Audubon ALASKA

Ecological Atlas of the Bering, Chukchi, and Beaufort Seas, 2nd Edition: Metadata

Chapter 6: Mammals

Shortcut to metadata for

Maps 6.1a–d Polar Bear Seasonal Distribution

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.

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)

Reference list available here.

Map 6.2a Pacific Walrus Summer/Fall

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.

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)

Reference list available here.

Map 6.2b Pacific Walrus Winter/Spring

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.

MAP DATA SOURCES

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)

Reference list available here.

Map 6.3.1 Bearded Seal

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).

- 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.

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)

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.

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)

Reference list available here.

Map 6.3.2 Ribbon Seal

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).

- 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.

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)

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.

MAP DATA SOURCES

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)

Reference list available here.

Map 6.3.3 Ringed Seal

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).

- 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.

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)

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.

MAP DATA SOURCES

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)

Reference list available here.

Map 6.3.4 Spotted Seal

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).

- 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).

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)

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.

MAP DATA SOURCES

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)

Reference list available here.

Map 6.4 Steller Sea Lion

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.

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)

Reference list available here.

Map 6.5 Northern Fur Seal

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.

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)

Reference list available here.

Map 6.6.1 Beluga Whale Stocks

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 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.

MAP DATA SOURCES

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)

Reference list available here.

Map 6.6.2 Beluga Whale

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 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.

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)

Reference list available here.

Maps 6.7a–d Bowhead Whale Seasonal Distribution

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.

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)

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)

Reference list available here.

Map 6.8 Gray Whale

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.

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)

Reference list available here.

Map 6.9 Humpback Whale

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.

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)

Reference list available here.