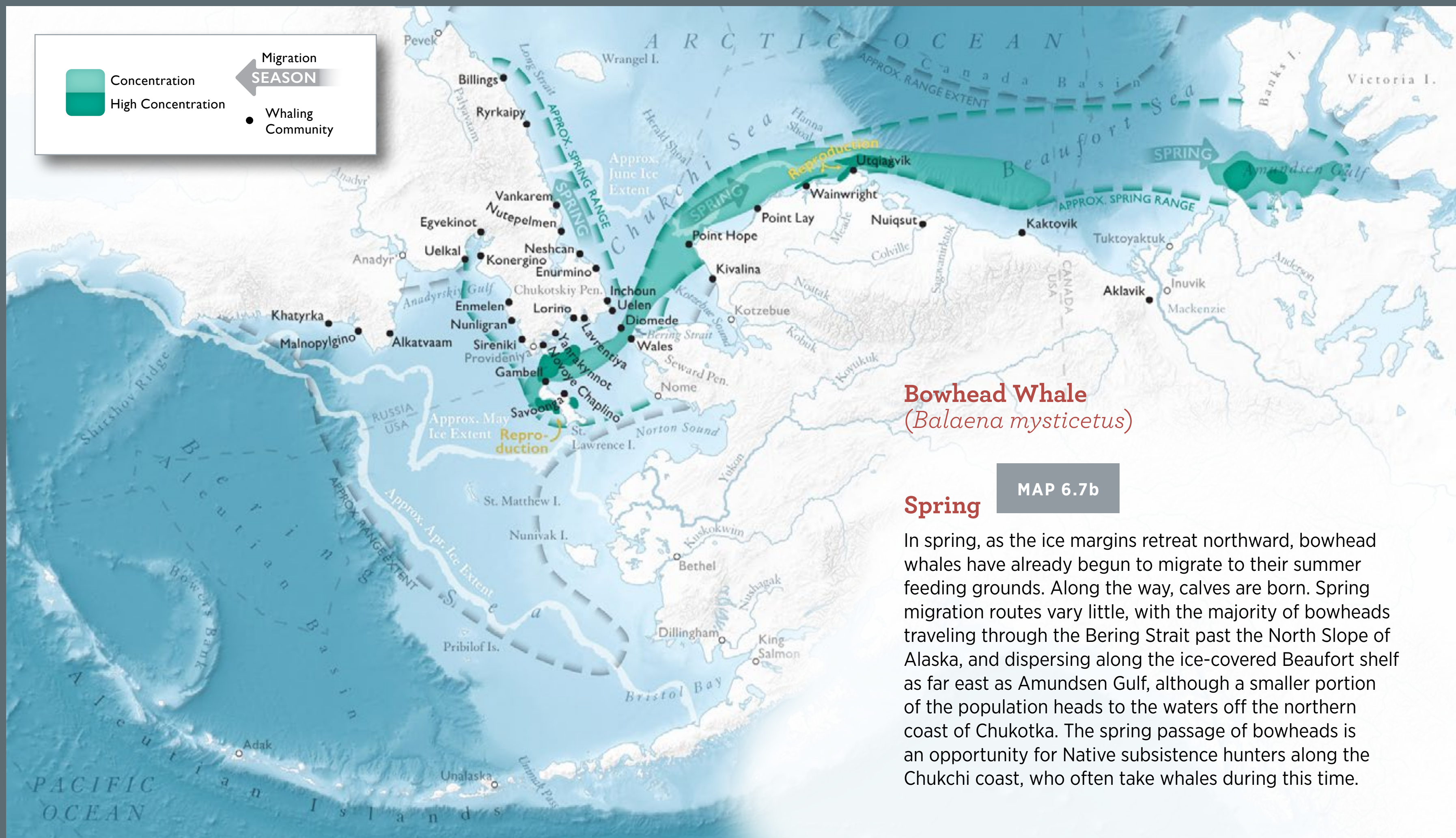
Map Authors: Melanie Smith, Erika Knight, and Max Goldman
Cartographer: Daniel P. Huffman



Winter

Bowhead whales are large baleen whales endemic to Arctic and subarctic waters. With the thickest blubber of any living animal, and a massive head well-suited for lifting and breaking sea ice, bowheads are adapted to winter life in the frigid waters of the far north. They spend this time bottom-feeding in the Bering Sea. In this dark, ice-covered world, vocalization is critical, and bowhead whales use song extensively, with seasonal, variable songs that are improved and passed down from generation to generation. Bowheads likely breed in winter.

Alaska Department of Fish and Game (1986); Audubon Alaska (2016d) [based on Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)]; Audubon Alaska (2016e) [based on Citta et al. (2015), Clarke et al. (2015), Noongwook et al. (2007), and Quakenbush et al. (2013)]; Audubon Alaska (2016f) [based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)]; Audubon Alaska (2016g) [based on Alaska Department of Fish and Game (2016b)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; National Oceanic and Atmospheric Administration (2013) [revised based on Audubon Alaska et al. (2017)]; National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003); Noongwook et al. (2007); Quakenbush et al. (2013)

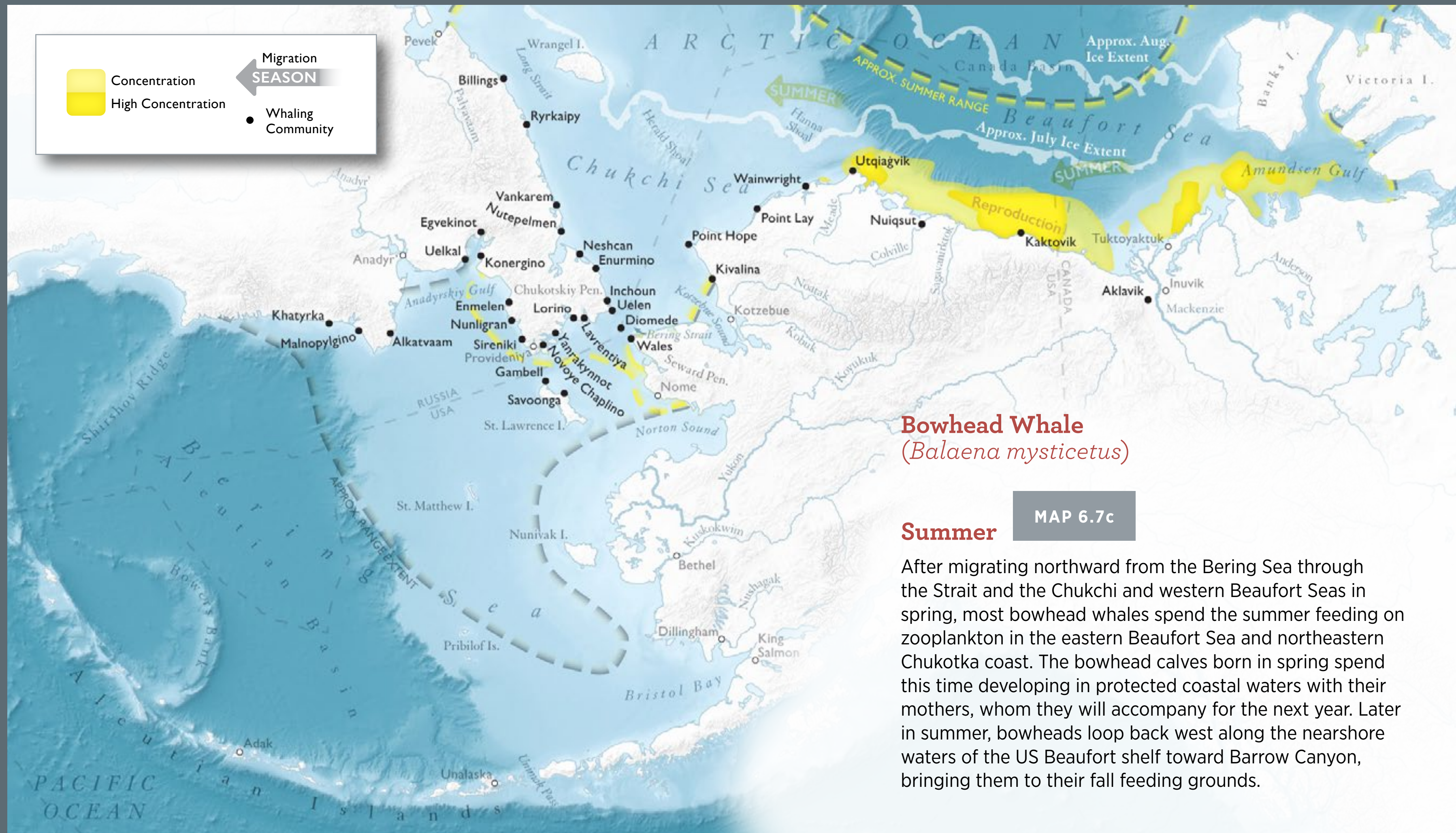


Spring

In spring, as the ice margins retreat northward, bowhead whales have already begun to migrate to their summer feeding grounds. Along the way, calves are born. Spring migration routes vary little, with the majority of bowheads traveling through the Bering Strait past the North Slope of Alaska, and dispersing along the ice-covered Beaufort shelf as far east as Amundsen Gulf, although a smaller portion of the population heads to the waters off the northern coast of Chukotka. The spring passage of bowheads is an opportunity for Native subsistence hunters along the Chukchi coast, who often take whales during this time.

Alaska Department of Fish and Game (1986); Audubon Alaska (2016d) [based on Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)]; Audubon Alaska (2016e) [based on Citta et al. (2015), Clarke et al. (2015), Noongwook et al. (2007), and Quakenbush et al. (2013)]; Alaska (2016f) [based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)]; Audubon Alaska (2016g) [based on Alaska Department of Fish and Game (2016b)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Clarke et al. (2015); Huntington and Quakenbush (2009); National Oceanic and Atmospheric Administration (2013) [revised based on Audubon Alaska et al. (2017)]; National Oceanic and Atmospheric Administration (1988); Noongwook et al. (2007); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003); Quakenbush et al. (2013)

KAWERAK, INC. Audubon ALASKA



Summer

After migrating northward from the Bering Sea through the Strait and the Chukchi and western Beaufort Seas in spring, most bowhead whales spend the summer feeding on zooplankton in the eastern Beaufort Sea and northeastern Chukotka coast. The bowhead calves born in spring spend this time developing in protected coastal waters with their mothers, whom they will accompany for the next year. Later in summer, bowheads loop back west along the nearshore waters of the US Beaufort shelf toward Barrow Canyon, bringing them to their fall feeding grounds.

Alaska Department of Fish and Game (1986); Audubon Alaska (2016d) [based on Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)]; Audubon Alaska (2016e) [based on Citta et al. (2015), Clarke et al. (2015), Noongwook et al. (2007), and Quakenbush et al. (2013)]; Alaska (2016f) [based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)]; Audubon Alaska (2016g) [based on Alaska Department of Fish and Game (2016b)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Clarke et al. (2015); National Oceanic and Atmospheric Administration (2013) [revised based on Audubon Alaska et al. (2017)]; National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003); Quakenbush et al. (2013)

Fall

Fall marks the start of the journey to return to the southern portion of their range. As colder temperatures move in, ice begins to form in the Beaufort Sea and food becomes scarce, necessitating the bowhead whale fall migration. Bowheads gather in the nearshore waters along the US Beaufort shelf to feed in the fall, before crossing the Chukchi Sea to congregate at fall feeding areas along the northern Chukotka coast. Later in the fall, the newly forming ice margins slowly push the whales further south from their feeding, breeding, and calving grounds until they reach the leads and polynyas they will rely on for the coming winter months. Newborn calves follow their mothers away from their birthplace for the first time, but will return again when the winter ends and the ice melts away.

Alaska Department of Fish and Game (1986); Alaska Department of Fish and Game (2009); Audubon Alaska (2016d) [based on Citta et al. (2015), Clarke et al. (2015), and Quakenbush et al. (2013)]; Audubon Alaska (2016e) [based on Citta et al. (2015), Clarke et al. (2015), Noongwook et al. (2007), and Quakenbush et al. (2013)]; Audubon Alaska (2016f) [based on Audubon Alaska et al. (2017), Bogoslovskaya et al. (2016), and Quakenbush et al. (2013)]; Audubon Alaska (2016g) [based on Alaska Department of Fish and Game (2016b)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska et al. (2017); Clarke et al. (2015); National Oceanic and Atmospheric Administration (2013) [revised based on Audubon Alaska et al. (2017)]; National Oceanic and Atmospheric Administration (1988); North Slope Borough Department of Planning and Community Services: Geographic Information Systems Division (2003); Quakenbush et al. (2013)

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Gray Whale

Eschrichtius robustus

Max Goldman and Erika Knight

Gray whales (*Eschrichtius robustus*) are large mysticetes, or baleen whales, that forage from the southern tip of Baja, Mexico in the winter to the Chukchi and Beaufort Seas in northern Alaska in the summer. The only species in the family *Eschrichtiidae*, gray whales are not closely related to any living cetacean (Árnason et al. 1993, Sasaki et al. 2005). There are two isolated geographic distributions of gray whales in the North Pacific Ocean during summer breeding: the Eastern North Pacific (ENP) stock, found along the west coast of North America, and the critically endangered Western North Pacific (WNP) stock, found along the coast of eastern Asia. In winter, these two stocks overlap in range, and limited genetic data seems to suggest overlap in genotype. Gray whales are generally observed alone or traveling in small, loosely affiliated groups, although large aggregations have been observed on feeding and breeding grounds (Zimushko and Lenskaya 1970, Berzin 1984).

ADAPTATIONS

Gray whales have a mottled, slate-gray body with small eyes located just above the corners of the mouth. The baleen of the gray whale is distinctively short and cream colored, and the whale has few of the ventral furrows that denote the closely related rorqual baleen whales. The length of their baleen is presumably linked to their unique strategy of scooping heavy sediments into their mouths in order to feed on benthic biomass within the top layer of the ocean floor (Nerini 1984). Instead of the dorsal fin of most cetaceans, gray whales have a dorsal ridge made up of 8–14 bumps or "knuckles" between the dorsal hump and the tail flukes. The tail flukes are more than 15 feet (3 m) wide and can be used by scientists to identify individual whales, based on the tail shape and the distinct white scarring left by parasites that fall off when gray whales enter the cold, Arctic waters of their summer habitat. Gray whales can grow to about 50 feet (15 m) long and weigh approximately 80,000 pounds (35,000 kg). Females are often slightly larger than males (Jones and Swartz 1984).

DISTRIBUTION

Gray whales are distributed throughout the North Pacific Ocean, generally staying within shallow coastal waters. Most of the ENP stock spends the summer feeding in the northern Bering and Chukchi Seas (Clapham et al. 1999), with some small groups or individuals feeding farther south along the Pacific coast of the US. In the fall, many gray whales migrate south along the coast of North America to winter off the coast of Baja California, Mexico, in their breeding and calving areas. However, studies indicate that gray whales move widely within their range on the Pacific coast, and are not always found in the same area each year (Calambokidis et al. 1999, Quan 2000, Calambokidis et al. 2002). There is some evidence of gray whales off of the northern coast of Alaska during winter (Stafford et al. 2007).

Migration

Gray whales make the longest known annual migration of any mammal: they travel about 10,000 miles (16,000 km) round trip, with the longest recorded migration of over 13,670 miles (22,000 km) by a female gray whale (Mate et al. 2015). From mid-February to May, the ENP stock of gray whales migrates north along the coast, often accompanied by their newborn calves (Ferguson et al. 2015).

LIFE CYCLE

Gray whales become sexually active around eight years of age (Rice et al. 1984). Courting and mating rituals are complex, consisting of arching out of the water, rolling in the water, side-swimming, flipper displays, and often involve three or more whales of mixed sexes. Breeding synchronized with their annual migration patterns ensures that newborns are calved in the warm waters off the coast of Mexico (Swartz et al. 2006). After 13 months of gestation, females give birth to a single, 15-foot-long (4.5 m), 2,000-pound (900-kg) calf (Rice et al. 1984). Calves are born in shallow coastal areas from early January to mid-February.

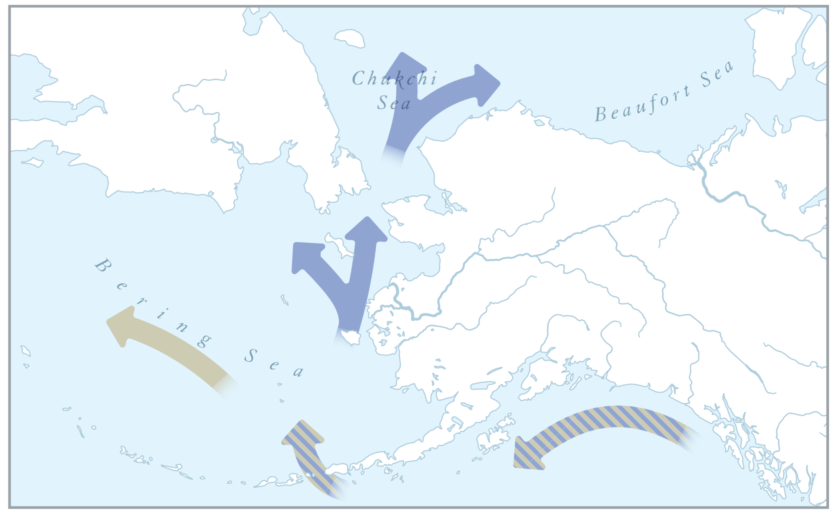

FIGURE 6.8-1. The Eastern and Western North Pacific gray whale stocks' spring migration routes through the Gulf of Alaska and the Bering, Chukchi, and Beaufort Seas.

By counting the layers of wax in the ear canal after death, researchers estimated that 1 female gray whale had lived for 75–80 years (Hohn 2002, Jones and Swartz 2002). Killer whales (*Orcinus orca*) are the only non-human predator of gray whales.

Diet

Gray whales feed on benthic and epibenthic invertebrates such as amphipods and isopods, as well as any other sea creatures that get stuck behind their short, stiff baleen when they turn on their side and scoop up a mouthful of water and seafloor sediment. When feeding, gray whales are often streaked with mud and are commonly observed leaving a trail of sediment behind them (Calambokidis et al. 2002, Jones and Swartz 2002, Brower et al. in press).

CONSERVATION ISSUES

In the mid-1930s, the League of Nations adopted a ban on commercial gray whale and right whale (*Eubalaena* spp.) hunting, entering into the first international conservation agreement. The ban on commercial gray whale catches continues under the International Whaling Commission (IWC), established in 1946 when the League of Nations faltered during the Second World War. Although gray whales are still hunted by the native people of Chukotka in Russia and Washington State in the US, they are subject to sustainable catch limits under the IWC.

The ENP stock of gray whales was removed from Endangered Species Act (ESA) protection after research estimated their population had recovered to pre-whaling numbers, with an expectation of sustained growth (50 CFR 222, June 16, 1994). In 1999, a review of the status of the ENP stock of gray whales recommended the continuation of this stock's classification as non-threatened, based on sustained growth of the population without evidence of any imminent threats to the stock.

The WNP stock of gray whales has not recovered, and is either severely depleted or is functionally extinct and is now made up of colonizing gray whales of the ENP stock (Mate et al. 2015). It is also possible that the 130 or so whales found in Asian waters are a combination of eastern gray whales inhabiting a larger-than-known range along with a smaller-than-estimated "true" Western gray whale population (Weller et al. 2002, Scheinin et al. 2011, Mate et al. 2015). This stock is listed as endangered under the ESA and depleted under the Marine Mammal Protection Act (MMPA).

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Due to their annual migration along the highly populated coastline of the western US as well as their concentration in limited winter and summer areas (Ferguson et al. 2015), the ENP stock may be particularly vulnerable to impacts from commercial and industrial development and local catastrophic events. While the immediate threat of over-harvesting has been quelled for the time being and this stock has been removed from the ESA, other issues remain.

As the Bering Sea is one of the world's most productive fisheries, bycatch is a perpetual concern for gray whale conservation, and entanglement in fishing gear such as nets, long lines, and crab pots are responsible for a number of gray whale deaths each year (Zerbini and Kotas 1998, Kiszka et al. 2009). This issue is exacerbated by the fact that Korean and Japanese fishermen are legally allowed to keep and sell any whales caught as bycatch, potentially incentivizing "accidental" entanglements of marine mammals (Lukoschek et al. 2009). They are also susceptible to other anthropogenic disturbances, such as ship strikes. Gray whales are particularly vulnerable to inadvertent ship strikes in summer off the Alaska Coast near Unimak Pass, and increasingly in the Bering Strait (Zerbini and Kotas 1998, Kiszka et al. 2009).

Subsistence harvest of gray whales by native Chukotkans in Russia is ongoing, adhering to the International Whaling Commission (IWC) quota that less than 140 gray whales be taken each year (Weller et al. 2002). The Makah people of Neah Bay in Washington State have applied for exemption from the MMPA in order to resume sustainable subsistence harvesting of gray whales, a cultural practice that has been halted due to protections by the US government (Jenkins and Romanzo 1998).

Aggregations of whales are often accompanied by guided tourist vessels (O'Connor et al. 2009). Harassment by whale watchers is an increasingly serious problem, and is likely responsible for increased stress in targeted whales and has resulted in inadvertent ship strikes (Carlson 2001, Wiley et al. 2008, Gabriele et al. 2011). While ecotourism is commonly thought of as a monetary replacement for more impactful practices such as harvest, care needs to be exercised and guidelines developed and implemented to ensure the safety of the whales (Weinrich and Corbelli 2009).

Hydrocarbon exploration may affect whales due to noise, especially from seismic activities. Offshore energy development may result in pollution or oil spills (Clapham et al. 1999). A large oil spill could be catastrophic due to sea-ice conditions that make a spill hard to clean up, coupled with very little localized response infrastructure or capability.

In far northern latitudes, such as the Bering and Chukchi Seas, large fluctuations in lower trophic recruitment have been observed as a result of a changing climate (Bakun et al. 2015). Gray whales, along with all other life in the Arctic, will be impacted by those changes (McBride et al. 2014).

MAPPING METHODS (MAP 6.8)

The gray whale map shows their migration as well as areas used for feeding and/or reproduction. Because gray whales only inhabit the project area during the summer, the mapped data are not differentiated seasonally.

Gray whale range information was compiled by Audubon Alaska (2016i) based on figures published in the 2013 Alaska Marine Mammal Stock Assessment (Allen and Angliss 2014), shapefiles of species range provided by Alaska Department of Fish and Game (2016c), observations recorded in Brower et al. (2015), and an assessment of Biologically Important Areas (BIAs) for Cetaceans in US waters (Clarke et al. 2015, Ferguson et al. 2015).

Similarly, feeding areas are shown based on information from many sources including the BIA assessment (Clarke et al. 2015, Ferguson et al. 2015); academic papers (Clarke and Moore (2002), Heide-Jørgensen et al. (2012), and Moore et al. (2003)); and book chapters (Bogoslovskaya et al. (2016), Highsmith et al. (2007), and Yablokov and Bogoslovskaya (1984)). Feeding areas also incorporate the 95% isopleth from an Audubon Alaska and Oceana analysis (Audubon Alaska and Oceana 2016) of data from 2000 through 2014 from the Aerial Survey of Arctic Marine Mammals (ASAMM) (National Oceanic and Atmospheric Administration 2015a). The ASAMM data (formerly Bowhead Whale Aerial Survey Project [BWASP]) were analyzed in consultation with Megan Ferguson and Janet Clarke. Aerial survey methods, data, and metadata for the ASAMM database are available at: http://www.afsc.noaa.gov/NMML/software/bwasp-comida.php. The Audubon Alaska and Oceana analysis used only on-transect data where there were more than 62 miles (100 km) of survey effort in a 12.4-mile x 12.4-mile (20-km by 20-km) grid cell. An observation rate (i.e. relative density) was calculated in each grid cell by dividing the observed number of animals over all years by the measure of total transect length over all years. This observation rate was converted into point data with one point per grid cell (at the centroid), and a kernel density function was run with an anisotropic kernel density function with a 24.8 mile (40 km) north-south search radius and a 49.6 mile (80 km) east-west search radius to smooth the data.

Rearing concentration areas were provided in the BIA assessment (Clarke et al. 2015, Ferguson et al. 2015). Additional rearing data were incorporated from Clarke et al. (2017) and based on personal communication with biologist Janet Clarke.

Migration data were compiled by Audubon Alaska (2016h) based on the BIA assessment, the National Oceanic and Atmospheric Administration's (NOAA's) Bering, Chukchi, and Beaufort Seas Coastal and Ocean Zones Strategic Assessment: Data Atlas (1988), Yablokov and Bogoslovskaya (1984), and Mate et al. (2015).

The sea-ice data shown on this map approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See Sea Ice Mapping Methods section for details.

Data Quality

Spatial information regarding gray whale distribution and use of the map area is sparse. Data regarding feeding concentration areas are available for both US and Russian waters, however, we only found spatial reproduction information for US waters.

Reviewer

• Janet Clarke

MAP DATA SOURCES

Extent of Range: Audubon Alaska (2016i) based on Alaska Department of Fish and Game (2016c), Allen and Angliss (2014), Clarke et al. (2015), and Ferguson et al. (2015)

Feeding: Audubon Alaska and Oceana (2013) based on Moore et al. (2003); Audubon Alaska and Oceana (2016); Bogoslovskaya et al. (2016); Clarke and Moore (2002); Clarke et al. (2015); Ferguson et al. (2015); Highsmith et al. (2007); Heide-Jørgensen et al. (2012); Yablokov and Bogoslovskaya (1984)

Rearing: Clarke et al. (2015); Clarke et al. (2017); Ferguson et al. (2015); J. Clarke (pers. comm.)

Migration: Audubon Alaska (2016h) based on Ferguson et al. (2015) and National Oceanic and Atmospheric Administration (1988); Mate et al. (2015); Yablokov and Bogoslovskaya (1984)

Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

Gray Whale

Audubon ALASKA

Gray Whale (*Eschrichtius robustus*)

Gray whales are large baleen whales that use Arctic and subarctic waters to feed on benthic invertebrates in the summer and fall, after migrating over 10,000 miles (16,000 km) from their subtropical breeding grounds. They are split into two stocks, the critically endangered Western North Pacific (WNP) and the Eastern North Pacific (ENP) stocks. Some WNP whales migrate across the Bering Sea from Unimak Pass to their summer feeding grounds in the Sea of Okhotsk. ENP whales head north to feed in coastal areas of the Bering and Chukchi Seas.

Audubon Alaska (2016h) [based on Ferguson et al. (2015) and National Oceanic and Atmospheric Administration (1988)]; Audubon Alaska (2016i) [based on Alaska Department of Fish and Game (2016c), Allen and Angliss (2014), Brower et al. (2015), Clarke et al. (2015), and Ferguson et al. (2015)]; Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Audubon Alaska and Oceana (2013) [based on Moore et al. (2003)]; Audubon Alaska and Oceana (2016); Bogoslovskaya et al. (2016); Clarke and Moore (2002); Clarke et al. (2015); Clarke et al. (2017); Ferguson et al. (2015); Highsmith et al. (2007); Heide-Jørgensen et al. (2012); J. Clarke (pers. comm.); Mate et al. (2015); Yablokov and Bogoslovskaya (1984)

Map Authors: Erika Knight, Melanie Smith, and Max Goldman
Cartographer: Daniel P. Huffman

The gray whale migration is the longest of any mammal, with adults regularly traveling a staggering 10,000 miles (16,000 km) each year.

Merrill Gosho / NOAA Fisheries, Alaska Fisheries Science Center

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Humpback Whale

Megaptera novaeangliae

Max Goldman and Erika Knight

Humpback whales (*Megaptera novaeangliae*) are a cosmopolitan species of Balaenopterid, or rorqual whales, known for their long migrations, male singing, and acrobatics. They are currently considered to be a single species, although humpback whales from the North Pacific, North Atlantic, and Southern Oceans show divergence in traits such as coloration, migratory and reproductive timing, and regional diet and feeding strategies (Jackson et al. 2014). Within the global humpback whale population, 14 discrete breeding units have been recently recognized—each considered a distinct population segment (DPS), with five in the North Pacific (National Oceanic and Atmospheric Administration 2015b).

As with most other large whales, heavy commercial hunting in the 19th century depleted the global humpback whale population by up to 90% (Breiwick et al. 1983). Since commercial humpback whale hunting was banned in the mid-20th century, orcas (*Orcinus orca*) have again become the most common predators of humpback whales (Dahlheim and White 2010).

ADAPTATIONS

Humpback whales are among the largest animals on the planet, regularly reaching lengths of 55 feet (16–17 m) and weighing in excess of 90,000 lbs (41,000 kg), with females often measuring up to 6 feet (2 m) longer than their male counterparts (Ohsumi 1966). They feed using their large, keratin baleen. They have long pectoral fins and distinct color pattern variation on the ventral side of their fluke, allowing for individual identification. Their dorsal surface is generally dark gray, although ventral coloration varies substantially from white to black to a marbled intermediate (Perrin et al. 2009). Humpback whales exhibit highly varied acoustic calls or songs, and a diverse repertoire of surface behaviors.

Vocalizations

Humpback whale songs have been studied for many years, yet their specific function remains unknown. The most likely utility for complex male humpback singing is interaction with female humpbacks or dominance over other males (Darling et al. 2006). What is known is that all males in a population sing the same song, yet that song changes and evolves over time, with individuals offering intermittent variation, and the group either adopting or rejecting the variations (Sousa-Lima 2005).

DISTRIBUTION

Humpback whales are a globally occurring species with breeding areas located in a latitudinal band from the 30°N to 30°S parallels (Melnikov et al. 2000, Gabriele et al. 2017; Figure 6.9-1). When not breeding or calving, many populations travel to areas of high latitude in both temperate, Arctic, sub-Antarctic and Antarctic waters to feed, often traveling 3,000 miles (5,000 km) or more (Gabriele et al. 1996, Rasmussen et al. 2007, Robbins et al. 2011). The humpback whales that utilize the Bering Sea in the summer are of the Western North Pacific DPS with breeding areas near southern Japan and the Philipines, (Fig. 6.9-1, #3), as well as the Hawaii-breeding DPS (Fig. 6.9-1, #4), and the Mexico-breeding DPS (Fig. 6.9-1, #5).

LIFE CYCLE

Humpback whales spend the colder months in low-latitude breeding grounds. Their mating system is thought to be male-dominated, described by Clapham (Clapham 1996) as a "floating lek." Males compete with each other for the affection of a female humpback whale by engaging in a complex series of aggressive behaviors, such as chasing and tail thrashing, with competing whales often colliding or surfacing on top of each other (Tyack 1981, Baker and Herman 1984, Clapham 1996). These behavioral displays are often accompanied by complex songs that may last nearly a half-hour and can be heard 20 miles (32 km) away (Clapham and Mattila 1990, Cato 1991).

Humpback whale gestation is 11–12 months and calves are typically born in tropical waters (Matthews 1937). Lactation lasts for approximately

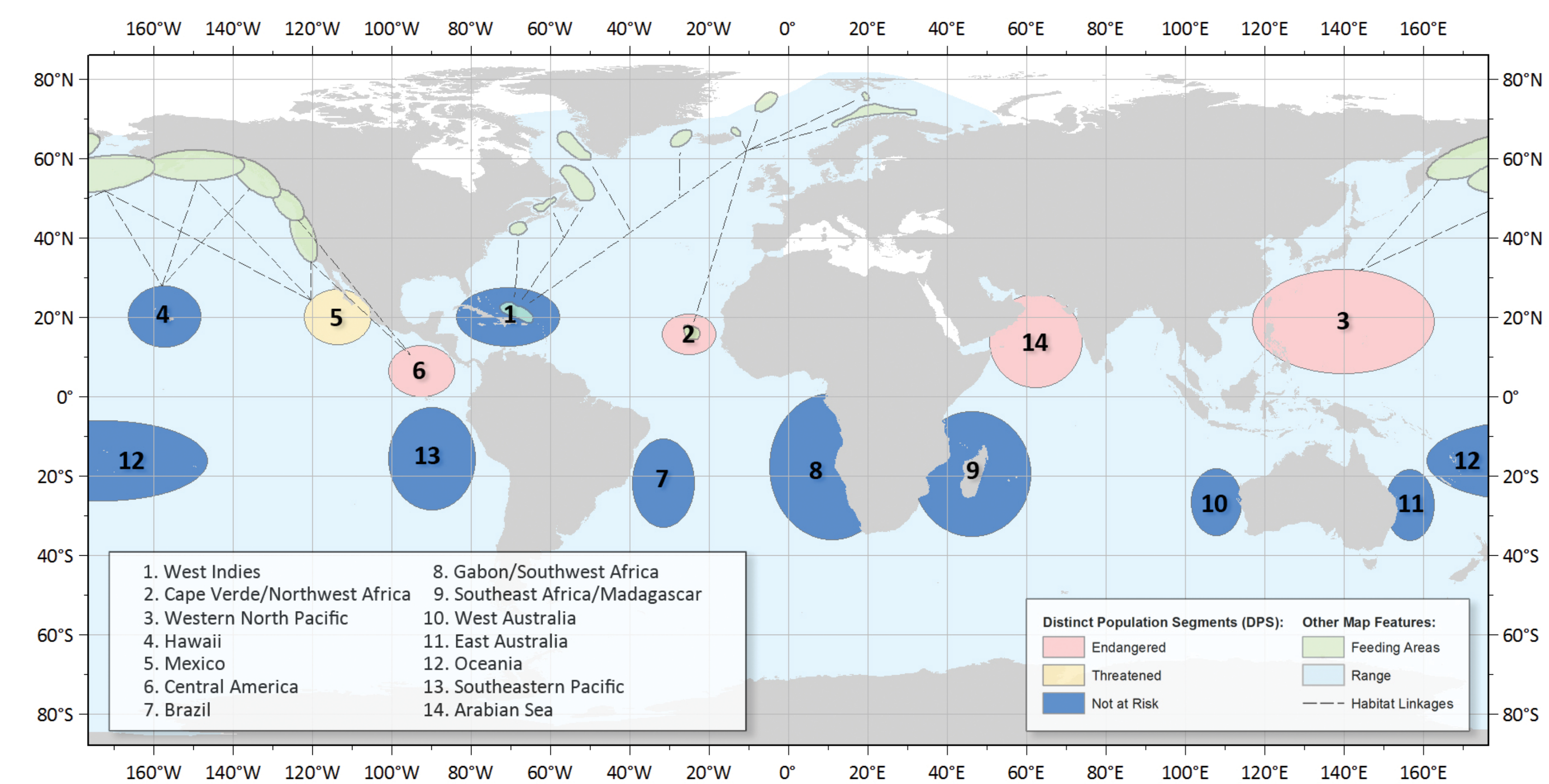

FIGURE 6.9-1. Global humpback whale distinct population segment (DPS) breeding/wintering grounds, and their respective summer feeding areas (National Oceanic and Atmospheric Administration 2017).

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11 months, and weaning begins at about age 6 months and culminates with calves reaching independence near the end of their first year (Clapham and Mayo 1990).

Diet

After migrating to summer and fall feeding areas in high latitudes, humpback whales spend their time storing energy in the form of blubber deposits for the long trip back to their breeding and calving range, where they will likely feed very little or not at all (Zerbini et al. 2006). In the Bering Sea, they concentrate their feeding efforts over the productive waters of the continental shelf, avoiding the relatively barren areas of the basin (Moore et al. 2002, Zerbini et al. 2006).

Humpback whales utilize many food sources and strategies. They are known to feed both in cooperative groups and as solitary animals (Clapham 1993). Most of the time they lunge feed, advancing on prey with wide-open mouths, then closing their mouths and filtering the water out through their baleen plates. Groups of whales will work together to trap schooling fish using bubble curtains and kick-feeding, unique methods likely taught and learned between individuals and populations (Weinrich et al. 1992, Friedlaender et al. 2009).

Their main prey species are euphausiids and small schooling fish, such as herring (*Clupea pallasii*), mackerel (*Scomber scombrus*), sand lance (*Ammodytes hexapterus*), and capelin (*Mallotus villosus*) (Baker et al. 1985, Calambokidis et al. 2001).

CONSERVATION ISSUES

Humpback whales were first listed as endangered in 1970 under the precursor to the Endangered Species Act (ESA), the Endangered Species Conservation Act of 1969. When the ESA was formally enacted in 1973, humpback whales were again listed as endangered. They are protected from any hunting under the Marine Mammal Protection Act of 1972. The International Whaling Commission (IWC) has protected all large cetaceans since the 1970s.

In September of 2016, the ESA listing for humpback whales was updated to specify 14 DPSs, with 1 considered threatened (Mexico DPS) and 4 listed as endangered (Cape Verde Islands/Northwest Africa, Arabian Sea, Western North Pacific, and Central America DPSs) (National Oceanic and Atmospheric Administration 2015b). Humpback whales from the Western North Pacific DPS venture into the Bering Sea in the summer (see Fig. 6.9-1).

While humpback whales have made a substantial recovery through much of their range, there are many areas of concern, especially regarding the endangered Western North Pacific DPS, which spends the summer in the Bering Sea. As the Bering Sea is one of the world's most productive fisheries, bycatch is a perpetual concern for humpback whale conservation, and entanglement in fishing gear, such as nets, long lines, and crab pots, is responsible for a number of humpback whale deaths worldwide each year (Zerbini and Kotas 1998, Kiszka et al. 2009). This issue is exacerbated by the fact that Korean and Japanese fishermen are legally allowed to keep and sell any whales caught as by-catch, potentially incentivizing "accidental" entanglements of marine mammals (Lukoschek et al. 2009). They are also susceptible to other anthropogenic disturbances such as ship strikes. Humpback whales are particularly vulnerable to inadvertent ship strike in summer off the Alaska Coast near Unimak Pass (Williams and O'Hara 2010).

While commercial hunting of humpback whales ended in 1966, humpbacks have been a proposed target for lethal sampling research conducted by Japan through the Japanese Whale Research Program under Special Permit in the Antarctic (JARPA, JARPA II), although no humpbacks were actually ever killed under those programs (Nishiwaki et al. 2009). In 2014, IWC pressure resulted in Japan abandoning the JARPA II program and its harvest goal of 50 humpback whales per year for the New Scientific Whale Research Program in the Antarctic Ocean (NEWREP-A), which does not include humpbacks as a species for lethal sampling, although more than 300 minke whales are included in the lethal sampling goals (International Whaling Commission 2015). Subsistence harvest of humpbacks is not widespread, although western Greenland (Denmark) and St. Vincent and the Grenadines (in the Lesser Antilles Islands) each participate in subsistence hunting of humpback whales, with Greenland adhering to the ten humpback whales per year quota recommended by the IWC and St. Vincent and the Grenadines taking two or fewer each year (Reeves 2002).

Aggregations of whales in areas such as the Gulf of Maine, Hawaii, and Southeast Alaska are often accompanied by guided tourist vessels (O'Connor et al. 2009, Gabriele et al. 2011). Harassment and noise by irresponsible whale watchers is a concern, and is likely responsible for increased stress in targeted whales and has resulted in inadvertent ship strikes (Carlson 2001, Wiley et al. 2008). While ecotourism is commonly thought of as a monetary replacement for more impactful practices such as whaling, care needs to be exercised to ensure the safety of the whales (Weinrich and Corbelli 2009).

In far northern latitudes, such as the Bering Sea, large fluctuations in lower trophic recruitment have been observed as a result of a changing climate (Bakun et al. 2015). Humpback whales, along with all other life in the Arctic, will be impacted by those changes, and substantial decreases in available food could prove detrimental to the already endangered Western North Pacific DPS as they rely on feeding in the Bering Sea to store up the energy needed to make the long migration south to their perennial breeding grounds (McBride et al. 2014).

MAPPING METHODS (MAP 6.9)

The humpback whale map shows summer and fall use of the project area; because humpbacks only inhabit our map area during the summer and fall, the data are not differentiated seasonally. The summer/fall northern range extent and regular-use areas are shown, as well as areas where humpbacks congregate to feed.

Humpback whale data were derived from two sources: a 2015 Alaska Marine Mammal Stock Assessment (Muto et al. 2016) and an assessment of Biologically Important Areas (BIAs) for Cetaceans in US waters (Ferguson et al. 2015). The range extent and regular use areas were digitized from the Marine Mammal Stock Assessment. Feeding concentration areas in Ferguson et al. (2015) were downloaded from the National Oceanic and Atmospheric Administration (NOAA) website.

The sea-ice data shown on this map approximate median monthly sea-ice extent. The monthly sea-ice lines are based on an Audubon Alaska (2016j) analysis of 2006–2015 monthly sea-ice extent data from the National Snow and Ice Data Center (Fetterer et al. 2016). See Sea Ice Mapping Methods section for details.

Data Quality

The information regarding humpback whale distribution shown on this map area is fairly general. Fine scale distribution data exist for US waters (e.g. Friday et al. (2013), Zerbini et al. (2006), and Zerbini et al. (2016) among others), and this detailed spatial information has been summarized by Ferguson et al. (2015) into the feeding BIAs shown as summer feeding concentration areas on our map. We were unable to find information regarding concentration and high-concentration areas for the Russian portion of the project area.

Reviewers

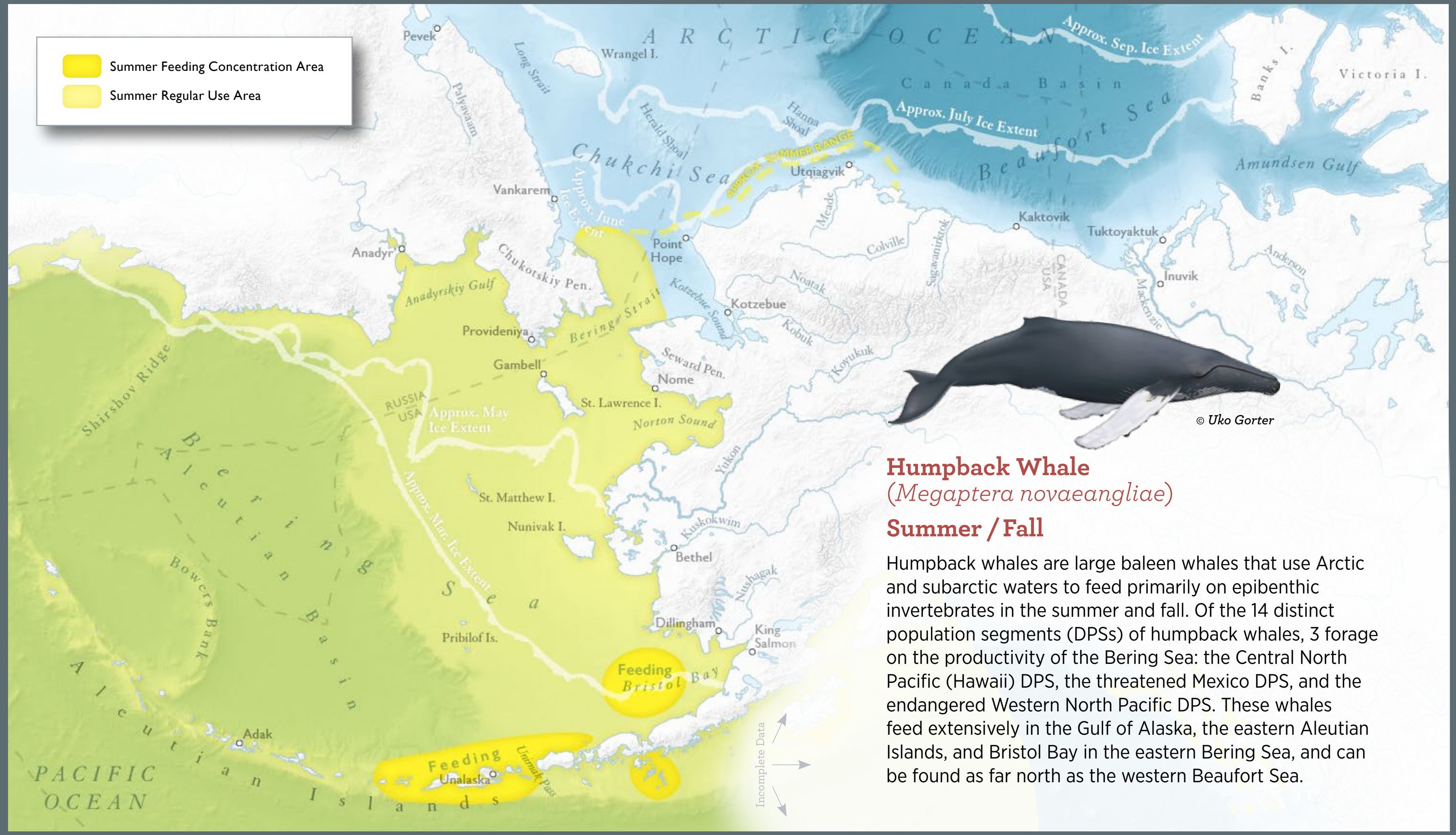
- Alex Zerbini
- Bering Strait Traditional Knowledge-Holder Map Review Workshop participants

MAP DATA SOURCES

Extent of Range: Muto et al. (2016)
Regular Use: Muto et al. (2016)
Feeding Concentration: Ferguson et al. (2015)
Sea Ice: Audubon Alaska (2016j) based on Fetterer et al. (2016)

Humpback Whale

Audubon ALASKA



Audubon Alaska (2016j) [based on Fetterer et al. (2016)]; Ferguson et al. (2015); Muto et al. (2016)

Map Authors: Erika Knight and Max Goldman
Cartographer: Daniel P. Huffman

Cooperative feeding by humpback whales drives prey species to the surface, where seabirds also partake in the bounty.

John Schoen

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