Photo-identification of Beluga Whales in Cook Inlet, Alaska:

Summary and Synthesis of 2005-2015 Data.

Final Report

Prepared by:

The Cook Inlet Beluga Whale Photo-Id Project

SEEN BELUGAS?

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Alaska Region

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Photo-identification of Beluga Whales in Cook Inlet, Alaska: Summary and Synthesis of 2005-2015 Data. Final Report

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LIST OF ACRONYMS

AKR	Alaska Region
ADF&G	Alaska Department of Fish and Game
CIBW	Cook Inlet Beluga Whale
ESA	Endangered Species Act
JBER	Joint Base Elmendorf Richardson
LGL	LGL Alaska Research Associates, Inc.
MMPA	Marine Mammal Protection Act
MML	Marine Mammal Laboratory
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OLE	Office of Law Enforcement (OLE)
POA	Port of Anchorage
TEK	Traditional Ecological Knowledge
ZPNE	zero-truncated Poisson log-normal mixed effects

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ABSTRACT

More information is needed to understand and reverse the unexplained lack of recovery of Alaska's endangered Cook Inlet beluga whale (CIBW) population (*Delphinapterus leucas*). This report presents a synthesis of 11 years of non-invasive, photo-identification (photo-id) data from the CIBW Photo-ID Project to assess population characteristics, habitat preferences, and life histories of individually identified CIBWs. Data were collected during dedicated vessel- and shore-based photo-id surveys April through October 2005-2015 in Upper Cook Inlet, Alaska. Beluga encounter rates and mean group size varied by month and location, and were highest in July, and in the Susitna River Delta. Annual maximum group size increased beginning in 2012. Most groups encountered consisted of white belugas, gray belugas, and calves/neonates, although the relative percentage of each varied by year, month, and area. Data from known-sex individuals showed little difference between the sexes in the number of days and years sighted, group composition, and area sighted. Beluga groups were not distributed uniformly, and individuals did not display either site or group fidelity. Feeding behavior was observed for groups in most of the areas surveyed and in all months surveyed except April. Calves were seen in all areas, months, and years surveyed. The first neonate sighting each year was in the Susitna River Delta between early July and early August. Neonates were seen as late as mid-October, and in all areas surveyed. A birth was observed and photographed on July 20, 2015 in the Susitna River Delta. Inter-birth intervals were measured at three and four years for the two mothers photographed with more than one neonate and estimated for other presumed mothers at an average of 2.7-5.2 years.

Results are presented by month and area to assist managers in evaluating seasonal and/or area closures or restrictions for mitigation, monitoring, and permitting purposes. The distinct areas where belugas are found seasonally, corridors connecting them, and "hotspots" of special biological significance (e.g., feeding and calving) warrant concerted management and protection. Anthropogenic activities should not be considered in isolation, but rather the cumulative effects of all activities in the CIBW range and their potential to affect the entire population must be taken into account when making management decisions. Integration of a continued long-term, Inlet-wide dataset from the CIBW Photo-ID Project, along with data from aerial surveys, acoustic surveys, remote biopsy sampling, stranding, and photogrammetry from aerial drones, into a population model that accounts for the relevant sampling constraints and biases will be the most powerful approach to help understand the continued lack of recovery of the CIBW population.

INTRODUCTION

Alaska's Cook Inlet beluga whale (CIBW) population (*Delphinapterus leucas*) is considered a distinct population segment by the National Marine Fisheries Service (NMFS) due to geographic and genetic isolation from other beluga stocks (NMFS 2008a). A steep decline in the CIBW population was observed in the mid-1990s, and the population was designated as depleted in 2000 under the *Marine Mammal Protection Act* (MMPA). In 2008, NMFS listed the CIBW population as endangered under the *Endangered Species Act* (ESA, 73 FR 62919). As a consequence of the ESA listing, NMFS was required to designate critical habitat (i.e., habitat deemed necessary for the survival and recovery of the population) and to develop a Recovery Plan for CIBWs. In addition, the ESA mandates that all federal agencies consult with NMFS regarding any action that is federally authorized, funded, or implemented, to ensure that the action does not jeopardize the continued existence of the endangered species or result in the destruction or adverse modification of its designated critical habitat.

Despite the cessation of an unsustainable level of subsistence hunting that was thought to have contributed to the initial population decline (NMFS 2008b), and despite the protections of the ESA listing, there is no evidence that the CIBW population is recovering. Although monitoring of CIBW abundance and distribution has been conducted via aerial surveys, satellite tagging, photo-identification (photo-id) surveys, and passive acoustics, many information gaps and uncertainties are associated with the current understanding of the CIBW population's lack of recovery. More information on annual abundance estimates of age-specific cohorts, habitat preferences for feeding, calving, and rearing of young, life history characteristics associated with population growth (births, calving intervals, age at sexual maturity, etc.), and sources of stress and mortality (natural and human-induced) is needed to promote recovery and conservation of the CIBW population.

Studies of CIBWs using photo-id methods have been ongoing since 2005 as part of the Cook Inlet Beluga Whale Photo ID Project (CIBW Photo-ID Project), with primary geographic focus in Upper Cook Inlet. The CIBW Photo-ID Project has confirmed that most CIBWs possess distinct natural marks that persist across years, and these marks can be effectively identified and re-sighted with digital photography. The photo-id catalog and associated surveys provide information about the distribution, movement patterns, and life-history characteristics of individually identified beluga whales, including mothers with calves. The CIBW Photo-ID Project has been supported by research grants and contracts from a variety of sources (Appendix A). Annual funding had allowed for yearly fieldwork, data processing, and annual reporting, but had not provided for a retrospective summary and analyses of results obtained over the duration of the project. The CIBW Photo-ID Project was contracted by the NMFS Alaska Region (AKR) to summarize the results of all photo-id surveys of CIBWs conducted during 2005 to 2015 in a report with the following components:

1. An overview of the contents of the catalog (e.g. total number of whales identified; number of whales seen in multiple years; number of potential mothers vs. unknown sex; seasonal habitat hotspots)

2. A summary of calf/neonate data obtained from the catalog

3. Estimates of the number of identified mothers and calves in the catalog, with estimates of the inter-birth interval, calving rate, and period of maternal care/association

4. A summary of beluga group size, age class composition, calves and neonates relative to group size, and groups containing calves/neonates, compared across year, season, and geographic location

5. A summary of the important beluga whale habitat areas, as determined by the prevalence of feeding behavior and/or calf presence (with corresponding maps)

6. A summary of any documented unusual observations along with any potential explanations as to the cause

These components are organized and presented in this report as survey results (components 2, 4, 5, and 6) and catalog results (components 1, 2, and 3). The report then discusses the insights these results provide into understanding CIBW population characteristics and trends, habitat preferences, individual life histories, and reproductive histories, as well as their management implications.

METHODS

Project activities consisted of field surveys, photo processing, cataloging of photos, data entry, database management, data analysis, reporting, and educational outreach.

Field Surveys

Survey effort

Dedicated photo-id surveys were conducted from small vessels and from shore during the ice-free season (April through October) 2005 through 2015 in Cook Inlet, Alaska (Figure 1). Survey effort was focused in Upper Cook Inlet, primarily in the Susitna River Delta (defined here as the area between the Beluga River and the Little Susitna River), Knik Arm, Chickaloon Bay, Fire Island, and Turnagain Arm (Figure 2). The Kenai River Delta area (defined here as the area between the East Forelands and the Kasilof River) was also included in 2011 through 2013 (McGuire et al. 2014a). Survey schedules varied according to those combinations of season, location, and tide that provided the greatest likelihood of detecting whales. These combinations were derived from results of NMFS aerial surveys (Hobbs et al. 2015; Rugh et al. 2000, 2004, 2005, 2006, 2010; Shelden et al. 2013, 2015a&b), other studies of CIBWs (Funk et al. 2005, Markowitz and McGuire 2007, Markowitz et al. 2007, Nemeth et al. 2007, Prevel-Ramos et al. 2006), as well as from ongoing photo-id surveys in this area (McGuire and Kaplan 2009; McGuire et al. 2008, 2009, 2011a&b, 2013a&b, 2014a&b). New surveys of areas that had not previously been surveyed by any study were based on seasonal and tidal patterns from incidental reports of CIBW sightings in the area (reported to NMFS and to the CIBW Photo-ID Project via an existing observer network and the project website www.cookinletbelugas.org). Established general survey routes were followed (Figure 2), although deviations were made depending on where beluga groups were encountered. Surveys lasted approximately six hours, although the duration of surveys depended on hours of daylight, tidal conditions, if whale groups were encountered, and size and behavior of whale groups. Tidal information was obtained from the program JTides (www.arachnoid.com/JTides/), TIDES.net, and www.Tides.info.

Vessel-based surveys

Vessel-based photo-id surveys were conducted primarily from the R/V *Leucas*, a 4.9 m (16 ft) inflatable Proman 9 Zodiac® powered by a 4-stroke 50 hp Yamaha motor. Vessel surveys of Chickaloon Bay were sometimes conducted from an 8.5 m (28 ft) aluminum-hulled Munson landing craft powered by twin 140 hp 4-stroke engines. The landing craft was used when weather and sea conditions made the trip from the Anchorage small boat launch to Chickaloon Bay too dangerous for the smaller vessel. A third boat, a Willie Predator 6 m (20 ft) aluminum river boat with a 50 hp Yamaha 4-stroke engine, was used for surveys of the Kenai River Delta. The zodiac and river boat usually carried one skipper and one photographer, while the landing craft also carried an additional observer to assist with beluga observations because the vessel design made it difficult for one observer to monitor both fore and aft of the vessel.

Survey routes were determined by tidal stage, water depth, and navigational hazards, and were designed to maximize the probability of encountering belugas throughout the season and all of the survey areas. Boat-based surveys in 2014 and 2015 were scheduled to encounter the largest groups of belugas. Surveys were not appropriate for line-transect methods designed to estimate abundance. A whale group was only approached once per survey and usually followed in the manner described by Würsig and Jefferson (1990): the research vessel approached slowly, parallel to the group, and matched group speed and heading in order to obtain images of lateral sides of individuals while minimizing disruption of the group. At times, the boat drifted with the engine off, or was at anchor with the engine off, and whales were photographed as they passed by. Researchers noted the position of whales relative to the vessel and GPS-logged tracks of the vessel were used to estimate approximate whale group positions. The majority of the vessel-based surveys were centered around low tide.

All vessel-based surveys were conducted under authorization by NMFS. Vessel-based research in 2005 through 2008 was conducted under General Authorization, Letter of Confirmation No. 481-1759, which placed no restrictions on vessel approach distances to photograph beluga whales. After the ESA listing of CIBWs in October 2008, research was conducted under MMPA/ESA Research Permit #14210, which allowed 54 annual takes (i.e., approach of the whales by the vessel at distances <50 meters/164 ft). A new MMPA/ESA Research Permit, #18016, was issued in 2014 and allowed for 30 annual takes of CIBWs, and 200 takes of harbor seals (often encountered incidentally during beluga surveys). Because of the permit restrictions, the survey vessel never intentionally approached belugas at a distance <50 meters (164 ft) during the 2009-2015 surveys.

Vessel-based surveys of middle and upper Knik Arm were not conducted in 2014 in order to avoid disruption of beluga studies (visual and acoustic) being conducted in Eagle Bay by research teams with Joint Base Elmendorf Richardson (JBER) and the Alaska Department of Fish and Game (ADF&G). One exception was made on August 23, 2014, when NMFS requested the LGL boat-based team survey the waters of Knik Arm for any belugas that may have been involved in a mass live-stranding event reported to have occurred that day.

Land-based surveys

Shore-based surveys were conducted from observation stations along Turnagain Arm, at the mouth of Eagle River, along the lower reaches and mouth of the Kenai River, and occasionally from Salamantof Beach and the mouth of the Kasilof River (Figure 2). Surveys along Turnagain Arm generally began three hours before high tide, based on results from previous CIBW studies in the area that indicated that this was when belugas were most likely to be present (Markowitz and McGuire 2007). The observer(s) drove south and east from Anchorage along the Seward Highway adjacent to Turnagain Arm and stopped at turnouts along the highway, alternating searches for marine mammals with binoculars and the naked eye. When beluga whales were seen, the observer attempted to follow them along Turnagain Arm as they moved with the tide. Most photographs were taken from sites where whales approached closest to shore and that afforded relatively easy vehicle access. Land-based surveys in the Kenai River Delta were conducted from

sites overlooking the mouth of the Kenai River or the Port of Kenai dock during times when small-craft advisories, extreme low tides (river too shallow for vessels), or duck hunters firing weapons from boats prevented the safe deployment of the survey vessel. Land-based surveys at Eagle River were conducted from the north shore of the mouth of the river, in conjunction with beluga studies led by biologists with JBER. Additional CIBW photographs and associated data were collected by JBER biologists while conducting their own projects and shared with the CIBW Photo-ID Project.

Survey data

Standardized data forms were used to record beluga whale sightings and environmental conditions. For each beluga whale group sighting, observers recorded time of day, group size, GPS position of the vessel or location, magnetic compass bearing to the group, estimated distance of the observer from the group (distance at first detection and minimum distance to individual whales), water depth (under the vessel), group formation, direction of travel, movement patterns, behavioral data (see below for details), average distance among individuals, and any other marine mammals or human activities near the sighting.

For groups with multiple records on a single day, the best record was selected at the end of the survey, which was either the highest count (for groups that merged) or the count considered by all observers to be the most accurate. Group size was usually difficult to determine and counts provided are best estimates of the number of whales seen at the surface, rather than the actual number of whales in the group (i.e., correction factors were not applied). In cases when it was unclear if multiple groups encountered on the same day in similar locations were the same group, photo-id records were reviewed and if the same individuals were photographed in the same groups on the same day, the groups were re-classified as the same single group.

Behavioral data were collected using focal group sampling (Mann 2000). Behavior was recorded as activities (i.e., group behavior patterns of relatively long duration) or events (i.e., individual behavior patterns of relatively short duration, such as discrete body movements; Martin and Bateson 1993). Group activity was recorded at the beginning and end of each group encounter, and approximately every five minutes during the encounter. Events were noted as they were observed throughout the group encounters, although it should be clarified that the observers were focused on photographing whales, not observing all events. Activities were classified into primary and secondary activities. Primary activities appeared to be the dominant behavior of the group, and secondary activities occurred sporadically during primary activities. For example, a group might be recorded to have the primary activity of traveling (most of the group most of the time), with the secondary activity of diving (some of the group some of the time). A tail slap or spy hop would be an example of a discrete event by an individual, not a group activity.

Behavioral activities were defined as follows:

> *Traveling* – directed movement in a linear or near-linear direction, transiting through an area, usually at a relatively high speed.

Diving – movement directed downward through the water column.

Feeding Suspected – chasing prey, as evidenced by bursts of speed, lunges, and/or focused diving in a particular location, or by fish jumping out of the water near belugas.

Feeding confirmed – beluga was seen with a prey item in its mouth.

Resting – little or no movement, body of animal visible at or near the surface.

Milling – non-linear, weaving or circular movement within an area.

Patrolling – beluga(s) swimming back and forth along the same linear pathway, close to shore or an exposed tidal flat (this was added in 2015).

Socializing – interactions among whales indicated by physical contact observed at the surface, or by audible vocalizing of multiple whales.

Body color (white or gray) and relative size/age-class (calf, neonate) of whales in the group were recorded. Calves were usually dark gray, relatively small (i.e., <2/3 the total length of adult belugas), and usually swimming within one body length of an adult-sized beluga. Beginning in 2008, observers noted if any calves appeared to be neonates (i.e., newborns, estimated to be hours to days old) based on extremely small size (1.5 m [5 ft]), a wrinkled appearance because of the presence of fetal folds, and uncoordinated swimming and surfacing patterns. Between 2005 and 2007, neonates were not differentiated from calves in the photo-id survey data. Likewise, calves and neonates were not differentiated in the beluga group data shared by JBER biologists.

Environmental conditions were noted hourly or when conditions changed. Environmental variables recorded included Beaufort sea state, swell height, cloud cover, glare, visibility, wind speed and direction, air temperature, precipitation, water temperature at the surface, and water depth.

Digital photographs of beluga whales were collected using a digital SLR camera with a telephoto zoom lens (100-400 mm) with auto-focus. Typical settings included shutter speed priority, dynamic-area autofocus, 100-800 ISO, and shutter speed of 1/1,000 sec or faster. Photographs were taken in RAW (not compressed) format until 2013. Beginning in 2014, photographs were taken in JPEG format. Photographs were stored on compact flash or SD memory cards. Photographs taken by the public and shared with the CIBW Photo-ID Project were taken on a variety of cameras and cell phones.

Archiving and Analysis of Field Survey Data

Photographs were downloaded from the memory card onto a computer hard drive and archived to external hard drives to preserve the original data before any further processing. All photo-id data, survey data, and photographs were integrated into the CIBW Photo-ID Project database. Data associated with each photograph included the metadata, such as the original camera settings, the time the original photograph was

taken, and the dates and locations when photos were taken. Time was synchronized between the GPS and the cameras in the field, and the time and date stamps of the photos were linked to those of the track line of the vessel when both were uploaded into the database, which allows for geo-referencing of the photos. Locations of beluga whale sightings and survey routes were mapped in QGIS version 2.14 (http://www.qgis.org/) and figures were prepared showing survey routes, group location, group size, and group color composition for each survey conducted.

Processing of Photographs

All RAW format photographs (taken before 2013) were downloaded from the camera's compact flash memory card onto a computer hard drive and archived to DVDs to preserve the original data before any further processing. Copies of RAW photographs were then reformatted into JPEGs (JPEG files are smaller than RAW files) for more-efficient processing. Photographs taken after 2013 were taken as JPEGs and did not need to be converted. These photographs were downloaded and archived to hard drives rather than DVDs.

Photographs were sorted according to image quality using ACDSee photo software (http://www.acdsee.com). Photographs of unsuitable quality for identification (e.g., poor focus, whale obscured by splash, or too distant) were noted and archived, but not used for subsequent analyses. If distinguishing marks were obvious even in poor quality photographs, the photo was considered for inclusion in the catalog.

All suitable quality images were cropped to show only the focal whale. When an original field photograph contained more than one whale, each whale was cropped individually and given a separate file name. Cropped images were separated into left and right sides of whales. Daily photo samples (i.e., all cropped photos taken on a single survey day) were sorted into temporary folders. Each temporary folder contained all of the cropped images taken of the same individual beluga on a single day (this could be one to many images). Images within a temporary folder may have been taken seconds or hours apart, and often showed different sections of the body as the beluga surfaced and submerged. Images within temporary folders were then examined to determine if there was a match to photographic records of individual belugas identified within that year or in previous years. If a match was made to a previous year in the catalog, the new photos were entered into the catalog. Temporary folders that were not matched to individuals within the photo-id catalog were archived and periodically reexamined for matches to the catalog as it developed and photos from new field seasons were added.

Cataloging of Photographs

Markings used for photo-id of individual beluga whales consist of natural marks from conspecifics, pigmentation patterns, scars from injury or disease, and marks left from satellite tags attached by NMFS during 1999-2002. The CIBW Photo-ID Project depends on existing marks and does not apply marks to whales. Mark-type categories were created in order to facilitate cataloging. Computer software specialized for this species was

developed by the project to allow for computer-aided filtering of the database according to mark type and location.

As a beluga surfaces and submerges, different portions of its body are available to photograph. Side-profile photographs are most useful for matching marks used to identify individual whales. Profile images were divided into 11 sections along the right and left halves of the whale (Figure 3); sections containing the head, tail, and ventral half of the whale were less commonly captured in photographs and were therefore less likely to provide identifying marks than were the other five body sections. "Profile completeness" was determined by the number of sections with high quality images; a right or left side profile set was considered complete if it contained high quality images of all five sections of the dorsal half of the whale, beginning just behind the blowhole to the base of the tail. In order to be included in the catalog and given a unique ID number, a whale had to have a complete profile set. Whales with complete profile sets were considered individuals in the catalog. Another criterion that allows for the acceptance of a whale into the catalog is if two temporary whale folders that spanned two or more years were matched, regardless of profile completeness. All matches in the existing catalog were reviewed and verified by at least two experienced photo-analysts.

Classification of mothers and calves in photographs

Identified belugas were classified as presumed mothers if they appeared in the same uncropped photo frame with a calf or neonate alongside them. Belugas were classified as calves if they were gray, relatively small (i.e., <2/3 the total length of adult belugas), and photographed alongside a larger, lighter-colored beluga. Neonates were distinguished in photographs by visible fetal folds and often a "peanut-shaped" head. Sighting histories (i.e., dates and locations of sightings) were compiled for all identified presumed mothers and calves. Sighting records for presumed mothers included information on when the mother was photographed with and without a calf, as well as information on the relative size of the calf. If a presumed mother was seen with a calf in multiple years, and the calf appeared larger every year (Figure 4), it was assumed to be the same calf maturing (the majority of photographed calves cannot be identified as individuals because they are either not well marked with the long-lasting marks used for photo-id, or they are not photographed with enough of the body above water to allow marks to be seen).

Classification of dual-side whales

Whales where classified as dual-side whales if they met the criteria to be classified as individuals in both the right- and left-side catalogs and if marks that spanned both sides of the bodies could be used to link the two sides (Figure 5).

Classification of previously satellite-tagged whales

Previous photo-id reports have documented CIBWs with scars from satellite tags attached by NMFS during 1999-2002 (McGuire and Stephens 2016). A whale was classified as a "confirmed satellite-tagged" individual if the following were visible in photographs: scars with a distinct shape (circular, crescent-shaped, or band-like); scars in an obvious pattern (depending on the tag type and attachment used, tags caused scars in pairs, trios, or up to five); and/or scars in known tagging locations on the body (Figure 6). In some cases, biopsy scars were seen in addition to the tag scars and were used as additional evidence of a tagging event. Individuals with photographs of scars that were similar to "confirmed tagging scars" but were less distinct in shape, pattern, or placement were classified as "suspected satellite-tagged" individuals. Individuals classified as satellite-tagged whales were differentiated from one another based on photographs showing a combination of natural marks and tag scars to avoid mistakenly matching similar scar patterns caused by the same tag type. Two experienced photo-analysts independently reviewed all photographs currently in the CIBW Photo-ID Project catalog to classify images of individuals bearing satellite-tag scars.

Identification of Stranded Belugas

Stranding response to live and dead stranded marine mammals in general, and of endangered CIBWs in particular, is regulated by NMFS. Designated responders in the Alaska Marine Mammal Stranding Network may respond to CIBW strandings if activities are first authorized by NMFS on a per-case basis; these activities fall under the umbrella of the permit held by NMFS.

When stranded (dead or alive) belugas were encountered during surveys, or when informed of stranded belugas by the Alaska Marine Mammal Stranding Network, and as authorized by NMFS, CIBW Photo-ID Project biologists photographed stranded belugas or relied on other stranding responders to obtain photographs of stranded belugas. The project developed a protocol for photographing stranded belugas for identification marks that was distributed to members of the Alaska Marine Mammal Stranding Network and posted on the NMFS AKR website https://alaskafisheries.noaa.gov/pr/beluga-research-cook-inlet. Photographs of stranded belugas were examined for marks that could be used to compare to records from the 2005-2015 catalog. Sex and relative age (i.e., neonate, calf, juvenile, adult) of dead whales were determined from necropsy reports and/or photographs, and were entered into the records of individuals in the photo-id catalog.

Database Development

All photo-id data (2005–2015) were consolidated into a single integrated database. Data from surveys included the survey route, environmental conditions, photographs, and group size, color, and behavior. Data associated with each photograph included the "metadata", such as the original camera settings, the time the original photograph was taken, and the lighting conditions. Catalog data also included the number of photos in the catalog, the dates and locations when photos were taken, the number of individual whales represented in the catalog, and the number of temporary folders yet to be matched.

Sighting Histories

Sighting histories (i.e., dates and locations of sightings) were compiled for cataloged belugas in order to examine residency and movement patterns. These sighting histories include information from surveys conducted during 2005-2015, and are presented graphically according to year and geographic area. Locations of cataloged beluga whale sightings were mapped in QGIS version 2.14 (http://www.qgis.org/). The study area was divided into different survey areas (Figure 2), and the occurrence and movement of identified belugas among these areas were examined.

Incidental Beluga Sighting Reports and Photographs

Incidental beluga sighting reports were collected by the CIBW Photo-ID Project from the public and colleagues via email, phone calls, public presentations, and conversations in the field. The project website (www.cookinletbelugas.org) contains a page for the public to report CIBW sightings. The website address was distributed via the project bumper sticker, wallet-sized cards, project pamphlets, and public outreach. Incidental beluga sighting reports were entered into the project database and shared with the NMFS AKR and NMFS's Marine Mammal Lab (MML).

RESULTS

Surveys

Survey effort 2005-2015

There were 396 photo-id surveys of Cook Inlet conducted over eleven consecutive field seasons in 2005 through 2015 (Table 1, Figure 7) for a total of 367 survey days. The number of survey days is less than the number of surveys because surveys of different areas were sometimes conducted on the same day. Survey effort was greatest in 2012 and lowest in 2007 (Table 1, Figures 8-18). Most of the effort was concentrated in the Susitna River Delta, Knik Arm, and Turnagain Arm, with fewer surveys in the Kenai River Delta and Chickaloon Bay/Fire Island (Table 2, Figure 7). Surveys were conducted between April and October, with heaviest effort in August and September, and lightest effort in April (Table 2, Figures 19-25). Fifty-eight percent of the surveys were vessel based and 42% were land based.

Beluga encounter rates 2005-2015

Belugas were encountered on 326 of the 367 survey days. The encounter rate (number of belugas per survey) fluctuated between 2005 and 2012, and began increasing in 2013 (Figure 26). Encounter rates were highest in July and lowest in April (Figure 26). Encounter rates were highest in the Susitna River Delta and lowest in the Kenai River Delta (Figure 26).

Groups encountered 2005-2015

In total, 496 groups were encountered throughout the survey area during 2005-2015 (Figure 27), with a mean of 1.3 groups encountered per survey (Table 3). Group encounter rates were highest in 2006 and 2007, and lowest in 2013. Groups were encountered most often in July and September, and least often in April (Table 4). Group distribution varied according to month (Figure 28-34). Groups were encountered most often per survey in Turnagain Arm and least often per survey in the Kenai River Delta (Table 5).

Group size 2005-2015

Group size ranged between 1 and 313 individuals, with a mean group size of 31.7 whales. Mean group size was largest in July (57 whales) and smallest in October (13.9 whales) (Table 4). By location, mean group size was greatest in the Susitna River Delta and smallest in the Kenai River Delta (Table 5). Maximum annual group size has been increasing in recent years; groups of 200 or more individuals were first seen in 2012 and the maximum group of 313 whales was seen in 2015 (Table 3, Figures 35-45). In each of the 11 field seasons, the largest group encountered annually occurred in the Susitna River Delta during a 2.5-week period between mid-July and early August (Table 6).

Color composition and relative age class of groups encountered 2005-2015

Eighty-five percent of the groups encountered during photo-id surveys contained a mixture of white belugas, gray belugas, and calves, although the relative percentage of each varied somewhat by year, month, and survey area (Table 7, Figures 46-48). Fifteen percent of groups contained whales of only one color (Table 8); these were mostly small groups (fewer than 10 individuals) of white whales. There were two instances of groups containing only gray individuals. Mothers with calves were usually seen in groups with other whales; there were only four instances of mother-calf pairs by themselves (Table 8).

Groups with calves and neonates 2005-2015

Fifty-nine percent of all beluga groups encountered contained at least one calf (Table 7). Calves (combined with neonates) comprised three to 20 percent of the groups encountered (Figures 46-48). Calves were seen in all of the areas, months, and years surveyed (Figures 49-67).

Neonates were counted separately from calves beginning in 2008. Twenty-nine percent of all groups encountered between 2008 and 2015 contained at least one neonate (Table 7). Neonates comprised zero to five percent of the total number of belugas encountered, depending on the month, year, and survey area. Overall, two percent of all belugas encountered between 2008 and 2015 were neonates (Table 9), and neonates were seen in all of the areas and years surveyed (Figure 68). Neonates were not seen April through May, but were seen July through October (Figures 69-75). The first neonate sighting of each field season occurred at the Susitna River Delta, during a period that ranged between early July and early August (Table 10). This often coincided with the date and location of the largest group encountered for the year. Neonates were seen as late as mid-October (Table 10 and Figure 75).

A birth was observed and photographed on July 20, 2015 in the Susitna River Delta (Figure 76). The birth took place during low tide, in shallow waters (~1.3 m) along the exposed mudflats, 5-10 m from shore, in a cove-like area where the current was reduced relative to nearby areas. The birth occurred in a larger group of 313 whales, with at least three other neonates seen in the group. Little of the birth event was visible at the surface and the turbid waters prevented viewing into the water. An adult beluga was observed a few meters away from the main group. The group was traveling along the exposed edge of the mudflats, but the lone beluga was floating log-like at the surface. It was eventually joined by other belugas (whites and grays), and soon after a neonate with deep fetal folds surfaced explosively from alongside the lone beluga. During the 37-minute observation period, the neonate was often seen listing to one side at the surface and appeared motionless, but then was pushed upright by other belugas. At times, it would disappear from view, but later was seen being pushed forcefully to the surface by the small group of attending belugas, with what appeared to be occasional blows to its flanks. When last seen, the neonate appeared to be breathing and swimming on its own, but remained surrounded by a small group of belugas.

Feeding groups encountered 2005-2015

Of the 496 groups encountered during surveys, 33% were observed engaging in feeding behavior (suspected or confirmed). It could not be determined if feeding behavior was occurring for 10% of the groups, because they were seen at too great a distance, too briefly, or very early in the study when behavior sampling protocols were not developed. Feeding behavior was observed for groups in all areas surveyed except Chickaloon Bay (Figure 77), and in all months except April (Figures 78-84).

Stranded Belugas Photographed 2005-2015

There were 16 stranded belugas with photographs of a quality sufficient for photo-id (i.e., not too far away, not missing skin, not in advanced states of decomposition, not floating belly-up). Fourteen of these individuals were dead at the time of stranding (Table 11). The other two were an adult and a calf who live-stranded together and were assumed to be mother and calf. All of the dead whales were adults (eight females and six males). Three of the females were pregnant at the time of death. Dead pregnant belugas were documented as early as May 14 and as late as October 9 (the October 9th fetus was near-term; Kathy Burek, Alaska Veterinary Pathology Services, personal communication). Two dead adult males had scars from previous satellite tags. Details of the strandings, including necropsy reports, can be requested from NMFS AKR. Matches between the stranded whales and individuals in the photo-id catalog are presented in the catalog section of this report.

Incidental Sighting Reports of Belugas 2005-2015

In addition to the 396 photo-id surveys conducted, there were 490 incidental reports of sightings of belugas received by the CIBW Photo-ID Project between 2006 and 2015 (Table 12). Figure 85 shows the locations of place names given in incidental sighting reports. Sightings were reported by fisherpeople, pilots, the media, law enforcement officers, vessel operators, tourists, biologists, educators, regulators, port operations staff, environmentalists, and energy-sector employees (oil and gas, coal, tidal power). The annual number of sighting reports ranged from 12 to 100. Belugas were reported in the Susitna River Delta April through November; in Knik Arm August through October; and in Turnagain Arm in all months except February, July, and November. Sighting reports from Chickaloon Bay were similar to those from the Susitna River Delta, except that belugas were not reported in Chickaloon Bay in November. A large group of approximately 200 whales was reported around Kalgin Island in January 2010, and a large group of 150 whales was reported by personnel on the Tyonek Platform in January of 2015.

Sighting reports of belugas in the Kenai River Delta were first received in 2007, and every year except 2008 thereafter. Belugas were reported in the Kenai River Delta in all months except July, August, and December. Reports of belugas seen on the east side of lower Cook Inlet from south of Kasilof were received during 2012-2015, including reports of belugas in or near Kachemak Bay on three separate occasions (photos were

provided for one of these sightings, but were inconclusive with respect to species identification).

Human Interactions 2005-2015

Human activities with the potential to affect belugas were noted during photo-id surveys. In the majority of instances, these activities were incidental in the sense that the people conducting them were likely unaware belugas were even present. In a few cases when activities appeared to be intentionally directed at belugas and potentially harmful, the National Oceanic and Atmospheric Administration (NOAA) Office of Law Enforcement (OLE) was alerted.

The following human activities with potential to affect belugas/prey/habitat were observed during photo-id surveys between 2005 and 2015:

- Aircraft

Aircraft (e.g., small recreational planes, commercial aircraft, military jets, and military transport planes and helicopters) were observed during the majority of photo-id surveys. For example, aircraft were noted flying over belugas during all 10 surveys of the Susitna River Delta in 2015, and on three of these days, small planes were observed circling beluga groups. On two separate occasions on July 20, 2015, a large group of belugas was observed to suddenly quit vocalizing and exhibit low surfacing profiles when a small plane circled them at the Susitna River Delta. In both instances, the belugas remained in the area and appeared to resume their previous behavior after the plane left. Military overflights were most common in Knik Arm, while small recreational planes were common over other areas surveyed.

- Noise from Firearms

Exposure to loud noises from recreational firing ranges was a common occurrence during photo-id surveys. Recreational firing ranges are located at the Anchorage Coastal Refuge near Potters Marsh (Turnagain Arm), Goose Bay (Knik Arm), and Birchwood (Knik Arm). On several occasions in the fall along the Kenai River, boat-based duck hunters fired over the water, causing the photo-id boat to cease surveys and move operations to land; belugas were never seen to enter the Kenai River during these times.

- Subsistence Harvest

Subsistence harvest of CIBWs occurred in 2005, and had been planned for 2006. The photo-id survey boat stayed off the water during times that NMFS advised subsistence hunting might be taking place. Incidental subsistence harvest of a dead stranded CIBW occurred in Turnagain Arm in 2014. Hunting was not involved in this harvest; subsistence users opportunistically salvaged skin and blubber of a dead whale following a necropsy conducted by NMFS and the Alaska Marine Mammal Stranding Network.

- Poaching/Intentional Illegal Harassment

The NOAA OLE has investigated several incidents of reported harassment of CIBWs (Enforcement Officer Les Cockreham, NOAA OLE, personal communication) between 2005 and 2015. The potential for illegal harassment of belugas along Turnagain Arm may be especially high as CIBWs often approach within several meters of vehicle pullouts along the Seward Highway. Many of the educational signs along the Seward Highway are riddled with bullet holes and individual beluga whales have been seen to exhibit marks that appear to be healed gunshot wounds (McGuire et al. 2014a). Poaching activities were not directly observed during photo-id surveys.

- Military Detonations

In 2010, researchers conducting a vessel-based photo-id survey in Knik Arm's Eagle Bay noted unusual surfacing behavior by belugas during a period when explosives were being detonated on shore at JBER. Researchers felt the explosions through the bottom of the vessel and could see large smoke columns rising approximately 4 miles/6.4 km away. It is not known what type of military activities were being conducted or what caused the explosion.

- Research Activities

In addition to the vessel-based surveys conducted by the CIBW Photo-ID Project, other CIBW studies between 2005 and 2015 with a vessel component were conducted by JBER, the ADF&G, NMFS, the Knik Arm Crossing Project, the Ocean Renewable Power Company, Greeneridge Sciences, Scripps Institute of Oceanography, and the Alaska Energy Authority.

Annual and semi-annual aerial surveys of CIBWs were conducted by NMFS (Shelden et al. 2013, 2015a). These surveys generally occurred in late May, early June, and sometimes in early August. Surveys were conducted at low enough altitudes to require a scientific research permit for incidental take by harassment (from noise). Beginning in 2007, the CIBW Photo-ID Project did not conduct vessel-based surveys during those weeks that NMFS was conducting their aerial surveys, at the request of NMFS. Aerial surveys for CIBW and other marine mammals were also conducted by the Alaska Energy Authority and the Apache Corporation.

- Watercraft (non-CIBW Research)

Watercraft observed around belugas during photo-id surveys included container ships, tugs and barges, dredges, small recreational boats, US Coast Guard vessels, stand-up paddleboards, and windsurfing boards. There were three instances in which belugas were seen to dive in apparent response to intentional approach by vessels and to remain submerged until after the vessels had moved away. The first instance was at the Port of Anchorage small boat launch when a skiff of duck hunters approached a group of whales, the second instance was along Turnagain Arm when two paddle boarders approached a group of belugas, and the third was when a recreational vessel in the Kenai River drove at

high speed directly over a small group of belugas in shallow water. The NMFS OLE was contacted in all instances.

- Intertidal Construction

Pile driving, filling of the intertidal zone with earth and rocks, and cable-laying operations were all seen when belugas were present during photo-id surveys.

- Fishing

Set nets and set-net vessels were observed during photo-id surveys, as was recreational fishing from shore and small vessels. Photographs of a dead beluga calf entangled in an educational set net in the mouth of the Kenai River were received from the Alaska Marine Mammal Stranding Network (details available upon request from NMFS).

- Entanglement from Unknown Activities

One live beluga was observed entangled in line (Figure 86), and was last seen in 2013. Another live beluga was observed in 2005 entangled in what may have been a tire or a culvert liner (Figure 87). Neither beluga has been resighted without the entanglements.

Other Marine Mammals Encountered during CIBW Surveys 2005-2015 or Reported to the Project

These marine mammals were encountered during photo-id surveys for CIBW, or were reported incidentally:

- Harbor seals (*Phoca vitulina*) were commonly encountered in all years and all areas surveyed. The largest (often over 200 seals) and most persistent haul-out occurred at the mouth of the Susitna River. Harbor seals and belugas were often observed feeding in the same areas, such as the mouths of the Big and Little Susitna rivers, Eagle River, the Kenai River, and at Beluga Point along Turnagain Arm.

- Steller sea lions (*Eumetopias jubatus*) were seen on two occasions. A lone Steller sea lion was seen mid-way up Turnagain Arm in September 2006, and in June 2011, a lone Steller sea lion attempted to board the survey zodiac along the Susitna River Delta.

- Gray whales (*Eschrichtius robustus*) were seen on two occasions by project biologists. A lone sub-adult gray whale was photographed along Turnagain Arm in May 2006. A few days later, a lone sub-adult gray whale was seen at the Port of Anchorage. The second whale was not photographed so cannot be identified as the first whale, although it seems likely they were the same animal.

- A live-stranded juvenile humpback whale (*Megaptera novaeangliae*) was photographed mid-April 2014 in Turnagain Arm. A few days later, crews aboard

commercial vessels near Point Possession reported seeing a live mother and calf pair of humpback whales over a period of several days.

- A dead fin whale (*Balaenoptera physalus*) was necropsied in Knik Arm by JBER biologists in September 2015. The whale had been brought into the area on the bow of a ship, and the captain reported that it had most likely been struck somewhere in Cook Inlet but not in Knik Arm (Chris Garner, JBER, personal communication).

- Harbor porpoises (*Phocoena phocoena*) were not encountered during photo-id surveys. A dead-stranded harbor porpoise was reported by NMFS in September 2014 in Kincaid Park in Anchorage. An incidental report was received of live harbor porpoises in the Kenai River Delta in May 2013.

- A Dall's porpoise (*Phocoenoides dalli*) was reported dead-stranded in Kincaid Park in Anchorage in September 2011.

- Killer whales (*Orcinus orca*) were not encountered during photo-id surveys. An incidental report was received of a pod of live killer whales in Turnagain Arm in August of 2015 (Kathleen Leonard, LGL Alaska Research Associates, personal communication).

Catalog Development and Current Status 2005-2015

The number of identified whales in the CIBW Photo-ID catalog has grown with each year of effort. In addition to photos from 367 dedicated survey days, photographs from 37 days of incidental effort by colleagues and the public are included in the photo-id catalog.

The right-side catalog contains sighting histories for 376 individual whales photographed on the right side between 2005 and 2015 (Figure 88, Table 13), and the left-side catalog contains sighting histories for 301 individual whales photographed on the left side between 2005 and 2011 (Figure 89, Table 13). In order to conserve project funds, beginning in 2006 only photographs of the right sides of the whales were cataloged and images of the left sides of the belugas were archived without cataloging. The choice of the right side over the left was arbitrary at the time it was made. Funding was later provided that allowed for the cataloging of left-side photos taken between 2005 and 2011 (McGuire et al. 2011a, 2014b; Appendix A). There are 48 "dual" whales (i.e., individual whales whose right- and left-side catalog records are linked).

Sighting Histories of Identified Belugas 2005-2015

The following summary of sightings between 2005 and 2015 is for individuals in the right-side catalog, the dual catalog, and for subsets of particular interest. Summaries of the left-side catalog are not presented because it is still in development; however, relevant left-side records are included in the dual catalog summary.

Because the dual whales have the most complete sighting records of belugas in the catalog, they are one of two subsets of belugas in the catalog that are of highest value for obtaining information about reproduction. The other subset contains those identified

whales in the catalog that are of known sex because their photo-id records have been matched to whales whose sex was genetically determined during: 1) captures for satellite tagging, 2) examinations during strandings, or 3) biopsy studies.

Right-side catalog 2005-2015

The average individual beluga in the right-side catalog was photographed for a total of 8.3 days, and in four different field seasons (Table 13). Eighty-two percent of individuals were photographed during more than one field season, and three individuals were photographed during all 11 field seasons. Eighteen percent of the whales in the catalog were seen in both 2005 and 2015. Ninety-one percent of individuals were photographed on more than one day, and two individuals were photographed on as many as 39 different days. There was a mean of 1.8 years between resightings of the same individual, with a maximum gap of seven years between resightings.

The 2005-2015 right-side catalog contains records for 376 individuals, and seven of these have been matched to dead individuals. Because seven years was the maximum gap between resightings of individuals, an individual is suspected to have died if it had not been photographed after 2007. There are 30 individuals in the right-side catalog suspected to have died based on the lack of sightings after 2007, and another seven confirmed dead (from stranding records), leaving 339 individuals in the right-side catalog that are believed to still be in the population.

Dual catalog 2005-2015

The average individual in the dual catalog was photographed 24 days and in 7.5 different field seasons (Table 13). Three individuals were photographed during all 11 field seasons (Figures 90-92). Fifty-four percent of the whales in the dual catalog were seen in both 2005 and 2015. There was a mean of 1.1 years between resightings of the same individual, with a maximum gap of five years between resightings. The maximum number of resightings of an individual whale within a single field season was 12 days. One individual who was photographed as recently as 2015 was identified in photographs taken by NMFS in 1998, giving it a 17-year sighting history (Figure 93). Another whale, found dead in 2013, was matched to a photograph taken by NMFS in 1994 during a study where suction-cup tags were applied (Lerczak et al. 2000), giving it a 19-year sighting history (Figure 94). Five years was the maximum gap between resightings of individuals in the dual catalog; however, to be conservative and consistent in estimating the number of whales that had died, the same criteria from the right-side catalog was applied for dual whales, i.e., an individual was suspected to have died if it had not been photographed since 2007. There was one individual in the dual catalog suspected to have died, based on the lack of sighting record information after 2007, and another five whales known to be dead (from stranding records), leaving 42 individual belugas in the dual catalog that are believed to still be in the population.

Identified individuals with satellite-tag scars

Fourteen individuals in the photo-id catalog were confirmed as whales bearing scars from satellite tags, and a 15th individual in the catalog was identified as a whale that had been captured but not tagged (20 CIBWs were captured and 18 were tagged by NMFS between 1999 and 2002). Details about the capture and tagging, as well as whale movements during the life of the tags, are presented in Shelden et al. (in prep). Ten of the 15 confirmed captured/tagged whales in the photo-id catalog were resighted as recently as 2015; this represents 50% of the 20 CIBWs originally captured and/or tagged between 1999 and 2002. Three satellite-tagged whales were confirmed dead between 2001 and 2015. Photo-id records suggest a fourth whale, tagged in 2002, may have died after its last sighting in 2007. Details on the photo-id records of these individuals are presented in McGuire and Stephens (2016). Twelve of these 15 individuals have photo-id records on both the right and left sides (i.e., they are dual-side whales). Sighting histories of satellite-tagged whales are presented in Appendix B.

Six individuals in the photo-id catalog have been identified as individuals in the photos taken at the time they were captured and tagged (Table 14); three of these were females and three were males (confirmed via DNA collected during capture). One of the whales that was captured but not tagged was also matched to the photo-id catalog; this whale was a female (confirmed via DNA collected during capture).

Identification of stranded and entangled belugas 2005-2015

Thirteen stranded CIBWs were identified as individuals in the 2005-2015 photo-id catalog (Table 15). All 13 of these whales were adults; 12 were dead and one was alive. Of the 12 dead whales, six were males and six were females. Two of the males had scars from satellite tags. One of the females was pregnant at the time of stranding. The live-stranded adult was presumed to be a female because she stranded with a live calf at her side. Sighting histories of these 13 identified stranded whales are presented in Appendix C.

One live whale showed signs of rope entanglement (Figure 95). This whale was first encountered and photographed throughout the 2010 field season (McGuire and Bourdon 2012) and was also photographed in 2011, 2012, and 2013. The Alaska Marine Mammal Stranding Network was given annual updates of sighting information and photographs of this entangled whale. Based on how frequently this whale was seen during 2010-2013 and the abrupt cessation of sightings post-2013, it is assumed this whale died undetected. It is also possible it lost the rope and was no longer recognized; however, the natural marks (i.e., marks other than the rope) were quite distinct on this whale, and it seems likely it would still have been recognized if it had been photographed without the rope.

Identification of biopsied whales

A feasibility study for biopsy of CIBWs was conducted in 2016 (McGuire et al. 2017). Biopsy samples were obtained from six whales, and five of these whales were photographically matched to individuals in the CIBW photo-id catalog (Table 16). Genetic sex determined from biopsy skin samples indicates that four of the biopsied and

photo-identified whales were female and one was male. Although this biopsy information is technically beyond of the scope of this report because it occurred in 2016, outside of the 2005-2015 reporting period, we include it here because of the valuable information it provides about individuals of known sex in the catalog. Sighting histories of these five identified biopsied whales are presented in Appendix D.

Identification of individuals of known sex in 2005-2015 catalog

There are 22 individuals of known sex in the 2005-2015 catalog; eight are males and 14 are females. Sighting histories of these individuals of known sex are presented in Appendix E. There is little difference between sighting histories of the sexes with respect to number of sighting days, number of years of sighting records, or survey areas in which they were photographed (Table17, Figure 96). Ninety-eight percent of the 145 groups containing known females had calves and/or neonates in them, and 96% of the 110 groups containing known males had calves and/or neonates in them.

Reproductive Histories

Number of potential mothers in the 2005-2015 catalog

- Right-side catalog

  There are 169 presumed mothers in the right-side catalog (142 right side only and 27 dual), which represents 45% of the individuals in this catalog. Three of these are known to have died, leaving 166 that are presumed to still be alive. Eighteen of these presumed mothers were seen with calves in four or more years; their sighting histories are summarized in Table 18.

- Dual catalog

  There are 27 presumed mothers in the dual catalog, which represents 56% of the individuals in this catalog. Sighting histories of the presumed mothers in the dual catalog are summarized in Table 19. Two of these individuals, R9/L450 and R103/L493, were seen in every year of the study (Figures 97 and 98).

- Known-sex catalog

  There are 14 females of known sex (i.e., sex was confirmed from genetics or necropsy). Seven of the 14 known-sex females had been classified as presumed mothers based on their photo-id records (Table 20). Another two known-sex females had been classified as possible mothers based on ambiguous photos in which a calf may have been alongside the mother but could not be confirmed. Five of the known-sex females were never photographed with a calf.

Number of identified calves in the 2005-2015 catalog

Twenty-one calves were photo-identified as individuals; ten were from the left-side catalog, eleven were from the right-side catalog, and none had dual records (Table 21).

Individually identified calves (i.e., calves identified from their own markings, not merely from accompaniment of an identified mother) were photographed between one and seven years, with a mean of two years of sightings per individual calf. Identified calves were photographed alongside their mothers between one and four years, with a mean of 1.5 years.

Sixteen of the 21 identified calves were linked to mothers who were also identified individuals in the catalog. Nine of these calves were identified by their own marks in the same year they were first photographed with their mother, and five of them were identified a year after they were first noted as accompanying calves to their mothers. One calf had a four-year span between when it was first sighted with its identified mother and when it could be identified independently by its own marks. Only one calf (L10627) is of exact known age; it was first seen as a neonate of an identified mother in 2010, and then was identified by its own marks the following year.

Interbirth interval

Interbirth interval could be measured for only the two individual mothers who were each photographed with more than one neonate (Table 22, column E): one had an interbirth interval of three years (whale R165, Table 18) and the other had an interbirth interval of four years (whale R1238/L 2398, Figure 99, Table 19).

Interbirth interval may be estimated from the following three methods:

1. Dividing the total length of records examined during 2005-2015 by the number of different calves per individual (Table 22, column A). Presumed mothers had between one and four calves per individual over the 11 years of records examined, resulting in a calf every 3-11 years depending on the individual. The average mother calved every 3.9-5.2 years**,** depending on the subset of the catalog being examined.

2. Adding the span of years a mother was photographed with the same calf to the number of years between sightings of different calves **(**Table 22, columns B and C); this results in an average inter-birth interval of 3.4-5.1 years, with a range of 2-13 years depending on the individual.

3. Examining the number of years between first sightings of different calves of the same mother **(**Table 22, column D). The average gap was 2.7-3.7 years between sightings, with a range of 1-8 years.

Estimated calving rate

During the eleven years examined in this report, identified individuals that were presumed to be mothers had between one and four calves each, with means of 2.1, 2.4, and 2.8 calves per mother, depending on the subset of the catalog being examined (i.e., right, dual, or known-sex, respectively; Table 22). In terms of calves per presumed mother per year, this is a rate of 0.19- 0.25 calves per year per presumed mother.

Estimated period of maternal care/association

Calves that were first photographed as neonates were photographed with their mothers for between one and four years (Tables 18-20). The period of maternal association between identified mothers and associated but unidentified calves averaged between 1.4 and 2.2 years, depending on the subset of the catalog examined, and ranged between one and six years, depending on the individual (Table 22, column B). The period of maternal association between identified calves and their mothers ranged between one and four years with an average of 1.5 years (Table 21).

One mother-calf pair had robust enough sighting records from both the mother and the calf to illustrate their history of maternal association, followed by the independence of the calf and subsequent calving of the mother (Table 21, Figure 100). The calf (R7199) was identified from its own marks the first time it was photographed (August 3, 2009), and it was photographed with its mother (R3215), who could also be identified. Although the calf was classified as "small" the first time it was photographed, it did not appear to be a neonate, and was likely born in 2008. Neither mother nor calf were photographed in 2010. Mother and calf were photographed together in 2011 and 2012. Neither was photographed in 2013. In 2014, the calf was photographed without its mother, and the mother was not photographed that year. In 2015, the mother was photographed with a new calf of undetermined age and was not photographed with her previous calf. Assuming the second calf was born in 2014 (it appeared too small to have been born in 2013) and the first calf was born in 2008, there was a six-year gap between calves, and the first calf was still with its mother at four years of age, and was independent by six years of age, when its mother had her next calf. If the first calf was born in 2009, then there would have been a five-year gap between calves and the first calf would have been with its mother at three years of age and independent by five years of age.

DISCUSSION

Despite the challenges presented by beluga whale morphology (i.e., no dorsal fin) and behavior (e.g., typically low surfacing profile) in the turbid water of Cook Inlet, over an eleven-year period, 376 individual belugas were identified from their distinctive marks. The photographic tracking of these individuals has produced a long-term dataset that provides insight into the following:

- **General Population Characteristics and Trends**
- **Habitat Preferences**
- **Individual Life Histories**
- **Reproductive Histories**

In the following discussion, we describe patterns and trends that are apparent within the data, while also pointing out sources of sampling bias and how they may affect the data from photo-id surveys and identification of individuals. The next phase of the CIBW Project, now underway, includes working with modelers to quantify these biases and confounding variables and explicitly build them into models that will allow scientists to better assess the significance of the patterns for understanding beluga population dynamics. In the meantime, however, these descriptive results will be useful to managers seeking to minimize effects of human activities on belugas, and to help inform future research efforts.

General Population Characteristics and Trends

Seasonal and spatial patterns in beluga encounter rates

There were distinct seasonal, spatial, and inter-annual patterns in beluga encounter rates during photo-id surveys. These patterns were also related to patterns in group size, and differences in survey effort (i.e., total number of surveys, and allocation of survey effort among different months and survey areas). Even after adjusting beluga encounter rates to standardize differences in monthly survey effort, there was a general pattern of encounter rates being initially low at the beginning of the field season in April (when belugas were in Knik and Turnagain arms), increasing in May and June (when belugas were along the Susitna River Delta and in Knik Arm, Chickaloon Bay and the Kenai River Delta), peaking sharply in July (when belugas were found mainly at the Susitna River Delta but occasionally seen in Chickaloon Bay and Knik Arm), then falling steadily from August until the end of the field season in late October (when groups were in the Susitna and Kenai river deltas and Knik and Turnagain arms). This same general seasonal pattern was seen for mean group size and maximum group size, but with slight differences: mean group size was small in April, increased sharply in May, fell in June, peaked in July, then fell steadily August through October. Maximum group size also peaked in July, but the biggest groups in August and September were larger than the biggest groups in May. These seasonal and spatial patterns are likely in response to patterns of timing, strength,

and location of the annual seasonal fish migrations (eulachon *Thaleichthys pacificus* runs in late May and early June, followed by salmon *Oncorhynchus* spp. runs late July to early August; NMFS 2008b) on which the belugas feed.

Inter-annual comparisons in beluga encounter rates and group size 2005-2015

We did not observe dramatic yearly differences in beluga encounter rates during photo-id surveys that would have led to immediate concerns about catastrophic population decline on one hand, or optimism for obvious population recovery on the other. Beluga encounter rates during photo-id surveys fluctuated yearly within the same general range between 2005 and 2012, as did the CIBW population size estimates from aerial surveys during this same period (Shelden et al. 2015b), although fluctuations in encounter rates from photo-id surveys and population estimates from aerial surveys did not follow the same yearly patterns (Figure 103). However, starting in 2012 and 2013 and continuing into 2015, there were noticeable increases in group size (both mean group size and annual maximum group size) and beluga encounter rates during photo-id surveys. Maximum group size has been increasing since 2012, beluga encounter rates began increasing in 2013, and mean group size increased in 2013. One of the most obvious explanations for this is that over time the photo-id surveys became selectively more focused on targeting whales in large groups in order to maximize the number of whales photographed per survey as project funds for surveys decreased. Additionally, the survey team became more experienced in predicting when and where to find large groups of belugas. There is no doubt that fluctuations in beluga encounter rates were related to annual differences in photo-id survey effort (i.e., total hours spent on surveys, months surveyed, and areas searched), and the modeling of the interactions of all contributory factors involved is needed to tease out any true inter-annual patterns from those influenced by sampling. However, the change in survey effort alone does not explain the trend in increasing group size: the largest group of every year always occurred in the same area (Susitna River Delta) and during the same general time period (mid-July to early August), and there is still a pattern of these groups becoming noticeably larger beginning in 2012 and continuing to increase in 2013 and 2014. This pattern should not be used as direct evidence that the population is recovering because of the many confounding variables involved, but it should be considered in conjunction with other datasets, such as the NMFS aerial surveys, when examining the general population trend for CIBWs.

In general, there do not seem to be many similarities between the aerial survey data and the photo-id survey data from within the same years. The largest annual groups during the aerial surveys for CIBWs conducted by NMFS in 2005-2012 (Shelden et al. 2013) were similar to those from photo-id surveys in that they were always at the Susitna River Delta, but these groups occurred in June when aerial surveys were flown, and did not follow the same annual patterns between 2005 and 2012 as those seen during photo-id surveys during the same period. This may be because of the differences in the months sampled each year by each method. The one commonality between aerial and photo-id survey data was that the maximum group size was greatest in 2014 for both survey types during the 2005-2014 period. It is unknown if this trend continued in 2015 because aerial surveys were not conducted that year.

Group composition by color and age class

Most of the belugas encountered during photo-id surveys were seen in groups, which is to be expected of this highly gregarious species. It was rare to see lone belugas. The majority of groups did not appear to be segregated by color or age class, but were composed of a mixture of white belugas, gray belugas, and calves. The slight differences in the color and age-class composition of groups found among different areas and seasons was most likely related to seasonality of birth and detection bias related to whale size, color, and distance from the observer. Although not quantified, observers on the survey vessel had the impression that white belugas were more likely to be detected than gray belugas, as gray belugas tended to blend with the turbid gray waters of Cook Inlet. It was even harder to detect small dark calves and neonates. This suspected bias in detection towards white whales seemed greater with distance from the observer. Behavioral differences between white and gray belugas, however, may have resulted in an opposite bias. Observers also had the impression that gray belugas, especially calves, were more likely to approach the survey boat and to remain near the boat. Therefore, although white belugas were more likely to be detected at a distance, gray belugas and calves may have been more likely to be photographed from vessels. Environmental conditions, most notably ambient light, may also have resulted in some variability in color assigned to whales during surveys (Figure 86). Distance from observer was often determined by survey area, which in turn was related to survey month because whales were in different areas in different months. For example, color composition was most difficult to determine in Turnagain Arm, where whales were often far from the land-based observers and harder to detect in the often-rough water. Groups in Turnagain Arm had a high percentage of whales of unknown color/age class and a small percentage of calves and neonates. The reverse was true for groups in the Kenai River Delta, where groups were smaller, whales were closer to the observer, and all whales in a group could be easily counted and photographed.

Although relative color composition of groups can give insight into social organization, it should not be used as an index of population age structure for assessing population recovery status for the following reasons:

- An increased ratio of gray belugas to white belugas could indicate more young whales being born, but it could also mean that more white animals are dying.
- The assignment of color is subjective. Because the same whale may look white one day and gray the next, the CIBW Photo-ID project attempted to develop an objective method to quantify whale color in photos by photographing gray and white reference cards in conjunction with whales, but results were mixed and this technique was discontinued (LGL 2009).
- Although belugas are born dark and lighten as they age, whale color is not a reliable indicator of reproductive status. We have photo-identified several mothers who were gray. Female belugas elsewhere have been reported to have some gray coloration for up to 21 or 42 years (depending on how dental layers are interpreted to

represent age), which is also the reported age of senescence (Burns and Seaman 1986).

The ratio of calves to non-calves per group (rather than relative color composition) has been used as an index assessing population demographics and recovery status/trends. As the endangered Saint Lawrence Estuary beluga population declined, changes were detected in the population age structure, including a higher proportion of mature animals relative to immature animals (Mosnier et al. 2015). NMFS developed an annual calving rate estimate for CIBWs based on the ratio of calves to non-calves in groups seen during aerial surveys conducted in early August. Between 2005 and 2009 (Hobbs et al. 2010), these ratios ranged between 6% and 14%, and were obtained for incorporation into models to estimate birth and survival rates and population viability. These same ratios from photo-id surveys between 2005 and 2015 ranged between 3% and 20%, depending on the area, month, and year of the survey. A similar index can be used for the relative percentage of neonates in the group, which we found to be roughly 2% overall, although this also varied by month, survey area, and year. While the development of population viability models is beyond the scope of this report, the inclusion of photo-id survey data in future models (with sample bias explicitly accounted for) should be useful, and will help to broaden the dataset with respect to the months, years, and areas covered. In particular, the inclusion of the mid-August through October period, when CIBWs are still giving birth, would be valuable.

Group composition by sex

Visual observations alone provided little information about the sex of belugas encountered during surveys. Smith et al. (1994) identified adult males in Canadian beluga populations by their "large size and heavy lateral musculature". We have photographed several large, white, well-muscled belugas, but at least two of these animals were closely accompanied by calves and were classified as presumed females. We felt this method of assigning sex based on body size was too subjective for our field conditions (little of the body is visible in the turbid water). The single instance in which the sex of a live whale could be determined by photo-id in the field was when an adult male beluga was photographed swimming in Knik Arm with its ventral side exposed.

The ability to photo-id individuals whose sex had been determined genetically from skin samples taken during capture for satellite tagging, stranding, or biopsy allowed us to examine the structure of the groups in which these individuals were photographed. We found no evidence of sexual segregation among groups. There were no differences between groups containing known males and groups containing known females in terms of average group size, color composition, or age-class composition; known males and females were found in mixed groups that contained white belugas, gray belugas, and calves/neonates.

Elsewhere in their range, other populations of belugas segregate outside of the breeding season into groups composed of maternal pods (containing adult females, calves, juveniles, and subadults), and smaller groups of adult males (Smith et al. 1994, Krasnova et al. 2009, Turgeon et al. 2012). We did not find much evidence to indicate that this was occurring during the times that we sampled, and instead found that identified males and females were occurring in the same groups. Only 14% of the groups encountered during

surveys were composed solely of white belugas, and 3% of these are questionable as all-white groups because they occurred in Turnagain Arm in September when gray belugas or calves are less likely to have been detected. Identification of some of the individuals in all-white groups showed that a few of them were suspected to be females, based on close accompaniment by calves at other times in their sighting histories. There were 110 groups containing known males, and only one of these groups was composed solely of white belugas (this group contained three individuals). If adult male belugas roam Cook Inlet, as singles or in small segregated groups of large white belugas, the possibility exists that we are rarely encountering and identifying them due to a survey schedule designed to locate and photograph large conspicuous aggregations.

Additional evidence that the groups sampled during photo-id surveys, and therefore represented in the photo-id catalog, contain males as well as females comes from photo-id of stranded belugas. Of the twelve dead whales with useful photographs, six were males who were identified as individuals with extensive sighting histories in the photo-id catalog. If we had not already encountered, photographed, and identified these males during previous photo-id surveys (i.e., if we were only photographing and identifying females) we would not have been able to match the stranding records to individuals in the catalog.

We will be further investigating the question of sexual segregation and social structure of CIBWs on a finer scale. We have observed that large groups of mixed color and age classes often have more homogenous sub-groups within them, and the CIBW Photo-ID Project will be examining the association patterns and known sexes of these sub-groups.

Group composition by identified individuals

To date, we have not found evidence that beluga groups in Cook Inlet are highly structured in terms of association patterns among individuals. Although results are preliminary and beyond the scope of this report, all group composition and individual sighting history information indicates the portion of the population we have identified is homogenous and group composition is fluid. Other than mother/calf bonds, there is no evidence of strong associations among individuals (McGuire et al. 2011b, 2014a&b). While some individuals were somewhat more likely than others to be seen together, these patterns were not widespread or consistent enough to allow the population to be divided into subgroups. In future studies we will examine this more to determine if subgroups exist on a seasonal scale (e.g., do the large groups seen in Chickaloon Bay or the Susitna River Delta break into smaller, more stable, subgroups during other seasons and in other locations?), and/or within the larger groups.

Habitat Preferences

General patterns of habitat use by CIBWs

Beluga whales encountered during photo-id surveys of Cook Inlet in 2005-2015 were rarely observed traveling among survey areas, but were instead encountered in distinct "hot spots" in predictable seasonal patterns that persisted year after year. Similar patterns

of localized aggregations and rapid and directed travel among areas of localized aggregations have been reported for satellite-tagged CIBWs (Hobbs et al. 2005) and beluga whales in Norway (Lydersen et al. 2001). The seasonal distribution and tidally driven movement patterns are likely in response to patterns of seasonal migrations of prey (e.g., eulachon runs in May, followed by salmon runs late July to early August; NMFS 2008b), as well as by variations in water temperature, ice coverage, and river discharge (Goetz et al. 2007, 2012; Ezer et al. 2013).

Large concentrations of belugas (i.e., groups in the hundreds) were found in the Susitna River Delta in May, early June, and mid-July through mid-August. Belugas in Knik Arm were observed in large concentrations in mid-August through mid-September, and followed a tidal pattern of traveling to the upper Arm with the high tide, and back down to Eagle Bay and sometimes the Port of Anchorage during the low tide. Belugas were most predictably found in Turnagain Arm beginning mid-August and followed a very clear pattern of following the tides in and out of Turnagain Arm throughout the fall. In contrast, the presence of belugas in the Kenai River Delta was much less predictable and more sporadic; although there was an overall spring/fall seasonal pattern, belugas might be present one day and absent the next. Belugas in Chickaloon Bay also had a seasonal pattern, but the tidal pattern seemed to vary somewhat according to season; on a few occasions in the springtime (May and June), groups of whales were encountered in transit between Chickaloon Bay and Fire Island, either heading to Chickaloon Bay with the falling tide or headed toward the Susitna River Delta with the rising tide. During the fall (August and September), belugas seem to be waiting in Chickaloon Bay during low tide, then following the rising tide up Turnagain Arm. Because sightings of belugas transiting between known hot spots were relatively infrequent, it remains unknown if there are distinct movement corridors among areas or if movement patterns are more diffuse and variable. For example, whales were sometimes seen using the channel between Fire Island and Anchorage to travel between Knik Arm and Turnagain Arm, while other times they were seen to take a circuitous route along the western inlet and Susitna River Delta. For CIBW conservation and protection of critical habitat, the identification and protection of movement corridors that link hot spots would seem to be as essential as the identification and protection of the hot spots themselves.

Extent of habitat used

Traditional Ecological Knowledge (TEK) reports the historic range of CIBWs included the Lower Inlet, defined here as the area of Cook Inlet south of the East and West Forelands (Huntington 2000, Braund and Huntington 2011). Aerial surveys have indicated that the distribution of CIBWs has changed significantly since the 1970s, when surveys were initiated. There has been a northward contraction of the CIBW core range into Upper Cook Inlet, as well as a shift west toward Anchorage (Rugh et al. 2010). Aerial surveys often detected belugas south of the Forelands prior to 1996 (Rugh et al. 2000, 2010), but since then they were only seen in the Lower Inlet in 1997, 2001, and 2012 (Rugh et al. 2010, Shelden et al. 2015a), and were only seen in the Middle Inlet (area around the Forelands) in 2006 and 2012 (Shelden et al. 2015a). Satellite-tagged whales were last tracked in the Middle Inlet in 2003 (Shelden et al. in prep). Incidental sightings of CIBWs south of the Upper Inlet have been reported to NMFS on occasion

(Vate-Brattstrom et al. 2010), but not as often and not in the large numbers that were historically reported (Vate-Brattstrom et al. 2010, Dutton et al. 2012).

Beluga groups (including calves and neonates) were observed during dedicated photo-id surveys in the Kenai River Delta in 2011 and 2012. Identified individuals in these groups were seen in the Kenai River Delta in both years, as well as multiple times within a year (these same individuals were also photographed elsewhere in Upper Cook Inlet; McGuire et al. 2014a). Belugas were not detected in the Kenai River Delta during photo-id surveys in 2013. The CIBW Photo-ID Project received incidental sighting reports of belugas as far south as Kachemak Bay in the Lower Inlet, and around Kalgin Island, Redoubt Bay, and the Kenai River Delta in the Middle Inlet. Reports from the Kenai River were first received in 2007, then yearly between 2008 and 2015. Incidental sightings of belugas outside of the Upper Inlet appeared to increase when dedicated outreach efforts were undertaken in this area (Appendix F). It is unknown if the observations of belugas during photo-id surveys and from incidental sightings in the Middle and Lower Inlet represent range expansion, or if they are simply the result of increased observer and reporting effort in the area.

Habitat use by individuals

Individually identified belugas did not display fidelity to any single area of Cook Inlet. Sighting histories of these whales indicated they moved among different areas of Cook Inlet. The same was true of the individuals tracked with satellite tags (Shelden et al. in prep).

When making inferences about the greater population of CIBWs based on sighting histories of individually identified whales, it is important to consider the results within the context of survey effort. Survey effort was affected by difficult and infrequent access to some survey areas (such as Chickaloon Bay) as well as the lower quality of photographs from some locations (such as Turnagain Arm), which were surveyed frequently but only allowed for very distant observations.

Identification rates were lower in areas where sampling is more difficult, and therefore results may under-represent beluga use of these areas. For example, overall sampling effort has been lower in Chickaloon Bay/South Fire Island than in other areas due to the logistical challenges in surveying this area. Several planned surveys of Chickaloon Bay were rescheduled or canceled mid-survey due to dangerous boating conditions in the area. Group encounters in Turnagain Arm typically yielded a much lower percentage of identified whales than groups encountered in other areas, which was likely a result of greater sighting distances in Turnagain Arm compared to other areas. Despite the limitations encountered while photographing belugas from land along Turnagain Arm, these photos have provided important evidence that belugas identified in Turnagain Arm were also seen elsewhere in Cook Inlet and are not a sub-population seasonally endemic to Turnagain Arm.

In general, the more robust the sighting record of an identified individual (i.e., the more times and years an individual is photographed), the more likely it is to have been

photographed throughout the survey area in the Upper Inlet, without displaying obvious preference for any particular area. An interesting exception is the female R111/L2467, who was captured and tagged by NMFS in 2000. Her fifteen-year span of records from both tagging and photo-id show her using Knik Arm and the Susitna River Delta, but never Turnagain Arm. Based on photo-id records alone, we had assumed sampling bias may have been the reason we never detected her in Turnagain Arm. After matching her photo-id records with her photos taken at the time of capture, we were able to see that her satellite tagging records also indicated that she never entered Turnagain Arm while being tracked.

Photo-identified males and females were found in the same habitats at the same time and did not appear to be using them differently. We will be examining these data further to see if there are differences at a finer scale.

Feeding habitat and behavior

Suspected and confirmed feeding behavior was observed in all months surveyed except April. This may be due to relatively low survey effort during this month. It may also be that the seasonal fish runs were not yet strong enough in the early spring for feeding behavior to be noticeable (see Moore et al. 2000, NMFS 2016, and Bechtol et al. 2016 for discussions of distribution and seasonal movements of beluga prey). There were two instances in which emaciated whales were observed and photographed, one occurred in April 2005 in Knik Arm, and the other occurred in early May in the Kenai River Delta in 2012.

Feeding behavior (suspected or confirmed) was observed in all areas surveyed, except Chickaloon Bay and the area between Chickaloon Bay and the southern end of Fire Island. In part, this may have been because of the relatively low survey effort in these areas. We received incidental reports from pilots of whales feeding at river mouths far into Chickaloon Bay during high tide, but we were unable to safely access these shallow areas to observe during high tide. Belugas in Chickaloon Bay were often first detected during the low tide and were seen milling along the shallow inner edges of the bay and in the mouths of the Chickaloon River, Big Indian Creek, and Little Indian Creek. It is likely they were feeding at the mouths of these rivers and creeks, but groups were too far from the survey vessel for observers to determine if that was the case, and sandbars prevented the vessel from entering further into the bay. When the water began to rise with the incoming tide, whales would often aggregate at the base of the cliffs at the far-eastern side of Chickaloon Bay, and then travel up the south shore of Turnagain Arm in a linear, fast-moving group. For example, a large group of 200 whales was first seen in Chickaloon Bay then later traveled up Turnagain Arm. This group was seen milling, socializing, traveling, and was suspected to be feeding by Gull Rock in Turnagain Arm.

Belugas in Turnagain Arm typically entered the Arm about four hours before the high tide and moved up (i.e., south and east) the Arm with the rising tides. The strong seasonal pattern of belugas in Turnagain Arm coincided with fall salmon runs in this area, and the scattered incidental sightings in the spring may have been associated with the eulachon runs up Turnagain Arm. Feeding behavior was more commonly seen in the middle and

upper (i.e., eastern) ends of Turnagain Arm. The outcropping at Bird Point appeared to be frequently used for belugas to congregate and wait until waters reached a sufficient depth with the incoming tide to allow for their continued travel up Turnagain Arm. On both the incoming and outgoing tides, belugas often used the coves and eddies created by natural and artificial outcroppings to mill, presumably searching for food, and possibly reduce their exposure to strong currents. Unlike previous years of the study, in 2015, belugas were not found traveling in the deeper channels along the north and south shores of Turnagain Arm. They were instead observed traveling in the visibly shallow areas in the middle of the Arm, and during the incoming tide, they sometimes appeared to be looking for and pursuing prey along the edges of these shallow areas.

Belugas in the Kenai River Delta often appeared to patrol the waters along Salamantof Beach as if searching for prey, then were seen traveling south and entering the Kenai River with the rising tide. In the Kenai River, belugas were observed most often in the relatively deep pools of the wide river bends, and appeared to search for and pursue prey (Figure 101) along the confluence ("rip") lines where river water met Inlet waters. Local fisherpeople report that belugas in the Kenai River Delta feed seasonally on king and silver salmon, hooligan, smelt, herring, Dolly Varden, sculpin, flounder, and halibut.

For groups observed in the Susitna River Delta, suspected/confirmed feeding behavior seen early in the field season in 2015 (late May and early June) was notably different than the suspected/confirmed feeding behavior seen later in the season (July and August). Early in the season, beluga groups would suddenly bunch up in a tight circular formation, then just as suddenly scatter, often with the group dividing in two and heading in opposite directions, then suddenly turning and bunching up again. Observers had the impression they were pursuing, or perhaps driving, fish that were schooling in circular clumps that would abruptly expand and contract, and frequently change direction. This fish behavior is consistent with schooling behavior of migrating eulachon (Moyle and Cech 2004). Later in the season, beluga groups that were suspected to be feeding were cohesive, faced the same direction (until a last minute high-speed lunge), and either traveled in a linear direction along the shoreline or displayed a circular path, following the current out of a river mouth, then traveling along the shoreline back upriver, then looping back downstream with the current. Observers had the impression that belugas were fishing along a steadily moving column of fish that were evenly spaced and traveling in a unidirectional linear formation. This fish behavior would be consistent with migrating salmon (Moyle and Cech 2004). We did not record the seasonal differences in behavior in previous years, but it may well have occurred and we failed to notice the difference as behavioral observations were secondary to obtaining photographs. It may also be that the timing of the eulachon run in 2015 was different than in previous years of the study and we were observing it for the first time.

Feeding behavior in Knik Arm was seen along the edges of mudflats during low tide and at the mouths of rivers during ebb and flood tides. In general, whales in mid-/upper Knik Arm traveled down Knik Arm and entered Eagle Bay and Eagle River during the falling tide, milled around and were suspected to feed in Eagle Bay and the mouth of Eagle River just before low tide, and traveled back up Knik Arm during rising tide.

All photo-id vessel surveys, as well as the land-based surveys at Eagle River, were scheduled around the falling, low, and rising tides; therefore, we cannot describe feeding habitat during high tide. We frequently observed beluga groups heading towards the mouth of the Susitna River with the incoming tide, but we were unable to follow them due to hazardous boating conditions, and do not know how far up the river they continued or if they were in pursuit of prey (which we assumed was the reason they were headed upriver).

Calving/calf-rearing habitat and seasonality

Unlike other beluga populations, the scientific literature had not identified distinct calving grounds for CIBWs, because births in the wild had not been documented previously. To our knowledge, our observation of a CIBW birth on July 20, 2015 in the Susitna River Delta is the first documentation of a CIBW birth, and provides evidence to support the designation of the Susitna River Delta as CIBW calving grounds. It should be noted that this does not mean calving does not occur elsewhere in Cook Inlet, only that it has not been documented elsewhere. The first neonates encountered during each field season were always seen at the Susitna River Delta in July, and were later seen in the other areas where groups were encountered. Within the broad area defined as the Susitna River Delta, neonates were seen in the river mouths of the Susitna River and Little Susitna River, and along the mudflats between the two rivers. A group with neonates was also seen at the mouth of the Chuitna River in July, to the southwest of the Susitna River Delta. No particular location could be singled out as a calf-rearing habitat because calves and neonates were seen in all parts of the survey area where belugas were encountered.

Seasonality of beluga calving in the Canadian Arctic has been determined using seasonal differences in proportions of calves, juveniles, and adults (Smith et al. 1994). Based on the presence of calves sighted in summer aerial surveys, Calkins (1983) speculated that calving might occur between mid-June and mid-July in the larger estuaries of western Upper Cook Inlet. Our observations of the birth, as well our documentation of the dates of the first neonate of each year, indicate that calving for CIBWs in the Susitna River Delta begins in mid-late July/early August, generally coinciding with our observed timing of annual maximum group size. Evidence also suggests that the calving season extends into October. We have seen neonates in October, and a dead stranded beluga was necropsied with a near-term fetus in October. It seems likely that we underestimate the number of neonates and perhaps fail to detect any births later in the season (i.e., after July) when beluga groups moved over to Turnagain Arm, where distance between land-based observers and whales increased.

A calf observed with an emaciated adult beluga in the Kenai River in early May 2012 had initially been classified as a neonate based on small size and unsteady swimming behavior, which would have been early in the season for a neonate compared to other neonate sightings. However, it is possible this was instead the small calf that was found dead in a gillnet a few days later, and the small size and uncoordinated behavior were a result of disease or poor nutrition rather than recent birth early in the season (photos of the live calf were taken at a distance and were of insufficient quality to be matched to photos of the dead calf).

Individual Life Histories

Is the 2005-2015 photo-id catalog representative of the CIBW population?

The number of identified individuals in the photo-id catalog is not a population estimate, although the number of individuals photographed each year does provide a minimum estimate of the number of CIBWs alive each year. We are unable to simply add the number of individuals in the right- and left-side catalogs to estimate population size for CIBWs for several reasons. With the exception of the 48 dual whales, we do not know which of the 301 left-side whales are the same individuals as the 376 right-side whales. If skin biopsies for genetic analysis continue to be collected concurrently with photographs of both sides, as they were during the 2016 CIBW biopsy feasibility study, more of the left- and right-side records will be able to be linked (McGuire et al 2017). In addition, there are many variables that determine if an individual will be identified from photos. The photo-id sighting history of an animal depends on the availability and identifiably of the animal. Availability factors include the behavior of the animal (i.e., reaction to the research vessel or land-based photographer, surfacing behavior, other behavior), affinity of the individual for the study area, and survey effort. Factors contributing to identifiability include the experience and skill of the photographer, boat driver, and photo-analyst; the quality of the camera and lens; weather conditions; and the conspicuousness and distinctiveness of the identifying mark. The distance between the whale and photographer, which is constrained by the survey area, animal behavior, and research permit restrictions, also affects identifiability. Estimating population size from photo-id data first requires models that consider these variables and the role they play in the probability that a whale is identified.

We had initially thought that a simple two-event mark-recapture model would be sufficient for estimating abundance from photographs of CIBWs. In such a case, the marked animals could be represented by those whales in the photo-id catalog and the second “sampling” or recovery event could be represented by the photographs of these same whales taken during later surveys. It became clear that generating a robust abundance estimate for CIBWs would require a more sophisticated model than a simple two-event mark-recapture study. This was unknown when the project began in 2005. In 2009, we developed an abundance estimate from the right-side catalog for 2008. This process required several steps (LGL 2009) in which we characterized the identifiability and permanency of marks on CIBWs. Every photograph of every whale in the right-side catalog was divided into body segments, and then each segment received one score for photo quality and one score for mark quality (each photograph was examined and scored independently by two photo-analysts). An estimation model was developed that could incorporate sightings of both marked and unmarked animals and that was robust to potential biases caused by differences in behavior among individuals. The final model used was the zero-truncated Poisson log-normal mixed effects model (ZPNE; McClintock et al. 2009, LGL 2009). The effort necessary to process the photographs in the 2005-2007 and 2009-2015 catalogs to make them useable for the ZPNE mark-recapture model to generate abundance estimates is well beyond the scope of current project funding and objectives.

The most-recent CIBW population estimate from aerial surveys was 340 whales in 2014 (NMFS 2016). The fact that the number of individuals in the photo-id catalog (376 individuals; 339 after subtracting known- and presumed-dead individuals) closely matches the population estimate from aerial surveys suggests that much of the population has been identified. Considering that during the duration of the CIBW Photo-ID Project several of the individuals in the catalog have died without photographs and many calves have been born that have not yet been identified, the numbers of individuals in the catalog should not be interpreted as a population count. Nevertheless, although the catalog does not represent every individual in the CIBW population, it does appear to contain records on the majority of individuals, and therefore data from individuals in the catalog should be representative of the CIBW population. As discussed previously, we have confirmed that both sexes are represented in the catalog. The shape of the discovery curve, representing the number of new individuals added to the catalog every year, is leveling off, which further supports the idea that most of the population (or the portion of the population that is available to us with current survey methods) has been identified. Life-history data derived from the catalog should therefore be generally characteristic of the CIBW population.

Mortality and longevity

NMFS reports that there were 73 dead CIBWs recorded between 2005 and 2015, although the age and sex of these individuals is not stated (NMFS 2016). The CIBW Photo-ID Project was provided with or took photos of 16 of these individuals. There does not appear to be a clear pattern for mortality of the dead photographed whales in terms of age class or sex; 81% were adults, 12% were calves, and one was of unknown age class. In addition, roughly one third were female, one third were male, and sex was undetermined for the remainder; suggesting a 50:50 sex ratio. In several cases, sex and age class were determined from photographs of whales that were not necropsied or otherwise examined by NMFS or the Alaska Marine Mammal Stranding Network.

Linking the sighting history of an identified whale with data obtained from its necropsy increases the value of both kinds of data. For example, being able to confirm the sex of a dead whale allows us to ground truth our assumption of mother/calf relationships based on photographs of live whales. Genetic identification of individuals also allows for the validation of photo-id of these same individuals. For example, a beluga that died in 2015 had been photo-identified as an individual that had been satellite-tagged in 2002 and later resighted between 2005 and2015; genetic comparisons of samples taken during capture for tagging and from the dead animal confirmed it was the same individual (McGuire and Stephens 2016). The potential exists for genetic samples taken from dead and live whales to provide information about kinship of identified individuals and we hope to be able to incorporate this type of information in the individual records in the CIBW Photo-ID catalog. NMFS OLE has indicated that photographs of belugas in suspected poaching or harassment investigations are useful when carcasses have been washed away by the tide and are not available to investigate directly (Enforcement Officer Les Cockreham, NOAA OLE, personal communication).

With the exception of a few whales first photographed as either young-of-the-year or one-year-old calves, the ages of most of the whales in the catalog are unknown. We know that one of the adult whales in the catalog is over 19 years old and another is over 17 years old, and that at least 154 individuals in the catalog are over 10 years old (because they were first identified in 2005) but we do not know their true age. NMFS (2016) reports that the oldest CIBW has been estimated to be at least 49 years old, based on measurements of teeth from stranded and harvested animals. Analysis of age from the teeth of photo-identified dead whales will provide the information needed to incorporate age information into the catalog. We had attempted to use lasers to measure the size of individuals in the field (LGL 2009) to compare to age/length curves from other beluga populations to estimate age, but could not obtain useful measurements due to calibration problems in the field and difficulties establishing a fixed reference point on the body.

Incorporating both the actual number of dead-stranded belugas and those predicted to have died based on a cessation of photo-id sighting records will be useful for population models. The number of stranded animals reported annually is surely an underestimate, given that many carcasses are not encountered and others are likely not reported. Winter strandings and strandings of calves are likely to be particularly underestimated because of detectability issues.

In order to obtain the maximum amount of information possible from a photograph of a dead whale, we have updated and distributed a protocol for photographing beluga mortalities (available at www.cookinletbelugas.org). This protocol can be used as a guide for stranding responders who are willing to photo-document markings on beluga mortalities and share their photographs with the CIBW Photo-ID Project.

Reproductive Histories

Number of presumed mothers in the 2005-2015 catalog

It seems likely that photo-id methods underestimate the number of presumed mothers, and thus females, in the CIBW population. We only classified as “presumed mothers” those individuals who had clear evidence of a calf alongside them in the same photo frame. We classified whales as “potential mothers” when calf accompaniment was ambiguous, either because of uncertainty about which adult in the photo frame was the parent of the calf (Figure 102), uncertainty differentiating calves from juveniles (for larger light-gray whales), or because too little of the suspected calf was visible above the surface of the turbid water to confirm that it was a calf. Potential mothers were not included in estimates of reproductive parameters. Our current method of defining mother-calf pairs at the level of association within the photo frame limits our ability to detect mothers with older calves, because the distance between mothers and offspring increases with increasing age of the calf (Mann 1997, Krasnova et al. 2009). We are also likely missing mothers because of the incomplete catalog status; we anticipate that the number of presumed mothers in the catalog will grow with the addition of the 2012-2015 left-side photographs to the catalog, particularly if we are able to link right and left sides and increase the size of the dual catalog. For example, 45% of the individuals in the right-side

catalog were classified as presumed mothers, compared to 56% of the individuals in the dual catalog.

Adding biological information obtained from invasive CIBW studies allowed for the validation of assumptions that had been made about individuals in the catalog based solely on their photo-id histories. We were able to use the information from the 22 individuals (eight males and fourteen females) for which sex had been genetically determined from samples collected during satellite tagging captures, strandings, and biopsy to test our classification of mothers. We wondered if all of the known females had been classified as mothers in the photo-id catalog, and if any males had been incorrectly classified as mothers.

Half of the 14 photo-identified females of genetically confirmed sex had been classified as presumed mothers based on their photo-id histories. In other words, seven individuals that had been presumed to be mothers based on their sighting histories with calves were later confirmed to be females from genetic samples. However, this means that 50% of the genetically confirmed females had not been classified as presumed mothers in the photo-id catalog, although two were classified as potential mothers. Photo-id records of confirmed females that were not classified as presumed mothers may have been too sparse and/or they may simply have not been photographed when they had calves with them. Alternatively, it is possible they were relatively young females and had not yet reached reproductive maturity. The age of first reproduction for belugas has been reported as between 4 and 14 years, depending on the population (NMFS 2016), but this value is currently unknown for CIBWs. Because none of the photo-identified calves of known age have yet been documented with calves of their own, we are currently unable to determine age of first reproduction for CIBWs from photo-id data. Another possibility is that these females without calves were of reproductive age, but for some unknown reason were not reproducing, or had lost their calves. These data will need to be further analyzed to understand better which of these processes may be occurring. Hormone analysis of the five females biopsied in 2016 is planned by NMFS and may give future insight into their sexual maturity and relative age. Regardless of the reasons the known females did not have reproductive histories in the photo-id catalog, if the sample of known-sex females is representative of the catalog and the population, our results indicate that the number of presumed *mothers* in the photo-id catalog underestimates the number of *females* in the catalog, and therefore in the population.

We examined the catalog records of the eight photo-identified males of known sex to determine if any had been mistakenly classified as a mother. There was only one male biopsied in 2016, and he did not have any photographs of accompanying calves in his photo-id history that would have resulted in him being misclassified in the photo-id catalog as a presumed mother. This was true of five other genetically confirmed males. However, in 2014 and 2015, two photo-identified males of known sex (each had stranded and been satellite tagged) had initially been classified as mothers based on photos of them with what may have been calves. This caused us to revise our earlier definitions, and instead differentiate “presumed mothers” from “potential mothers” (discussed earlier in this section). With these revised and narrower definitions, these males were no longer

classified as presumed mothers. We reviewed all of the photo-id records in the catalog and reclassified presumed mothers according to this revised definition.

Number of identified calves in the 2005-2015 catalog

Although most of the calves we photographed could not be identified as individuals, 21 calves were identified by their own marks rather than by those of their mothers, which allowed them to be tracked independently of their mothers as they aged. We were unable to identify neonates or young-of-the-year calves based on their own marks. The youngest calf identified from its own mark was a one-year old; its age was known because its identified mother had been seen with a neonate the previous year. With a few exceptions, the marks used to identify calves were not the same as those used to identify older animals in the catalog. Rather than distinct scratches or scars, the marks on calves were areas of pigmentation or patches of sloughing skin that often lasted no longer than a single field season or two. In some cases, older calves began to develop healed scars and other more permanent marks similar to those used to track adults in the catalog, and we were able to continue to follow them with these marks, even as we were losing the ability to track them from their calf marks. We have been able to track one of these calves for seven years. However, most of these temporary "calf marks" seemed to disappear after about two years and we lost the ability to track the calf if it did not pick up permanent marks in the interim. Although we have not observed CIBWs to undergo the catastrophic seasonal molt undertaken by many other beluga populations, it appears that calves undergo a diffuse molt over several years as they mature.

Inter-birth interval

Studies of other beluga populations have reported inter-birth intervals of two to three years (multiple sources summarized in NMFS 2016). The lactation period of different beluga populations is reported to be 18-32 months (multiple sources summarized in NMFS 2016), following a gestation period of 15.6 months (determined from captive studies; Robeck et al 2005).

In addition to inter-birth intervals seeming to vary among populations, they also may vary within a population, according to the age and experience of the mother (Suydam 2009), and the general health of the population. Concurrent with the population decline in the endangered St. Lawrence Estuary beluga population was a change from a 3-year reproductive cycle to a 2-year cycle (Mosnier et al. 2015).

We documented inter-birth intervals of three and four years for the two identified mothers who were photographed with more than one neonate each during their sighting histories. We were curious if the relatively longer inter-birth interval we documented in CIBWs was simply due to our small sample size, or if there was additional supporting evidence. As the gap in the 2012-2015 catalog is filled, and as more years of fieldwork and cataloging are added to the dataset, we anticipate being able to document inter-birth interval for more individuals in the near future.

In addition to the two known inter-birth intervals, there were 52 individuals for which we estimated inter-birth intervals, using the three different methods previously described in this report. Average estimated inter-birth intervals were between 2.7 and 5.2 years, which lends support to the idea that CIBWs may have an inter-birth interval that is somewhat longer than other populations of belugas. If this is actually the case, it will have interesting applications to future models of CIBW population status and viability. We are cautious in reporting these values however, because there are many factors that affect our ability to detect, photograph, and identify mothers and calves, and they all may result in biased, overly simplistic estimates of inter-birth interval (Arso Civil et al. 2017). For example, when animals are not seen every year, inter-birth intervals may be overestimated because of missed births (Barlow and Clapham 1997). Multivariate models are needed to quantify the effect of these factors (and their interactions) on estimating inter-birth interval, which in turn will affect the estimates of the reproductive rate for CIBWs derived from them.

Reproductive rate

Photo-id data can be used in two ways to estimate CIBW reproductive rates: from the proportion of groups encountered during photo-id surveys that were calves, and from the number of identified mothers photographed as a percentage of all whales identified (Steiger and Calambokidis 2000). As previously discussed, both of these methods could produce biased estimates because of the many factors affecting photo-id methods. We are beginning collaborations with modelers at Montana State University, NMFS MML, and ADF&G to use both survey data and photo data from the CIBW Photo-ID database to model reproductive rates and examine their implications for CIBW population viability and recovery.

Estimated period of maternal care/association

The period of maternal association between identified calves and their mothers ranged between one and four years with an average of 1.5 years. Only one of these identified calves was of known age, and it was estimated to have associated with its mother until it was 2.5 years of age. The lactation period of different beluga populations is reported to be 18-32 months (multiple sources summarized in NMFS 2016).

Changes in associations over time between a mother-calf pair have been used to quantify the weakening of the mother-calf bond and to help define the period of maternal care. For example, bottlenose dolphin mothers and their calves associated nearly 100% of the time in the first 3 years of life, but associations declined in most cases when the mother became pregnant again (Connor et al. 2000).

In this report, we have quantified mother-calf associations at the level of the photo frame, but in the future, we will also be examining how often an identified mother and identified calf are photographed in the same group even if they are not in close enough physical proximity to be photographed together, and if this varies with the sex of the calf and/or the age of the mother.

CONCLUSIONS

The CIBW Photo-ID Project used non-invasive, observational methods to provide longitudinal data about CIBW population characteristics, habitat preferences, and individual life histories of 376 whales over an 11-year period. The strength of the CIBW Photo-ID Project will continue to grow with the proportion of the CIBW population that is identified and re-sighted. The number of whales in the catalog is always increasing as more years of fieldwork are conducted, but also as more of the archived photos from previous years of fieldwork are cataloged. Filling in the gaps in the catalog will allow us to obtain more information about life histories of individuals, including reproductive females and their calves (e.g., left-side photos from 2012–2014 are being analyzed and cataloged under a separate contract for NMFS, with a final report due at the end of 2017).

The utility of the photo-id catalog greatly increased with the addition of biological information from invasive studies to the photographic records of an individual. Together these data helped form a more comprehensive picture of an identified individual, framing the biological information from tissue samples within the context of historical data gained from photo-id such as movement patterns, reproductive history, relative age, and social associations. To date, biological information obtained from skin samples allowed us to know the sex of some individuals (from genetic samples collected during tagging, strandings, and biopsy). Additional information that can be provided from biological samples and incorporated into the catalog includes age, reproductive status, familial relationships, diet, and contaminant loads.

We obtained estimates of beluga encounter rates, group sizes, relative color and size-class composition from surveys, the number of identified mothers, number of identified calves, inter-birth interval calving rate, and period of maternal care/association. We are cautious in reporting these values because there are many factors that affect our ability to detect, photograph, and identify individuals, particularly mothers and calves, and they all may result in biased estimates. Multivariate models are needed to quantify the effect of these factors (and their interactions) on estimating these population and life-history parameters.

Insights were recently gained into the population decline of the endangered St. Lawrence Estuary belugas by constructing an integrated model from multiple datasets, which revealed patterns and population dynamics that any single dataset alone would not have been able to explain (Mosnier et al. 2015). The continuation of a long-term, Inlet-wide photo-id dataset combined in an integrated model with other datasets (e.g., aerial surveys, acoustic surveys, biopsy sampling, necropsies, photogrammetry studies from aerial drones) and appropriately modeled to account for sampling constraints and biases inherent to each method will help with efforts to understand the continued lack of recovery of the CIBW population.

Recommendations

In order to maximize the utility of the CIBW Photo-ID Project to provide information needed for decision making to recover and conserve the CIBW population, we recommend the following:

- continue photo-id surveys to add to the long-term dataset of a long-lived species,
- fill gaps in the existing catalog,
- incorporate biological information from other studies with information contained in the photo-id catalog,
- team with modelers to maximize the information collected by the CIBW Photo-ID Project
- collaborate with colleagues to integrate multiple datasets into an integrated model
- continue to communicate project results to managers, colleagues, and the public

MANAGEMENT APPLICATIONS/IMPLICATIONS

Results from the CIBW Photo-ID Project can be used to inform management needs for CIBWs, such as the identification of seasonal hot spots and transit corridors. They have also identified areas of special biological significance, such as feeding and calving, within areas already generally designated as critical habitat for CIBWs. We intentionally presented our results according to different months and survey areas so that the patterns of distribution and abundance in the figures, tables, and maps could be accessible in a useful format to managers during their evaluations of possible seasonal and/or area closures or restrictions for mitigation, monitoring, and permitting during consultations about human activities and developments projects that may affect CIBWs.

CIBW groups are not distributed uniformly throughout Cook Inlet; therefore, the distinct areas in which they are found seasonally, and the transit corridors connecting them, warrant concerted management and protection. The sighting histories of individual CIBWs photographed throughout the study area have provided evidence that CIBWs do not display fidelity to any single area of Cook Inlet, but move throughout the Upper Inlet, with possible increased presence in the Middle and Lower Inlet in recent years. Whales traveling among distinct areas of Cook Inlet increase their likelihood of exposure to multiple potential threats that may be localized in particular areas. For example, the same individual whale might be exposed to noise from seismic exploration in the Susitna River Delta, fishing vessels and nets in the Kenai River Delta, vessel traffic in the shipping lanes for the Port of Anchorage, military exercises in Knik Arm's Eagle Bay, and physical habitat alteration and rock-blasting noise from in-water highway expansion activities in Turnagain Arm. Anthropogenic activities with the potential to affect CIBWs should not be considered in isolation, but rather the cumulative effects of all activities in the range of CIBWs and their potential to affect the entire population must be taken into account when making management decisions.

CIBWs also face natural threats such as mass strandings and predation events. These stranding events have been reported to occur more often in Turnagain Arm and Knik Arm than elsewhere in Cook Inlet (NMFS 2008b). If a mass-stranding event were to occur at the Susitna Delta in July, this could have catastrophic consequences because the entire population, including calving females, appears to congregate here during this time to feed. Photo-id has provided evidence that most or all of the individuals in the CIBW population use these areas at some time during the year, which underscores the threat that such events pose to the entire population, and should prompt managers to have site-specific stranding response plans ready to activate should such events occur.

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TABLES

Table 1. Number of photo-id surveys conducted in Cook Inlet, Alaska between 2005 and 2015 according to survey area and year.

		Year											***Total Number of Surveys***
Survey Area		**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	
Susitna River Delta		16	17	5	8	13	14	11	13	8	9	10	***124***
Knik Arm		32	13	5	9	10	9	16	12	3	7	4	***120***
Turnagain Arm		0	4	5	12	12	15	16	15	12	8	8	***107***
Chickaloon Bay/Fire Island		4	1	1	2	1	0	2	5	2	2	1	***21***
Kenai River Delta		0	0	0	0	0	0	4	14	6	0	0	***24***
	Annual Number of Surveys	52	35	16	31	36	38	49	59	31	26	23	***396***
	Annual Number of Survey Days*	47	33	14	29	32	35	48	55	29	23	22	***367***

*because multiple areas were surveyed on the same day for 24 of the survey days, annual number of surveys is greater than the annual number of survey days

Table 2. Number of CIBW photo-id surveys conducted in Cook Inlet, Alaska between 2005 and 2015 according to month and survey area.

		Month							***Total Number of Surveys***
Survey Area		**April**	**May**	**June**	**July**	**August**	**September**	**October**	
Susitna River Delta		0	12	28	50	30	2	2	***124***
Knik Arm		1	1	6	3	49	43	17	***120***
Turnagain Arm		3	3	0	0	28	57	16	***107***
Chickaloon Bay/Fire Island		0	4	5	4	3	5	0	***21***
Kenai River Delta		0	9	0	0	0	5	10	***24***
	Monthly Number of Surveys	4	29	39	57	110	112	45	***396***
	Monthly Number of Survey Days	4	25	30	53	101	110	44	***367***

*because multiple areas were surveyed on the same day for 24 of the survey days, montlhy number of surveys is greater than the monthly number of survey days

Table 3. Survey effort, number of groups and belugas encountered, and mean and maximum group size of groups encountered during photo-id surveys of Cook Inlet, 2005-2015, according to survey year. The annual number of belugas encountered is not meant to be a population estimate, because individuals were resighted multiple times within a year.

	Year											
	2005	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	***Total***
Number of Surveys	52	35	16	31	36	38	49	59	31	26	23	***396***
Number of Groups Encountered	60	62	28	40	39	51	59	62	22	35	38	***496***
Mean Number of Belugas Encountered	2,130	907	402	1,198	1,053	1,427	1,690	1,328	1,452	1,891	2,266	***15,744***
Mean Number of Belugas per Survey	40.96	26.7	25.1	38.6	29.3	37.6	34.5	22.5	46.8	72.7	98.5	***39.8***
Mean Group Size	35.5	14.6	14.4	30.0	27.0	28.0	28.6	21.4	66.0	54.0	59.6	***31.7***
Maximum Group Size	152	61	74	121	152	173	136	200	200	250	313	***313***
Number of Groups per Survey	1.2	1.8	1.8	1.3	1.1	1.3	1.2	1.1	0.7	1.3	1.7	***1.3***

Table 4. Survey effort, number of groups and belugas encountered, and mean and maximum group size of groups encountered during photo-id surveys of Cook Inlet, 2005-2015, according to survey month.

	Month							
	April	**May**	**June**	**July**	**August**	**September**	**October**	***Total***
Number of Surveys	4	29	39	57	110	112	45	***396***
Number of Groups Encountered	2	17	42	84	144	164	43	***496***
Mean Number of Belugas Encountered	32	785	978	4,788	5,093	3,470	598	***15,744***
Mean Number of Belugas per Survey	8.0	27.0	25.1	84.0	46.3	31.0	13.3	***39.8***
Mean Group Size	16.0	46.2	23.3	57.0	35.4	21.2	13.9	***31.7***
Maximum Group Size	19	150	105	313	205	200	50	***313***
Number of Groups per Survey	0.5	0.6	1.1	1.5	1.3	1.5	1.0	***1.3***

Table 5. Survey effort, number of groups and belugas encountered, and mean and maximum group size of groups encountered during photo-id surveys of Cook Inlet, 2005-2015, according to survey location.

	Area Surveyed					
	Susitna River Delta	**Knik Arm**	**Turnagain Arm**	**Chickaloon Bay / Fire Island**	**Kenai River Delta**	***All Areas***
Number of Surveys	124	120	107	21	24	***396***
Number of Groups Encountered	164	146	163	16	7	***496***
Mean Number of Belugas Encountered	8,363	4,535	2,234	562	50	***15,744***
Mean Number of Belugas per Survey	67.4	37.8	20.9	26.8	2.1	***39.8***
Mean Group Size	51.0	31.1	13.7	35.1	7.1	***31.7***
Maximum Group Size	313	129	82	207	10	***313***
Number of Groups per Survey	1.3	1.2	1.5	0.8	0.3	***1.3***

Table 6. Date, survey area, and size of the largest group encountered annually during photo-id surveys of Cook Inlet, 2005-2015.

Date	Survey Area	Maximum Group Size
Jul 23 2005	Susitna River Delta	152
Jul 26 2006	Susitna River Delta	61
Jul 27 2007	Susitna River Delta	74
Jul 29 2008	Susitna River Delta	121
Aug 3 2009	Susitna River Delta	152
Jul 16 2010	Susitna River Delta	173
Jul 27 2011	Susitna River Delta	136
Jul 20 2012	Susitna River Delta	200
Jul 22 2013	Susitna River Delta	200
Jul 31 2013	Susitna River Delta	200
Jul 27 2014	Susitna River Delta	250
Jul 20 2015	Susitna River Delta	313

Table 7. Percent of groups encountered during the 2005-2015 CIBW photo-id surveys that were composed of a single color or age-class.

	Number of Groups	Percent of All Groups Encountered 2005-2015
Total Groups Encountered 2005-2015	496	100%
Groups containing one or more whales of unknown color or age-class	106	21%
Groups containing one or more white belugas	423	85%
Groups containing one or more gray belugas	349	70%
Groups containing one or more calves	291	59%
Groups containing one or more neonates*	101	29%

*out of the 346 groups encountered 2008-2015, when neonates were differentiated from calves

Table 8. Number and descriptions of groups encountered during 2005-2015 CIBW photo-id surveys that were composed of a single color or age-class.

			Survey Area					Survey Month						
Composition (group only consists of this color/age class)	**Group Size**	**Number of Groups 2005-2015 (of 496 groups total)**	**Susitna River Delta**	**Knik Arm**	**Turnagain Arm**	**Chickaloon Bay / Fire Island**	**Kenai River Delta**	**April**	**May**	**June**	**July**	**August**	**septembe**	**October**
white	1	30	yes	yes	yes	yes				yes	yes	yes	yes	yes
white	2	13	yes	yes	yes					yes	yes	yes	yes	yes
white	3	10	yes		yes	yes				yes	yes	yes	yes	yes
white	4 to 10	16			yes								yes	
only gray	1	1	yes							yes				
gray (3) and calf (1)	4	1			yes								yes	
white mom with calf	2	4		yes	yes							yes	yes	yes

Table 9. Percent of belugas encountered during CIBW photo-id surveys that were neonates, according to month, survey area, and year, 2008-2015*.

Month	# Neonates Encountered	# Belugas Encountered	% of Belugas that Were Neonates
April	no surveys	no surveys	no surveys
May	0	624	0.0%
June	0	563	0.0%
July	52	3,049	1.7%
August	93	3,798	2.4%
September	35	1,389	2.5%
October	11	214	5.1%
Survey Area			
Susitna River Delta	117	5,927	2.0%
Knik Arm	47	2,236	2.1%
Turnagain Arm	19	946	2.0%
Kenai River Delta	1	30	3.3%
Chickaloon Bay / Fire Island	7	498	1.4%
Year*			
2008	21	786	2.7%
2009	32	912	3.5%
2010	29	1,239	2.3%
2011	12	1,459	0.8%
2012	12	756	1.6%
2013	7	1,103	0.6%
2014	46	1,698	2.7%
2015	32	1,684	1.9%
Total 2008-2015	**191**	**9,637**	**2.0%**

*neonates were not differentiated from calves during the 2005-2007 surveys

Table 10. Summary of date and location of the first and last neonate sightings of each field season of the CIBW Photo-ID Project during the 2005-2015 study period.

Year	Field Season	First Neonate Sighting	Last Neonate Sighting	# Weeks from First to Last Neonate Sightings of Season	Location of First Neonate Sighting and Largest Group of Year	Date of Largest Group of Year	Date Dead Pregnant Females Necropsied
2005*	Apr 14 – Oct 21	Jul 6	n/a	n/a	Susitna River Delta	Jul 23	
2006*	May 12 – Oct 5	n/a	n/a	n/a	n/a	Jul 26	
2007*	Jun 28 – Oct 27	Jul 27	n/a	n/a	Susitna River Delta	Jul 27	
2008	May 21 – Oct 28	Jul 24	Sep 30	9	Susitna River Delta	Jul 29	
2009	Jun 19 – Oct 24	Aug 1	Oct 15	9	Susitna River Delta	Aug 3	11-Jun; 9-Oct (near-term)
2010	May 9 – Oct 15	Jul 16	Oct 8	12	Susitna River Delta	Jul 16	Jun 26
2011	Apr 16 – Oct 22	Jul 27	Sep 27	9	Susitna River Delta	Jul 27	
2012	May 2 – Oct 21	Jul 20	Oct 4	11	Susitna River Delta	Jul 20	
2013	Apr 20 – Sep 21	Jul 31	Sep 3	5	Susitna River Delta	Jul 22 & Jul 31	
2014	Jul 8 – Oct 3	Jul 21	Oct 3	10.5**	Susitna River Delta	Jul 27	May 14
2015	May 28 – Oct 1	Jul 19	Oct 1	10.5**	Susitna River Delta	Jul 20	
*neonates were not differentiated from calves during the 2005-2007 surveys, but neonates were noted if visible in photos							
**last day of field season							

Table 11. Summary of stranded Cook Inlet beluga whales with useable* photographs provided to or taken by the CIBW Photo-ID Project during the 2005-2015 study period.

Year	Date	Location of Stranded Beluga	Type of Stranding	Necropsy Performed by Alaska Marine Mammal Stranding Network?	Number of Belugas	Age Class	Sex	Comments
2008	Aug 8	Knik Arm (necropsied Fish Creek, Goose Bay)	dead on shore	yes	1	adult	female	
2008	Aug 8	Knik Arm (stranded near Pt MacKenzie, necropsied Port of Anchorage)	dead floating	yes	1	adult	female	
2009	Jun 11	Kincaid Park, Anchorage	dead on shore	yes	1	adult	female	pregnant
2009	Oct 9	Ship Creek, Port of Anchorage, Knik Arm	dead on shore	yes	1	adult	female	pregnant
2012	Oct 5	Tyonek, necropsied at Nikiski	dead floating	yes	1	adult	male	
2013	Sep 4	Taylor Creek, Turnagain Arm	dead on shore	no	1	adult	female	
2013	Oct 7	Hope, Turnagain Arm	dead on shore	yes	1	adult	male	
2014	May 26	Kincaid Park, Anchorage	dead on shore	yes	1	adult	male	
2014	May 26	Kincaid Park, Anchorage	dead on shore	yes	1	adult	female	pregnant
2014	Aug 1	Tyonek	dead on shore	yes	1	adult	male	
2014	Sep 2	Chuitna River mouth	dead on shore	yes	1	adult	female	
2014	Sep 8	Indian, Turnagain Arm	dead on shore	yes	1	adult	male	
2014	Sep 27	Point Possession	dead on shore	no	1	adult	female	
2015	Jun 12	South of Tyonek	dead on shore	yes	1	adult	male	
2015	Aug 27	Turnagain Arm: east of Bird Point, milepost 98.5	live on mudflats	not applicable	1	calf	unknown	with mother
2015	Aug 27	Turnagain Arm: east of Bird Point, milepost 98.5	live on mudflats	not applicable	1	adult	female**	with calf
Total			**14 dead; 2 live**	**12 necropsied**	**16**	**15 adults, 1 calf**	**9 female, 6 male**	**3 pregnant**

*photographs of whales taken at a distance, or without skin, or in advanced states of decomposition, or floating on their backs have not been included

**assumed to be a female because of accompanying calf

Table 12. Summary of 490 incidental sighting reports of Cook Inlet belugas shared with the CIBW Photo-ID Project from 2006-2015. (Incidental reports were not collected in 2005). Shaded cells indicate beluga sightings were reported. Numbers in shaded cells indicate the total number of years belugas were reported in each location in each month across all years. X indicates no sightings reported. See Figure 85 for a map showing locations of places where sightings were reported.

2006-2015	Susitna River Delta (Beluga River to Little Susitna River)	Knik Arm	Turnagain Arm	Chickaloon Bay/Fire Island	Kenai River Delta (Nikiski-Kasilof River)	Port of Anchorage	Chuitna River to Granite Point (including Tyonek Oil and Gas Platform)	Lower Inlet (Kasilof to inside Kachemak Bay)	Other Locations
January	x	x	1	x	1	x	1	x	1 (Big River and Kalgin Island)
February	x	x	x	x	1	1	x	x	x
March	x	x	1	x	3	2	x	1	x
April	4	x	8	1	6	5	3	1	x
May	3	x	6	2	7	1	2	1	x
June	9	x	2	4	1	3	1	x	x
July	6	x	x	1	x	2	1	x	x
August	5	6	10	2	x	7	1	1	x
September	4	2	10	3	5	3	1	x	x
October	1	2	4	2	2	2	x	1	x
November	1	x	x	x	1	3	1	x	1 (mouth of Big River Lake, which is south of West Forelands, north of Redoubt Bay)
December	x	x	1	x	x	x	x	x	x

Table 13. Summary of the number of individual CIBWs and their sighting histories in the 2005-2015 photo-id catalog.

Catalog	Years	Number of Individuals	Number of Days Each Individual Was Photographed	Mean Number of Days Each Individual Was Photographed	Number of Years Each Individual Was Photographed	Mean Number of Years Each Individual Was Photographed	Number of Individuals Photographed in 2005 and 2015	Mean Number of Years Between Resightings of the Same Individual	Maximum Number of Years Between Resightings of the Same Individual
right-side	2005-2015	376	1-39	8.3	1-11	4	68	1.8	7
left-side	2005-2011	301	1-36	6	1-7	3	na	n/a	n/a
dual	2005-2015 (right); 2005-2011 (left)	48	2-55	24	1-11	7.5	26	1.1	5

Table 14. Summary of CIBWs captured and satellite-tagged between 1999 and 2002, and matches to individuals in the 2005-2015 photo-id catalog.

NMFS CIBW ID Tagging Number	Capture Location	Capture Date	Sex	Color (assigned during capture)	Length (cm)	Photo-ID Catalog Number	Dead?
no number (captured, not tagged)	Little Susitna	May 31 1999	F	gray	230	L2191	
CI-9901	Little Susitna	May 31 1999	M	White	370	possible match	
no number (captured, not tagged)	Knik Arm	Sep 08 2002	F	light gray	274	no match (no tagging photos to examine)	
CI-0001	Knik Arm	Sep 13 2000	M	White	413	possible match	
CI-0002	Knik Arm	Sep 13 2000	F	White/gray	272	R111/L2467 Humperdink	
CI-0101	Little Susitna	Aug 10 2001	F	Gray	257	R243/L7861 Scrappy	
CI-0102	Knik Arm	Aug 11 2001	M	White	323	possible match	
CI-0103	Knik Arm	Aug 12 2001	F	White	312	possible match	
CI-0104	Knik Arm	Aug 13 2001	F	White	340	no match (no tagging photos to examine)	may have died in 2001 post-tagging
CI-0105	Knik Arm	Aug 13 2001	F	White	357	possible match	
CI-0106	Knik Arm	Aug 15 2001	F	White	401	R103/L 493 Strapped	
CI-0107	Knik Arm	Aug 20 2001	M	White	442	no matches (blurry tagging photos)	
CI-0201	Little Susitna	Jul 29 2002	M	White	412	possible match	
CI-0202	Little Susitna	Jul 30 2002	F	White/gray	340	possible match	may have did in 2002 post-tagging
CI-0203	Knik Arm	Jul 31 2002	F	White	366	possible match	
CI-0204	Little Susitna	Aug 01 2002	F	White	379	no post 2002 photos	confirmed dead post-tagging Aug 9 2002
CI-0205	Knik Arm	Aug 02 2002	M	White/gray	386	L2303/R17366 Sash	confirmed dead June 12 2015
CI-0206	Knik Arm	Aug 03 2002	M	White/gray	353	L2204/R17367 Jabbathehut	lack of photo-id resightings since 2007 suggests this whale may have died
CI-0207	Knik Arm	Aug 03 2002	F	White	374	possible match	may have died in 2002 post-tagging
CI-0208	Knik Arm	Aug 04 2002	M	White/gray	376	L2579/R115 Sashtoo	confirmed dead May 26 2014

Table 15. Summary of stranded CIBWs that were identified as individuals in the 2005-2015 photo-id catalog.

Year	Date	Location of Stranded Beluga	Type of Stranding	Necropsy Performed by Alaska Marine Mammal Stranding Network?	# Belugas	Age Class	Sex	Comments	Photo-ID Catalog Number	Photographed with a Calf 2005-2015?	Sighting History and Photos (rename with figure numbers)
2008	Aug 8	Knik Arm	dead on shore	yes	1	adult	female		R16	no	Figure 16
2008	Aug 8	Knik Arm	dead floating	yes	1	adult	female		R197	no	Figure R197
2009	Oct 9	Knik Arm	dead on shore	yes	1	adult	female	pregnant	R157 / L7416	yes	Figure R157 / L7416
2012	Oct 5	Tyonek	dead floating	yes	1	adult	male		R7244 /L8898	no	Figure R7244 /L8898
2013	Sep 4	Turnagain Arm	dead on shore	no	1	adult	female		L2634	yes	Figure L2634
2013	Oct 7	Turnagain Arm	dead on shore	yes	1	adult	male	photographed 1994 NMFS	R106/L2278	no	Figure R106/L2278
2014	May 26	Kincaid Park, Anchorage	dead on shore	yes	1	adult	male	satellite tag scars	R115/L2579	no	Figure R115/L2579
2014	Aug 1	Tyonek	dead on shore	yes	1	adult	male		L2294	no	Figure L2294
2014	Sep 2	Chuitna River mouth	dead on shore	yes	1	adult	female		L1849	yes	Figure L1849
2014	Sep 8	Turnagain Arm	dead on shore	yes	1	adult	male		L496	no	Figure 496
2014	Sep 27	Point Possession	dead on shore	no	1	adult	female		L265	no	Figure L265
2015	Jun 12	south of Tyonek	dead on shore	yes	1	adult	male	satellite tag scars	R 17366/L2303	no	Figure R 17366/L2303
2015	Aug 27	Turnagain Arm	live on mudflats	not applicable	1	adult	female*	stranded with live calf	R1032	yes	Figure R1032
Total				**10 necropsied**	**13**	**13 adults**	**7 female (6 confirmed, 1 presumed), 6 male**	**1 pregnant; 2 satellite-tagged**			

*presumed to be female because of accompanying calf

Table 16. Summary of photo-id matches made to the six individuals biopsied during the 2016 CIBW Biopsy Feasibility Study.

Biopsy Date	General Location	Biopsy ID	Matched to Photo-ID Catalog*?	Side Targeted for Biopsy	Linked Right and Left Side Photos?	Left-side Photo-ID	Right-side Photo-ID	Year First Identified	Genetic Sex**
Aug 13	Little Susitna River	DL-CIB16-31	no	right	no	no photos	R18703	2016	female
Aug 15	Little Susitna River	DL-CIB16-32	yes	right	yes	L18813	R16873	2014	male
Aug 16	Little Susitna River	DL-CIB16-33	yes	left	no	L18698	no photos	2011	female
Aug 19	Eagle River	DL-CIB16-34	yes	left	yes	L18700	R16854	2014	female
Aug 19	Eagle River	DL-CIB16-35	yes	left	yes	L286	R154	2005	female
Aug 20	Eagle River	DL-CIB16-36	yes	left	yes	L2140	R220	2005	female

*right-side photo-id catalog complete 2005-2015; left-side photo-id catalog complete 2005-2011

**genetic sex from biopsy samples determined by Nick Kellar, NMFS Southwest Fisheries Science Center

Table 17. Summary of 2005-2015 photo-id sighting histories of 22 individual CIBWs of known sex.

Known Sex	Source of Sex Information	Photo-ID Catalog Number	Number of Sighting Days 2005-2015	Number of Years Photographed 2005-2015
male	tagging	R17367/L2204	10	3
male	dead	R106/L2278	31	9
male	tagging and dead	R17366/L2303	27	10
male	tagging and dead	R115/L2579	47	9
male	dead	R7244/L8898	7	5
male	dead	L496	6	3
male	dead	L2294	7	5
male	2016 biopsy (DL-CIB16-32)	R16873/L18813	1	1
8 males		**mean (male)**	**17.0**	**5.6**
		range (males)	**1-47**	**1-10**
female	tagged	R111/L2467	37	9
female	tagged	R103/L493	49	11
female	dead	R157/L7416	15	5
female	tagged	R243/L7861	21	10
female	dead	R16	10	4
female	captured for tagging (not tagged)	L2191	1	1
female	dead	L1849	3	3
female	dead	L2634	4	3
female	dead	L265	15	8
female	dead	R197	4	3
female	2016 biopsy (DL-CIB16-33)	L18698 V	1	1
female	2016 biopsy (DL-CIB16-34)	R16854/L18700	3	2
female	2016 biopsy (DL-CIB16-35)	R154/L286	38	10
female	2016 biopsy (DL-CIB16-36)	R220/L2140	21	9
14 females		**mean (females)**	**15.9**	**5.6**
		range (females)	**1-49**	**1-11**

Table 18. Summary of photo-id reproductive histories of 18 presumed mothers in the 2005-2015 photo-id right-side catalog who have been seen with calves in four or more years. (P=individual photographed; X=individual not photographed; C1=individual photographed with a calf; number indicates which calf sequentially in sighting history; C#=individual photographed with a calf, but relative calf size could not be determined; C*=calf is a neonate; c?=individual may have a calf alongside but visibility poor).

Photo-ID Catalog Number	# Years Seen with Calves	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	# of Different Calves per Individual	Maximum Span of Years Photographed with Same Calf	# of Years Between First Sightings of Different Calves	Minimum # Years between Last Sighting of One Calf, and First Sighting of Next Calf	# of Years between Neonates
R34	5	C1	P	P	C2	C2	x	P	x	x	C3	C4*	4	2	3,6,1	1	x
R68	5	C1	x	x	C2	C2	P	P	x	P	C3*	C3	3	2	3,6	3	x
R90	5	P	C#	x	C1	C1	x	P	C2	P	P	C2	2	4	4	3	x
R206	4	P	C1	P	P	C2	C2	P	c?	P	C3	P	3	2	3,5	3	x
R1086	4	x	P	x	C1	C1	x	C2	x	x	C3	x	3	2	3,3	2	x
R1416	4	x	P	C1	x	P	x	c?	C2	x	P	C3	3	1	5,3	5	x
R165	4	P	P	P	C1*	P	P	C2*	C2	x	C3	P	3	2	3,3	3	3
R18	4	P	x	x	x	C1	C1	C2	x	x	C3	P	3	2	2,3	1	x
R2995	4	x	P	x	x	P	x	C1*	C1	x	C2	C2	2	2	3	2	x
R3121	4	x	x	x	P	C1	x	P	C2	x	C#	C3	3	1	3,3	3	x
R3215	4	x	x	x	x	C1	x	C1	C1	x	x	C2	2	4	6	3	x
R521	4	x	P	x	P	C1	C1	C2	x	x	P	C3	3	2	2,4	1	x
R530	4	x	C1	C#	P	C2	x	x	C3	x	x	x	3	1	3,3	3	x
R540	4	x	C1	x	P	P	x	C2	x	x	C3*	C3	3	2	5,3	3	x
R545	4	x	C1	x	P	x	C2*	C2	x	P	x	C3	3	2	4,5	4	x
R67	4	C1	x	P	C2	x	x	C3	x	x	C4	x	4	1	3,3,3	3	x
R8	4	C1	P	x	x	x	P	P	x	C#	C2	C2	2	2	8	8	x
R84	4	x	P	x	C1	P	x	C1	C1	x	C2	P	2	5	6	2	x
											mean (±sd)		**2.8 (±0.6)**	**2.2 (±1.1)**	**3.7 (±1.5)**	**2.9 (±1.6)**	**x**
												range	**2-4**	**1-5**	**1-8**	**1-8**	**3**

Table 19. Summary of photo-id reproductive histories of 27 presumed mothers in the 2005-2015 photo-id dual catalog who have been seen with calves. (P=individual photographed; X=individual not photographed; C1=individual photographed with a calf; number indicates which calf sequentially in sighting history; C#=individual photographed with a calf, but relative calf size could not be determined; C*=calf is a neonate; c?=individual may have a calf alongside but visibility poor).

Photo-ID Right-Side Catalog Number	Photo-ID Left-Side Catalog Number	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	# Years Seen with Calves	# of Different Calves per Individual	Maximum Span of Years Photographed with Same Calf	# of Years Between First Sightings of Different Calves	Minimum # of Years between Last Sighting of One Calf, and First Sighting of Next Calf	# of Years between Neonates	Comments
R100	L3441	C1	c?	C2*	C2	c?	c?	P	P	x	x	x	3	2	2	2	2	x	
R102	L2737	C1	P	P	P	C2	x	C#	P	P	C3	C3	5	3	2	4,5	4	x	
R103	L493	P	P	c?	C1	P	C2	C2	c?	P	c?	c?	3	2	2	2	2	x	
R104	L2296	P	x	P	P	P	c?	P	P	C1	x	P	1	1	1	x	x	x	
R109	L1513	C1	P	P	C#	c?	P	c?	P	x	C2	c?	3	2	1	x	x	x	also photographed in 1994 by NMFS
R111	L2467	P	x	P	c?	C1	P	P	P	x	C2	C3*	3	3	1	5,1	1	x	
R112	L2034	C1	C1	P	C2	C1 &C2	C1 &C2	c?	P	x	P	c?	5	2	6	3	x	x	
R1220	L3648	C1	P	x	C2	C2	P	C3*	C3	x	P	P	5	3	2	3,3	2	x	
R1238	L2398	x	P	x	C1	C1	C2*	P	C2	C2	C3*	C3	7	3	4	2,4	1	4	
R128	L247	P	c?	x	C1	x	C1 & C2	P	P	x	C3	C3	4	3	2	2,4	0	x	
R154	L286	P	C1	C1	P	P	C2	P	C#	C3	C3	x	6	3	2	4,3	3	x	
R157	L7416	c?	P	P	C1	c?, then died (pregnant near term)	x	x	x	x	x	x	1	1	1	x	x	x	
R166	L401	P	c?	c?	C1	C1	C1	C#	P	C2	C3*	x	6	3	3	5,1	1	x	
R195	L7432	P	x	x	C1	C1	C2*	C2	P	P	C3	C3	6	3	2	2,4	1	x	2014 calf is a possible neonate, but too far away to confirm. If so, would give 4 year interbirth interval
R200	L305	P	x	x	C1*	C1	C1	P	x	x	C2	C2	5	2	3	6	4	x	
R220	L18701	P	x	C1	C1	P	C2	P	C3	x	C4	C4	6	4	2	3,2,2	2	x	
R224	L283	C1	C#	P	P	C2	C2	P	P	x	C3	C#	6	3	2	4,5	3	x	
R3293	L3024	x	x	x	x	P	C1	x	x	x	x	P	1	1	1	x	x	x	
R49	L480	P	c?	x	C1	x	P	C2	P	x	c?	P	2	2	1	3	3	x	
R50	L386	C1	P	P	C1& C2	x	P	C2	C3	x	C4	C4	6	4	4	3,4,2	0	x	
R529	L403	P	C1	x	P	P	P	P	x	x	x	P	1	1	1	x	x	x	
R5319	L7709	x	x	P	x	P	C1	C2	P	P	C3	p	3	3	1	1,3	1	x	
R549	L1936	P	C1	x	x	C2	x	C2	x	x	C3	P	4	3	3	3,5	3	x	
R60	L492	P	P	C1	C1	P	P	C2	x	x	P	P	3	2	2	4	3	x	
R75	L2021	P	C1	P	P	C2	c?	C3	x	P	P	P	3	3	1	3,2	2	x	
R9	L450	P	P	c?	P	C1	c?	C2	P	C2	C#	C#	5	2	3	2	2	x	can't see enough of 2014 and 2015 calves to tell if new (C3), or large C2
R987	L2229	x	x	P	P	P	P	P	x	P	C1	x	1	1	1	1	x	x	
											mean (±sd)			**2.4 (±0.8)**	**2.1 (±1.2)**	**3.1 (±1.3)**	**2.0 (±1.2)**	**4.0**	
												range		**1-4**	**1-6**	**1-6**	**1-4**	**4**	

Table 20. Summary of photo-id reproductive histories of 14 known-sex females in the 2005-2015 photo-id catalog. (P=individual photographed; X=individual not photographed; C1=individual photographed with a calf; number indicates which calf sequentially in sighting history; C#=individual photographed with a calf, but relative calf size could not be determined; C*=calf is a neonate; c?=individual may have a calf alongside but visibility poor).

Known Sex	Source of Sex Information	Photo-ID Catalog Number	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	# of Different Calves per Individual	Maximum Span of Years Photographed with Same Calf	# of Years Between First Sightings of Different Calves	Minimum # Years between Last Sighting of One Calf and First Sighting of Next Calf	# of Years between Neonates
female	tagging	R111/L2467	P	x	P	c?	C1	P	P	P	x	C2	C3*	3	1	5,1	1	x
female	tagging	R103/L493	P	P	c?	C1	P	C2	C2	c?	P	c?	c?	2	2	2	2	x
female	dead	R157/L7416	c?	P	P	C1	**died**	x	x	x	x	x	x	1	1	x	x	x
female	dead	L1849	x	C1	x	x	x	x	P	x	x	**died**	x	1	1	x	x	x
female	dead	L2634	x	x	x	C1	x	P	x	x	**died**	x	x	1	1	x	x	x
female	2016 biopsy (DL-CIB16-35)	R154/L286	P	C1	C1	P	P	C2	P	C#	C3	C3	X	3	2	4,3	3	x
female	2016 biopsy (DL-CIB16-36)	R220/L2140	P	X	C1	C1	P	C2	P	C3	X	C4	C4	4	2	3,2,2	2	x
												mean (±sd)		2.1 (±1.2)	1.4 (±0.5)	2.7 (±1.3)	2 (±0.8)	x
													range	1-4	1-2	1-5	1-3	x
female	tagging	R243/L7861	P	x	P	P	P	P	P	P	P	P	P	0	x	x	x	x
female	dead	R16	c?	P	P	**died**	x	x	x	x	x	x	x	0	x	x	x	x
female	tagged)	L2191	x	x	P	x	x	x	x	x	x	x	x	0	x	x	x	x
female	dead	L265	P	P	P	P	P	c?	c?	P	x	**died**	x	0	x	x	x	x
female	dead	R197	P	P	x	**died**	x	x	x	x	x	x	x	0	x	x	x	x
female	2016 biopsy (DL-CIB16-33)	L18698 V**	x	x	x	x	x	x	P	x	x	x	x	0	x	x	x	x
female	2016 biopsy (DL-CIB16-34)	R16854/L18700	x	x	x	x	x	x	P	x	x	P	P	0	x	x	x	x

**not photographed 2005-2015; biopsied and photographed in 2016

Table 21. Summary of sighting histories of 21 identified CIBW calves and mothers in the 2005-2015 right-side, 2005-2011 left-side, and dual catalogs. None of the calves were photographed with their own calf. (P=photographed; x=not photographed, M=photographed with mother, M?=photographed with beluga that may have been the mother, na=not applicable; C1= individual photographed with a calf; number indicates which calf sequentially in sighting history; C#= individual photographed with a calf, but relative calf size could not be determined; C*=calf is a neonate; c?=individual may have a calf alongside but visibility poor).

Photo-ID Catalog Number of Calf	Catalog Side	Is Calf of	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Estimated Size of Calf when First Photographed*	# of Years Calf Photographed	Span of Years Calf Photogapched with Mother	Minimum # of Years between when Calf First Photographed (with Identified Mother) and Calf Identified from its Own Marks
L10627	Left	L7432	x	x	x	x	x	x	M	n/a	n/a	n/a	n/a	large	1	1	1
L7432	Dual		P	x	x	C1	C1	C2*	C2	P	P	C3	C3				
L10799	Left	L2171	x	x	x	x	x	x	M	n/a	n/a	n/a	n/a	large	1	1	1
L2171	Left		x	x	P	P	x	C1	C1	n/a	n/a	n/a	n/a				
L10813	Left	L2339	x	x	x	x	x	M	M	n/a	n/a	n/a	n/a	large	2	2	-1
L2339	Left		x	x	c?	P	x	P	C1	n/a	n/a	n/a	n/a				(calf identified from its own marks a year before it was matched to an identified mother)
L8025	Left	L355	x	x	x	x	x	M	x	n/a	n/a	n/a	n/a	large	1	1	0
L355	Left		x	x	P	C1	x	C2	P	n/a	n/a	n/a	n/a				
L10367	Left	L1647	x	x	x	x	x	x	M	n/a	n/a	n/a	n/a	large	1	1	1
L1647	Left		P	P	P	x	x	C1	C2	n/a	n/a	n/a	n/a				
L10994	Left	L2254	x	x	x	x	x	x	M	n/a	n/a	n/a	n/a	medium	1	1	1
L2254	Left		x	x	C1	P	P	C2	C2	n/a	n/a	n/a	n/a				
L2379	Left	L417	M	x	x	M	x	M?	M?	n/a	n/a	n/a	n/a	medium	4	4	0
L417	Left		C1	c?	x	x	x	x	x	n/a	n/a	n/a	n/a				
R16613	Right	R3813	x	x	x	x	x	x	x	x	x	M	x	medium	1	1	0
R3813	Right		x	x	x	x	x	P	P	P	x	C	P				
R1081	Right	R109	x	x	x	M	P	P	x	x	x	x	P	large	4	1	0
R109	Dual		C1	P	P	C#	c?	P	c?	P	x	C2	c?				
R17096	Right	R154	x	x	x	x	x	x	x	x	x	M	x	large	1	1	4
R154	Dual		P	C1	c?	P	P	C2	P	C2	x	C2	x				
R6381	Right	R6386	x	x	x	x	x	x	M	x	x	x	x	large	1	1	0
R6386	Right		x	x	x	x	x	x	C1	P	x	x	x				
R16505	Right	R16548	x	x	x	x	x	x	x	x	x	M	x	medium	1	1	0
R16548	Right		x	x	x	x	x	x	x	x	x	C1	c?				
R17757	Right	R220	x	x	x	x	x	x	x	x	x	x	M	medium	1	1	1
R220	Dual		P	x	C1	C1	P	x	P	C2	x	C3	C3				
R1228	Right	R67	x	x	x	M	M	x	x	x	x	x	x	small	2	2	0
R67	Right		C1	x	P	C2	x	x	C3	x	x	C4	x				
R7199	Right	R3215	x	x	x	x	M	x	M	M	x	P	x	small	4	4	0
R3215	Right		x	x	x	x	C1	x	C1	C1	x	x	C2				
R3294	Right	R1220	x	x	x	M	M	x	x	x	x	x	x	small	2	2	0
R1220	Dual		C1	P	x	C2	C2	P	C3*	C3	x	P	P				
L259	Left	unidentified	M	P	x	x	x	x	x	n/a	n/a	n/a	n/a	large	2	1	n/a
L2299	Left	unidentified	x	x	M	x	x	x	x	n/a	n/a	n/a	n/a	large	1	1	n/a
L8120	Left	unidentified	x	x	x	x	x	M	x	n/a	n/a	n/a	n/a	large	1	1	n/a
R1293	Right	unidentified	x	x	P	M	x	M	P	P	x	P	P	large	7	3	n/a
R6436	Right	unidentified	x	x	x	x	x	x	M	x	x	P	x	medium	2	1	n/a
*large calf (2/3 length associated adult); medium calf (1/2-1/3 length associated adult); small calf (<1/3 length of adult)														**mean (±sd)**	**2 (±1.6)**	**1.5 (±0.9)**	**0.5 (±1.1)**

Table 22. Summary of number of calves, number of years with the same calf, and calving intervals of identified individuals in the CIBW photo-id catalog.

			mean (±sd); range			
		A	B	C	D	E
Catalog Subset	**Sample Size**	**# of Different Calves per Individual 2005-2011**	**Maximum Span of Years Photographed with Same Calf**	**Minimum # Years between Last Sighting of One Calf, and First Sighting of Next Calf**	**# Years between First Sightings of Different Calves**	**# of Years between Neonates of Same Mother**
Right-side whales seen with calves four or more years (2005-2015)	18	2.8 (±0.6); (2-4)	2.2 (±1.1); (1-5)	2.9 (±1.6); (1-8)	3.7 (±1.5); (1-8)	3
Dual (2005-2015 rights sides linked to 2005-2011 left sides)	27	2.4 (±0.8); (1-4)	2.1 (±1.2); (1-6)	2.0 (±1.2); (1-4)	3.1 (±1.3); (1-6)	4
Known-sex females (with calves)	7	2.1 (±1.2); 1-4	1.4 (±0.5); (1-2)	2.0 (±0.8); (1-3)	2.7 (±1.3); (1-5)	x
Values shown are mean (±sd)						

FIGURES

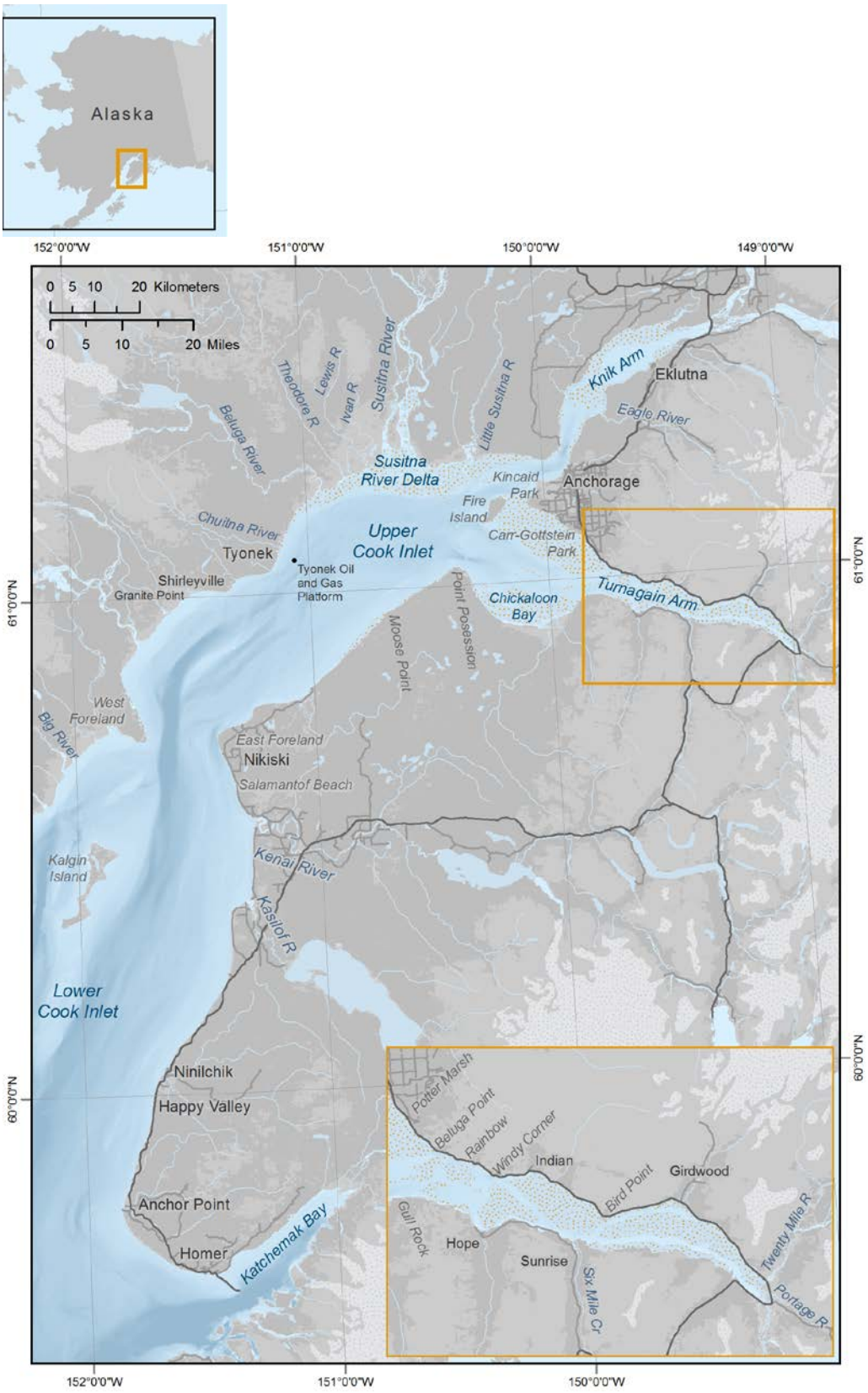


Figure 1. Map of Cook Inlet, Alaska, showing major features discussed in text.

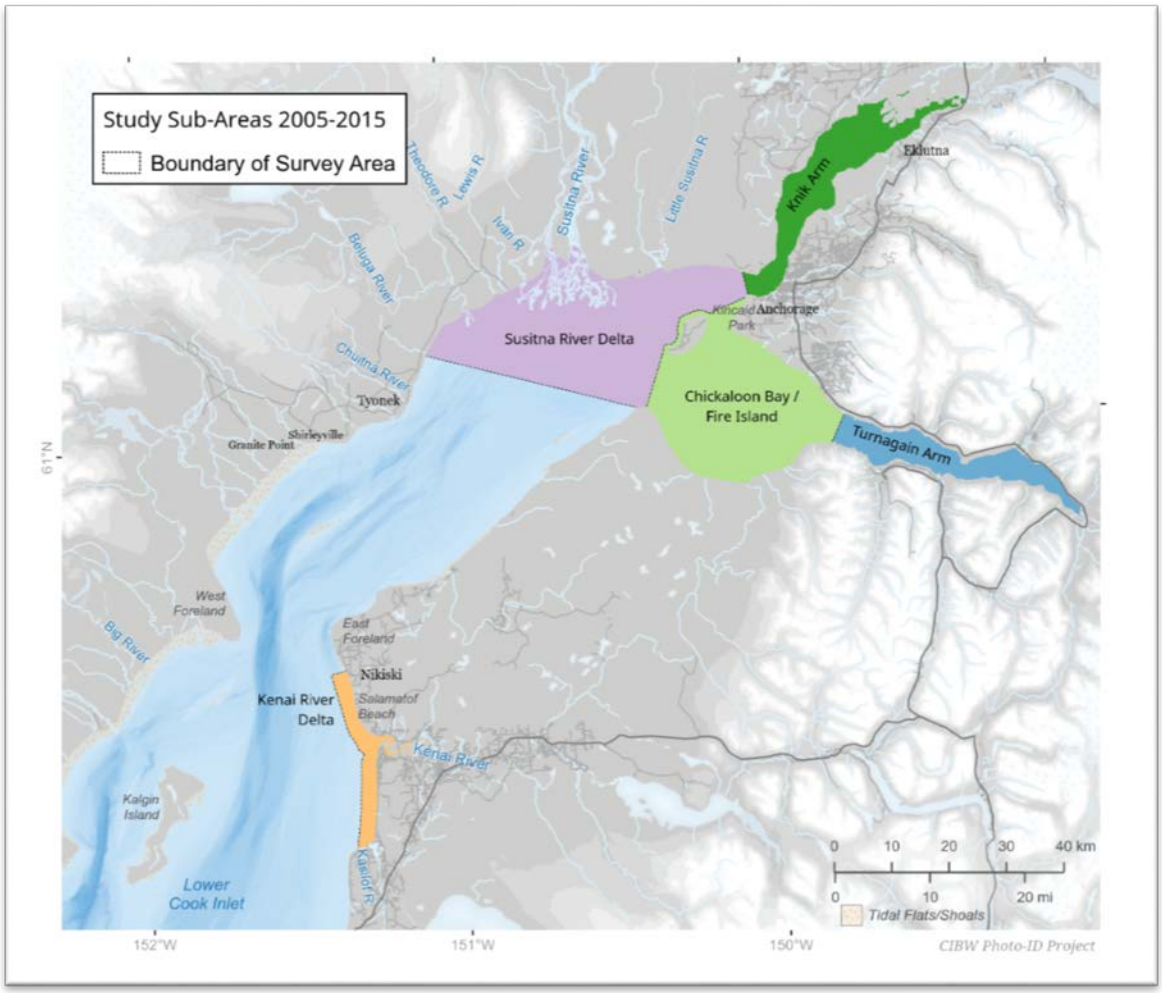


Figure 2. Map of Middle and Upper Cook Inlet, Alaska, showing boundaries of five survey areas within the study area and the general routes used 2005-2015. The Kenai River Delta study area was surveyed 2011-2013.

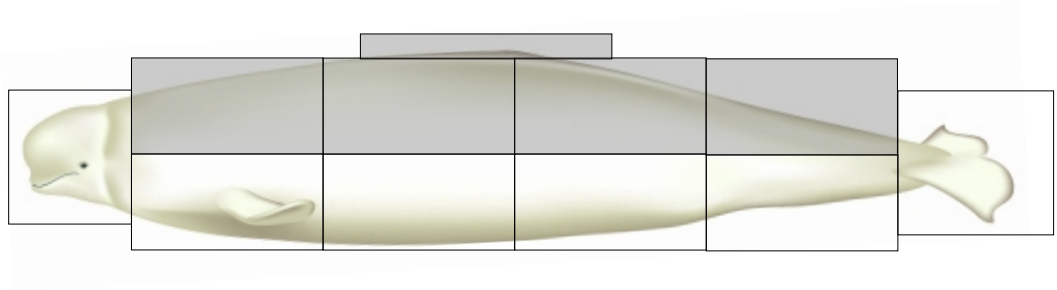


Figure 3. Body segments used when cataloging photographs of belugas for photo-id. The five shaded areas were the critical sections used in matching marks. Beluga illustration courtesy of Uko Gorter.

Figure 4. Example of a calf maturing. The top photo shows a presumed mother with a calf in 2009. The bottom photo shows the same presumed mother one year later, in 2010. The calf in 2010 is larger and lighter in color and is presumed to be the same calf maturing. These images show the right sides of the whales.

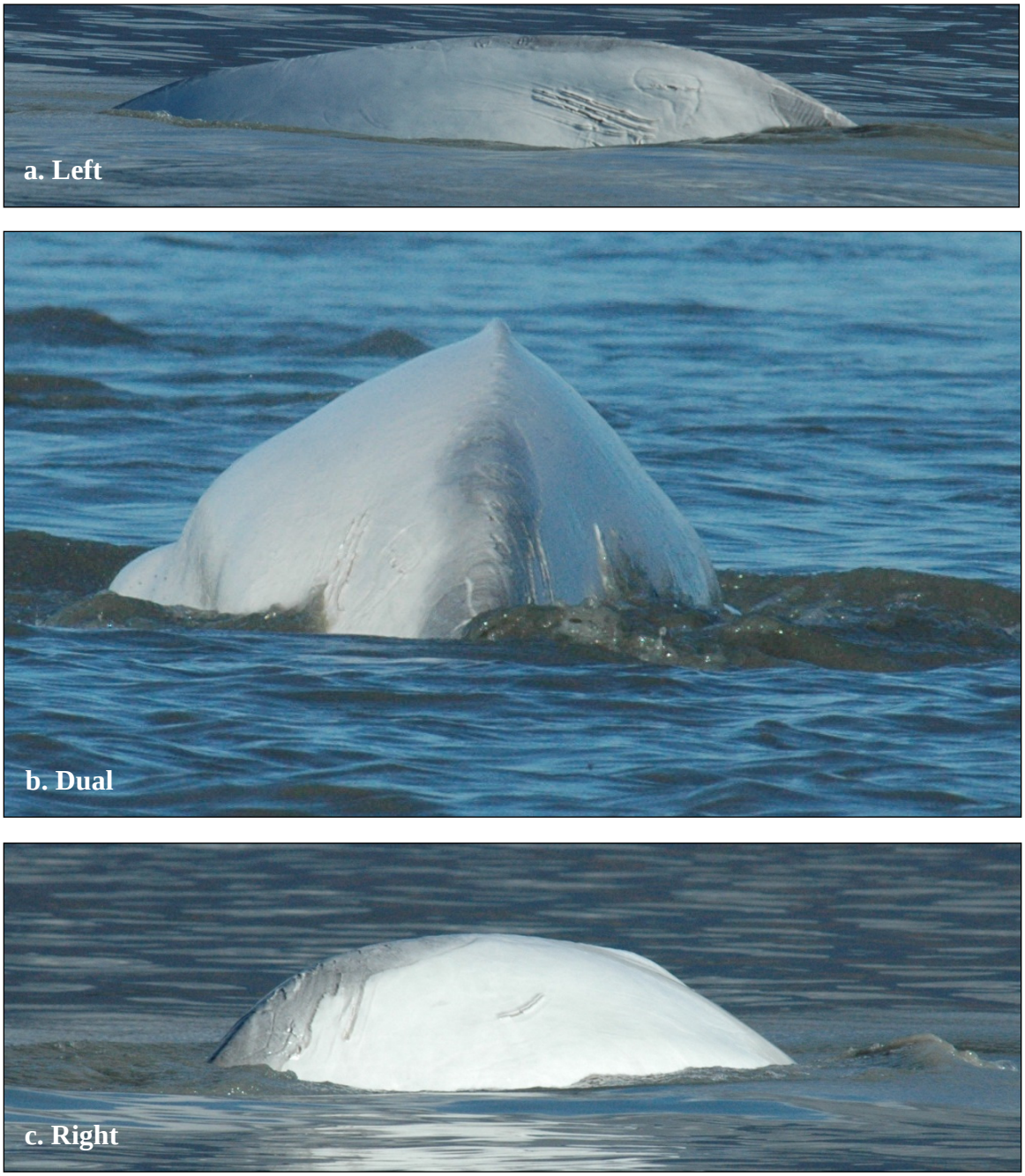


Figure 5. Photographs of an identified "dual" beluga, showing the left side (a), right side (c), and "dual" side (b) images that were used to link images and sighting records from the left and right sides of this whale. The "dual" image (b) is of the whale facing away from the photographer.

Figure 6. Example of scars resulting from satellite tags attached to CIBWs by NMFS during the 1999-2002 tagging study. This image is of the right side of the whale.

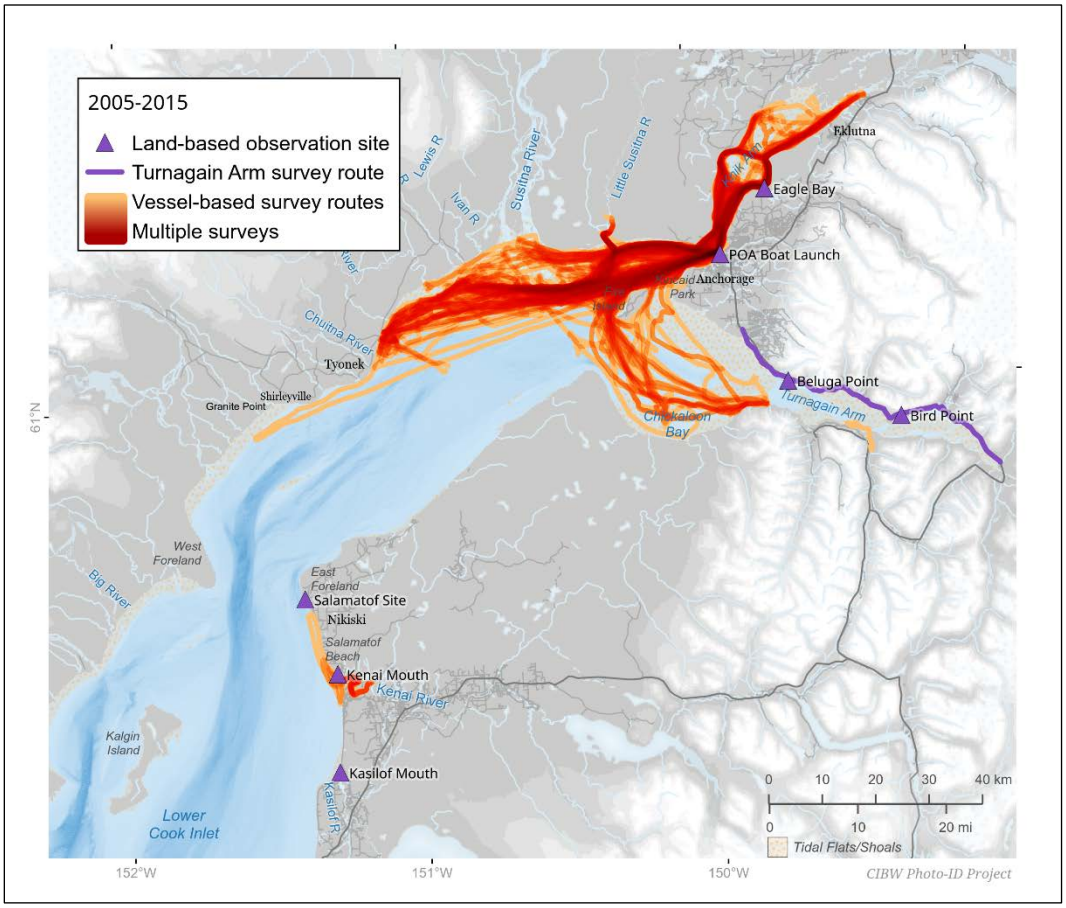


Figure 7. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

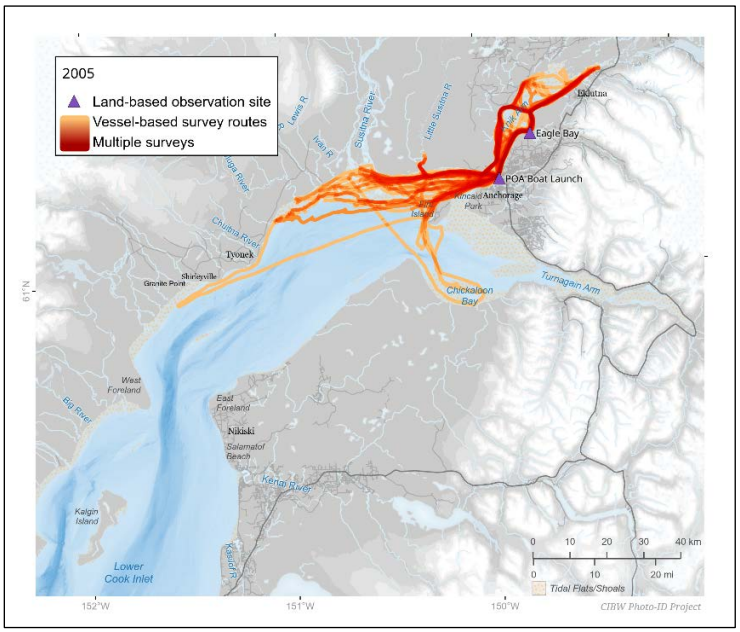


Figure 8. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2005. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

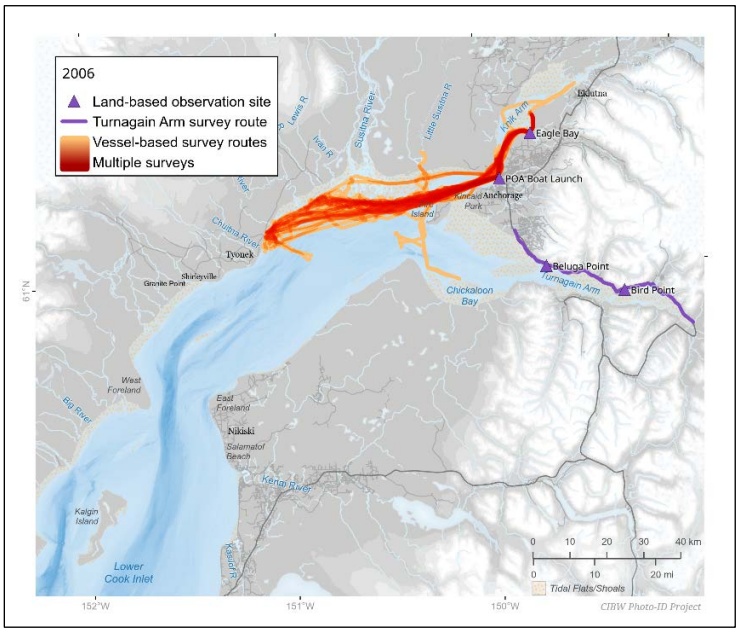


Figure 9. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2006. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

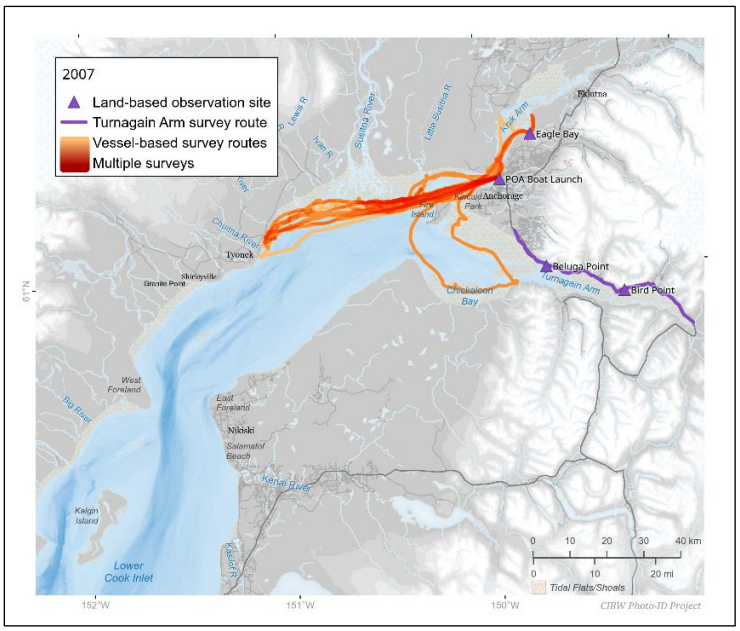


Figure 10. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2007. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

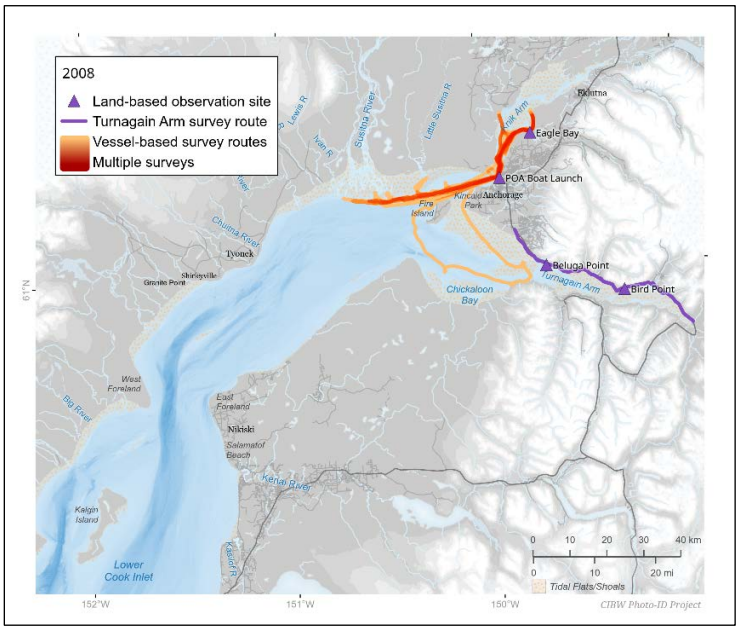


Figure 11. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2008. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

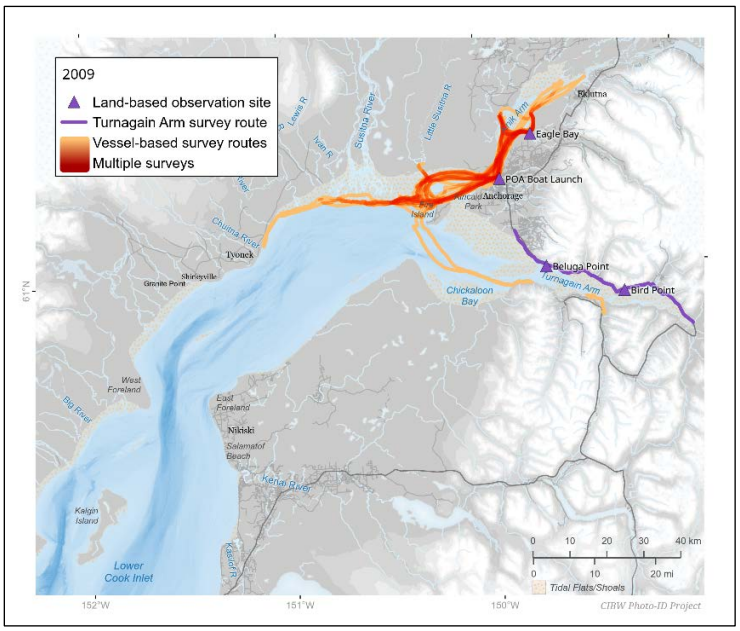


Figure 12. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2009. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

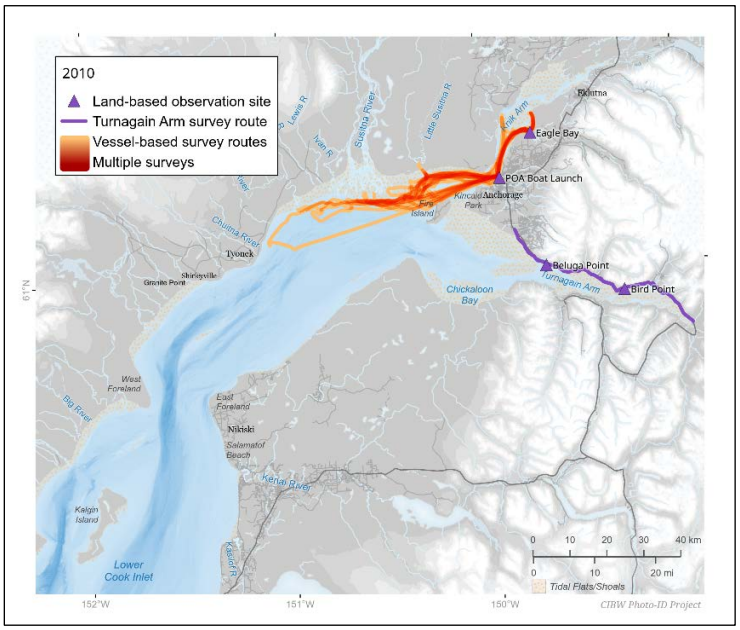


Figure 13. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2010. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

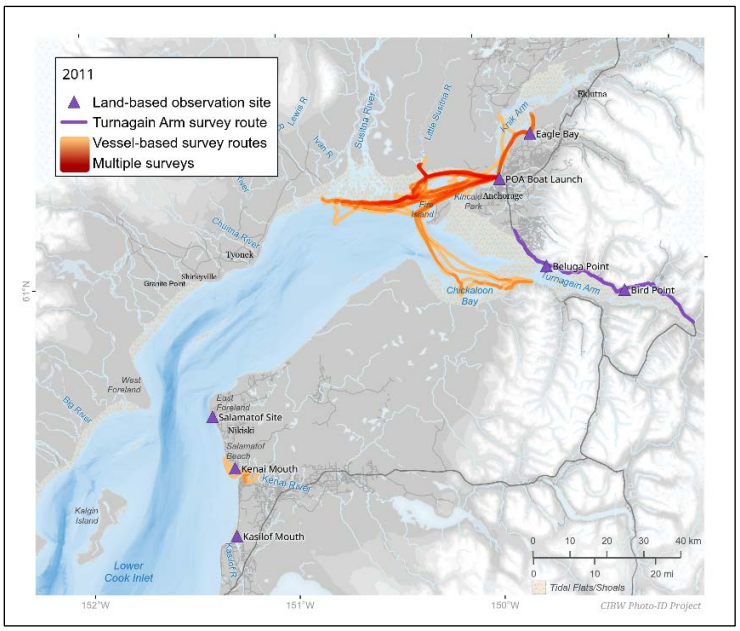


Figure 14. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2011. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. The Kenai River Delta was surveyed this year. POA=Port of Anchorage.

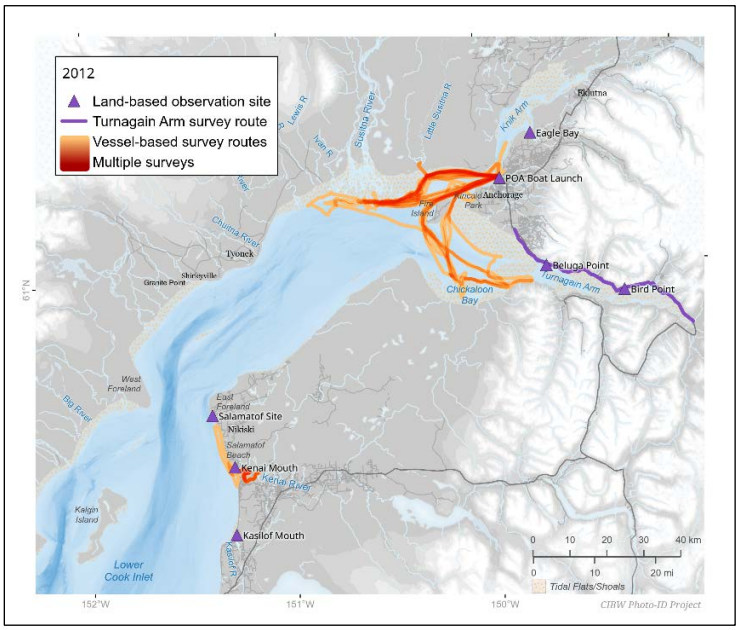


Figure 15. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2012. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. The Kenai River Delta was surveyed this year. POA=Port of Anchorage.

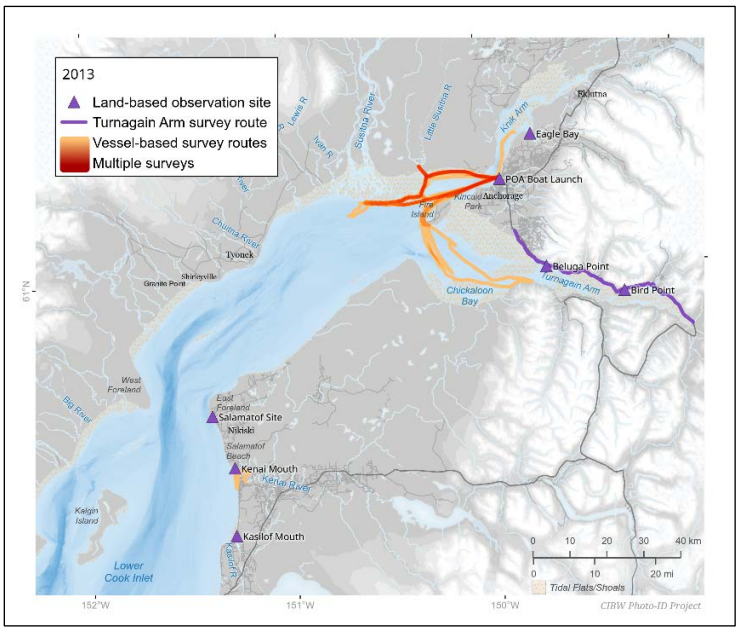


Figure 16. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2013. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. The Kenai River Delta was surveyed this year. POA=Port of Anchorage.

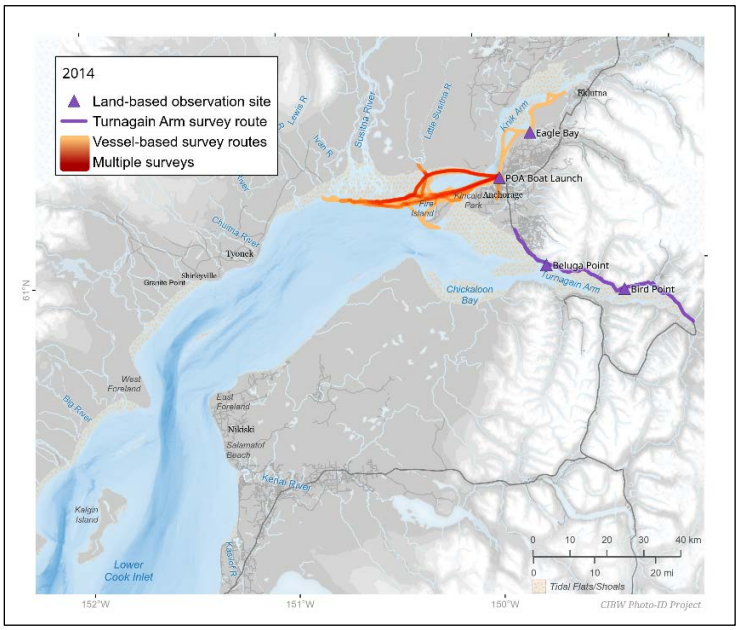


Figure 17. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2014. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

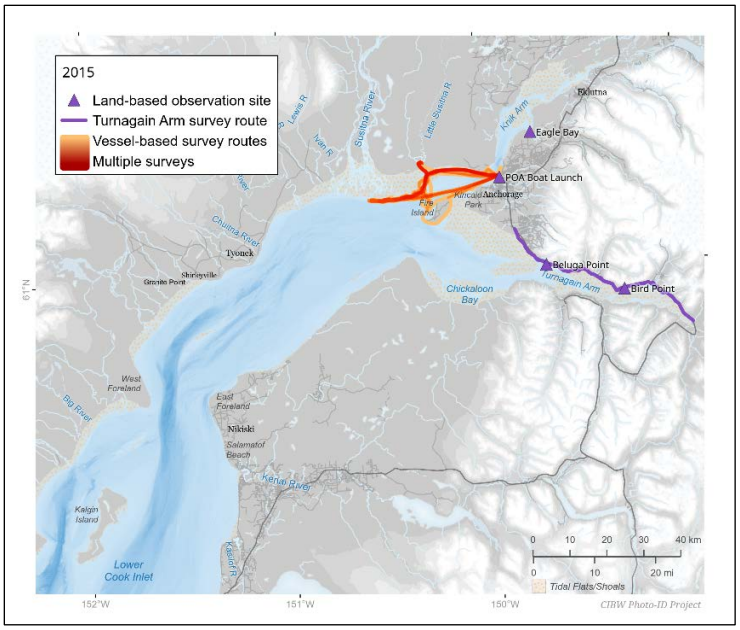


Figure 18. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for all photo-id surveys conducted in 2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 1 for exact number of surveys. POA=Port of Anchorage.

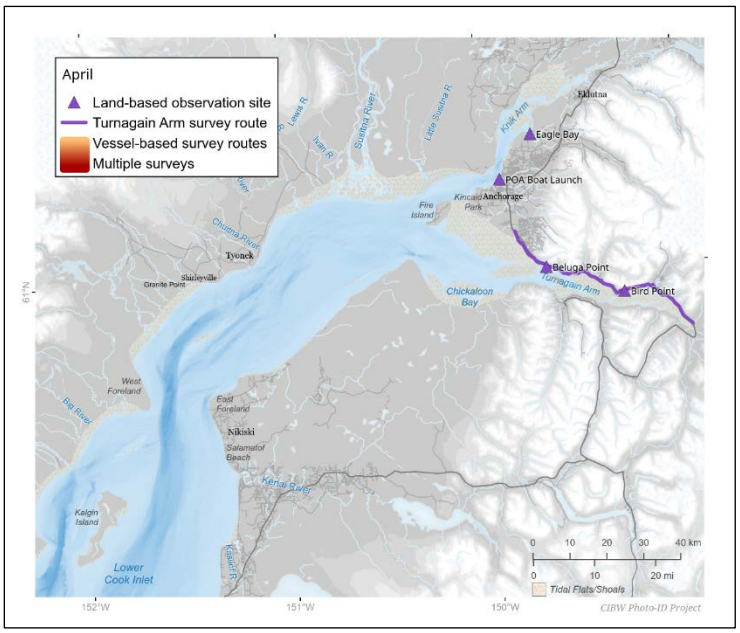


Figure 19. Land-based stations and survey routes for photo-id surveys conducted 2005-2015 in the month of April. Vessel-based surveys were not conducted in April of any project year. See Table 2 for exact number of surveys. POA=Port of Anchorage.

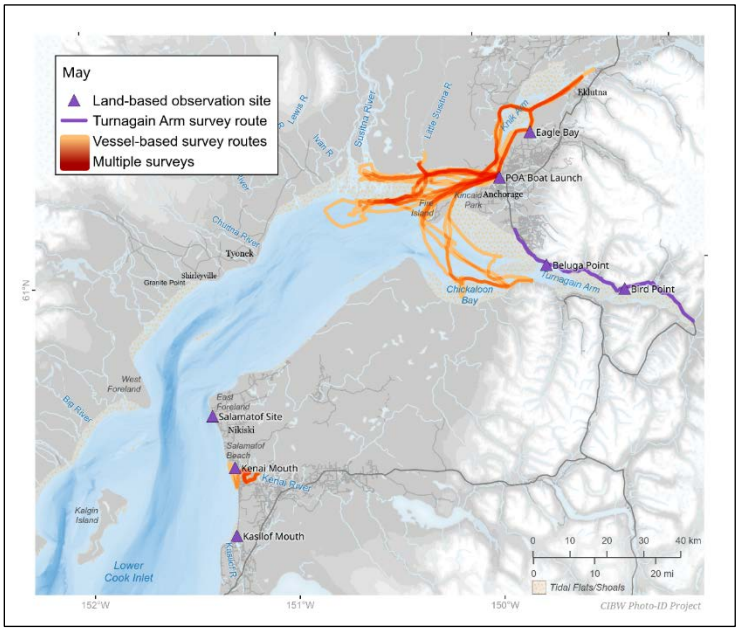


Figure 20. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for photo-id surveys conducted in the month of May 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 2 for exact number of surveys. POA=Port of Anchorage.

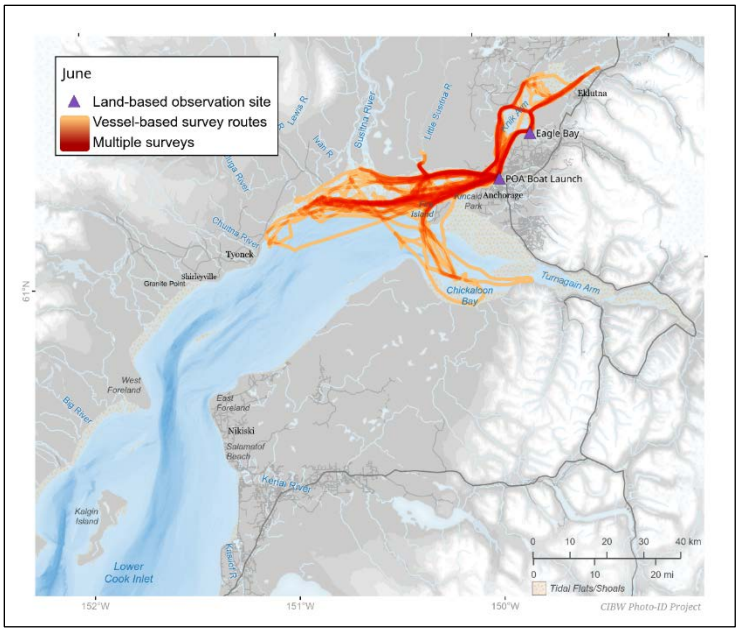


Figure 21. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for photo-id surveys conducted in the month of June 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 2 for exact number of surveys. Surveys of Turnagain Arm were not conducted during June of any project year. POA=Port of Anchorage.

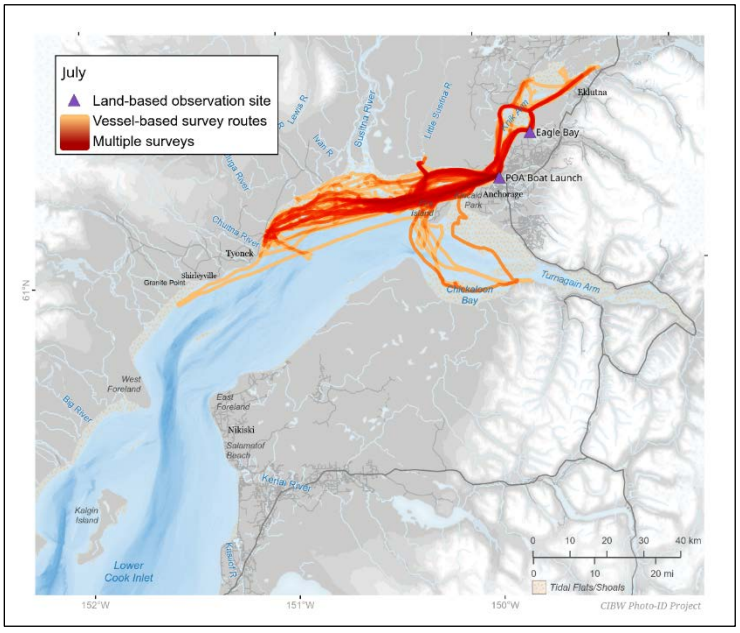


Figure 22. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for photo-id surveys conducted in the month of July 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 2 for exact number of surveys. Surveys of Turnagain Arm were not conducted during July of any project year. POA=Port of Anchorage.

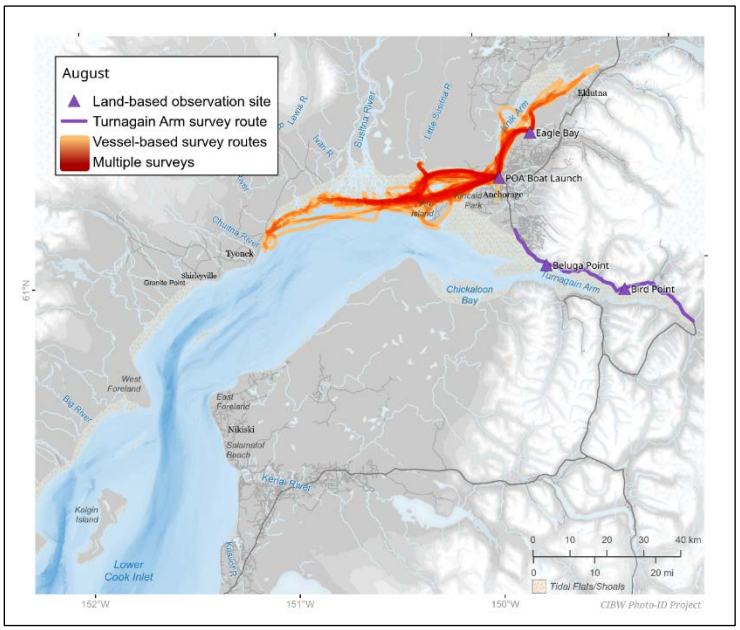


Figure 23. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for photo-id surveys conducted in the month of August 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 2 for exact number of surveys. POA=Port of Anchorage.

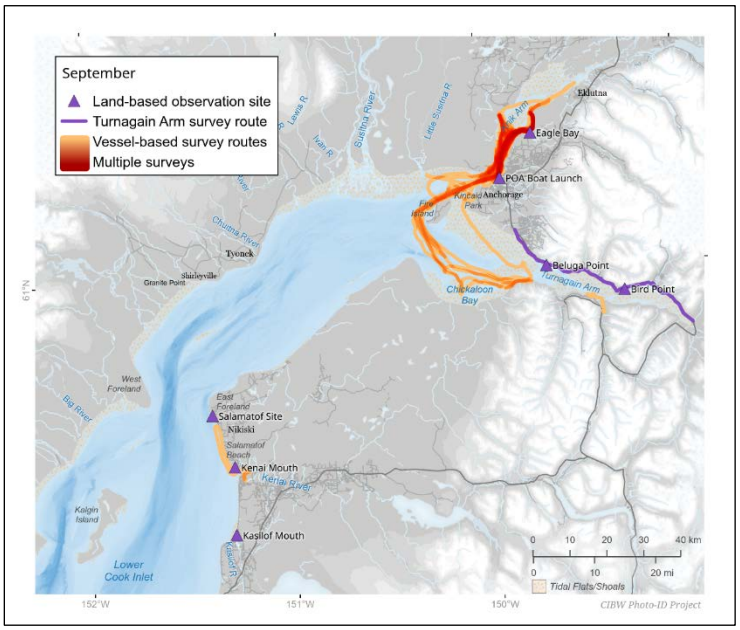


Figure 24. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for photo-id surveys conducted in the month of September 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 2 for exact number of surveys. POA=Port of Anchorage.

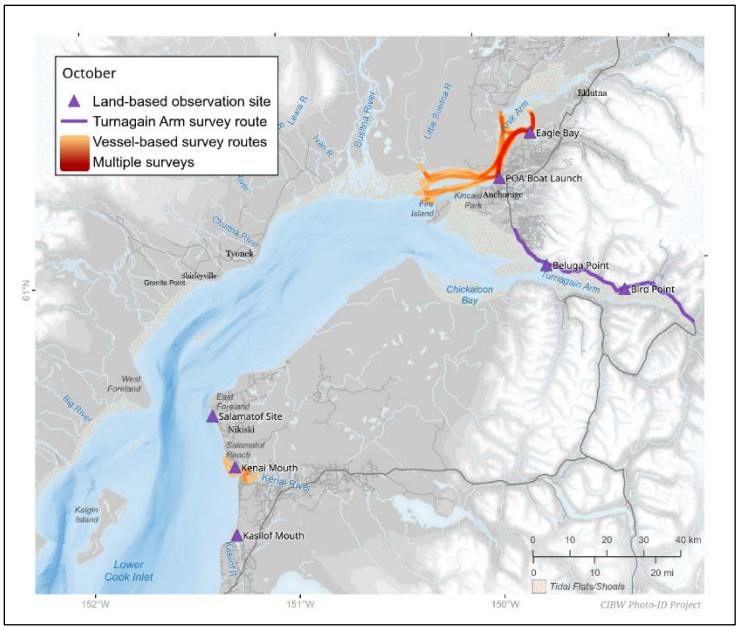


Figure 25. Vessel routes (from daily GPS track lines) with land-based stations and survey routes for photo-id surveys conducted in the month of October 2005-2015. Level of effort of the vessel-based surveys is indicated by the intensity of the colors of the track lines. See Table 2 for exact number of surveys. POA=Port of Anchorage.

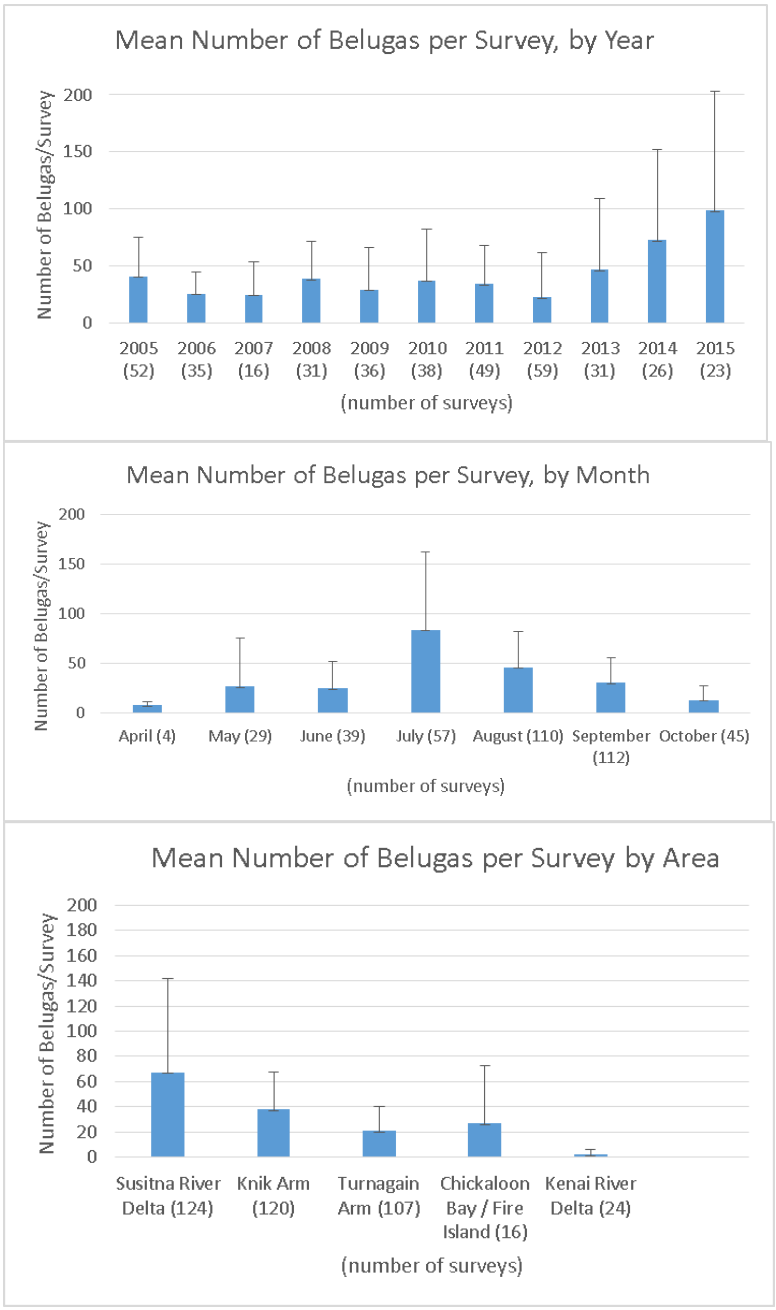


Figure 26. The mean number of belugas encountered per survey during photo-id surveys of Cook Inlet, 2005-2015, according to year (top), month (middle), and survey area (bottom). Bars represent the standard deviation about the mean.

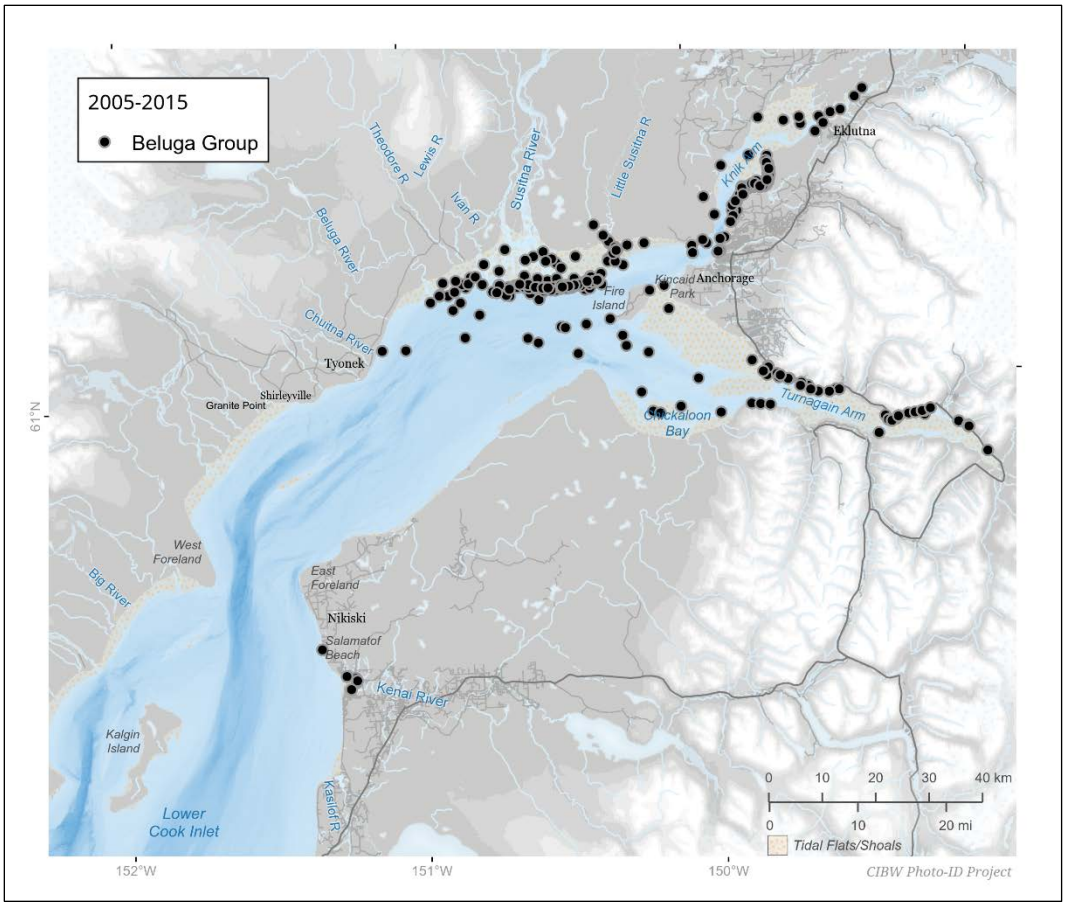


Figure 27. Beluga whale groups encountered during all photo-id surveys conducted 2005-2015. See Figure 7 for survey locations.

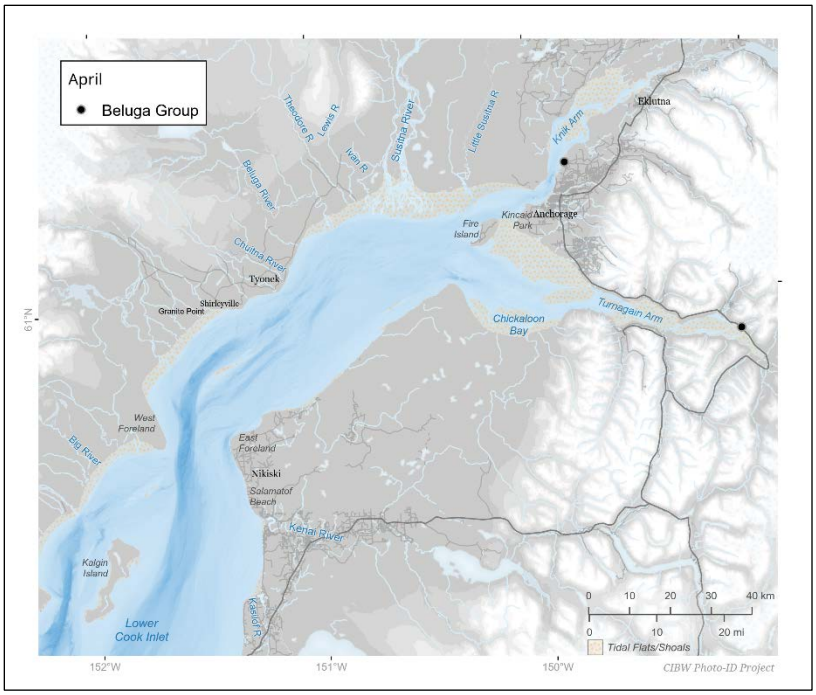


Figure 28. Beluga whale groups encountered during photo-id surveys conducted during the month of April 2005-2015. See Figure 19 for survey locations.

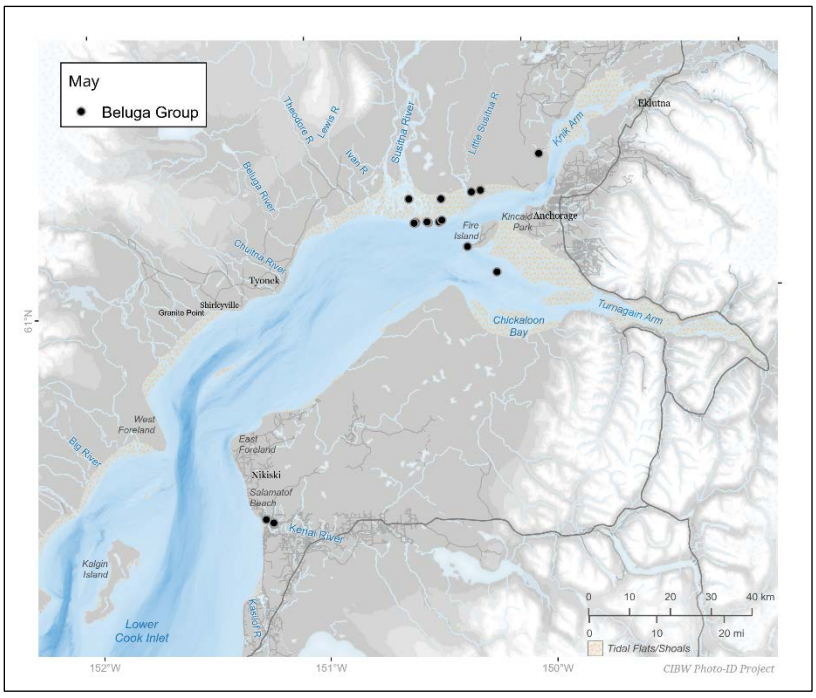


Figure 29. Beluga whale groups encountered during photo-id surveys conducted during the month of May 2005-2015. See Figure 20 for survey locations.

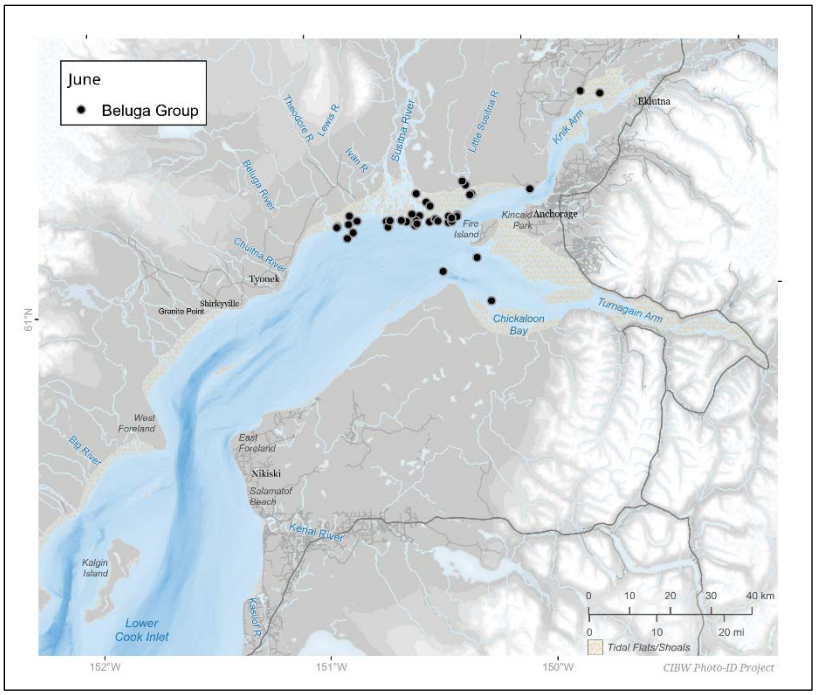


Figure 30. Beluga whale groups encountered during photo-id surveys conducted during the month of June 2005-2015. See Figure 21 for survey locations.

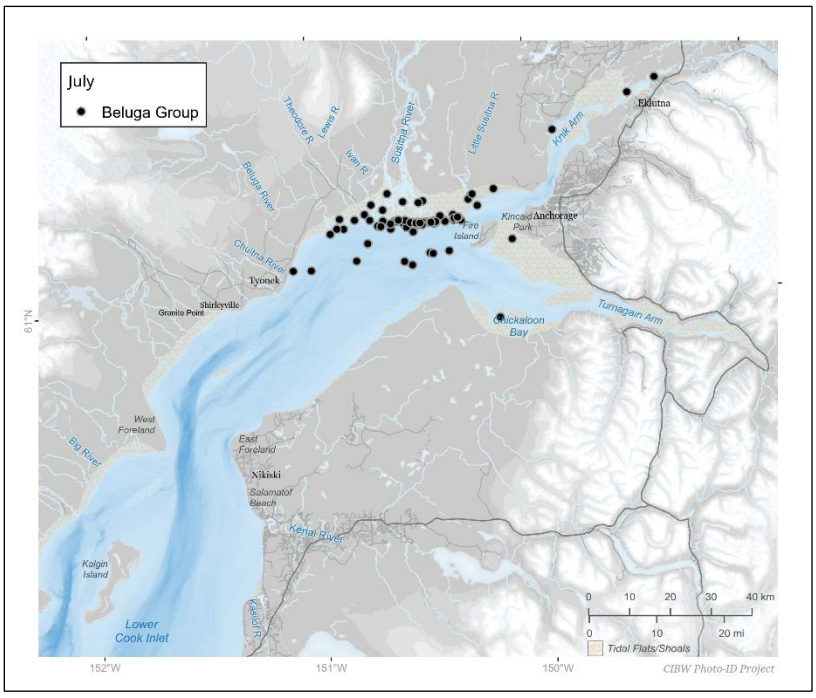


Figure 31. Beluga whale groups encountered during photo-id surveys conducted during the month of July 2005-2015. See Figure 22 for survey locations.

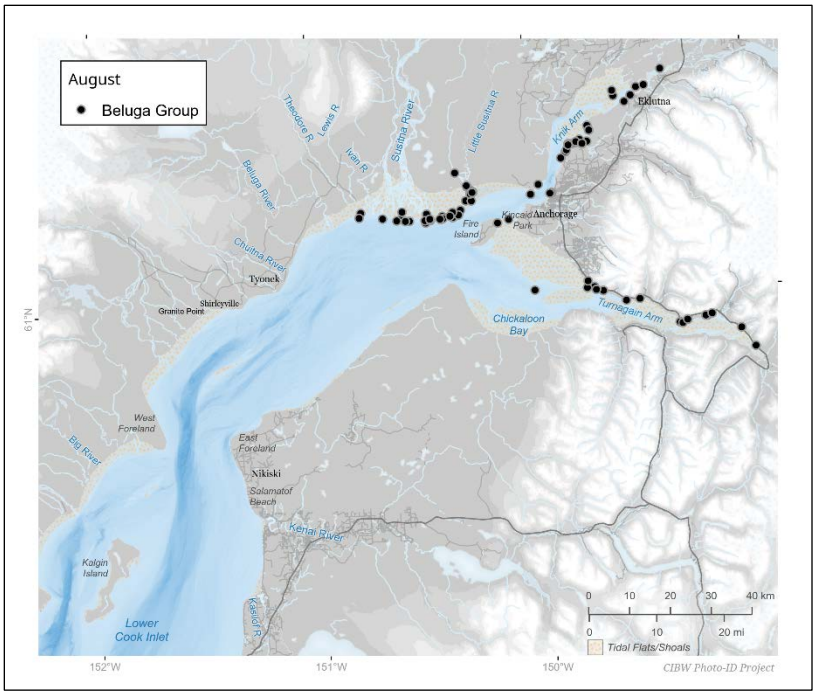


Figure 32. Beluga whale groups encountered during photo-id surveys conducted during the month of August 2005-2015. See Figure 23 for survey locations.

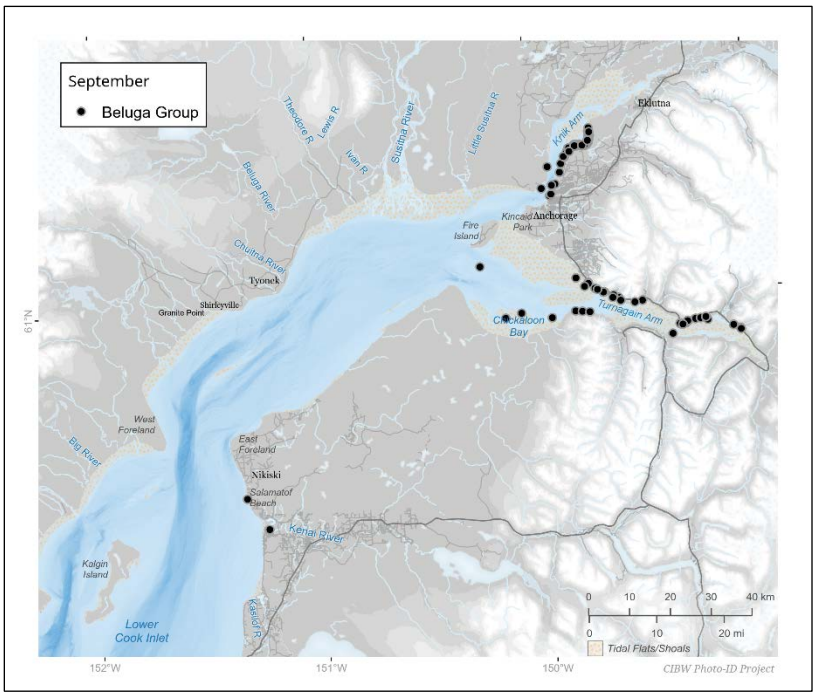


Figure 33. Beluga whale groups encountered during photo-id surveys conducted during the month of September 2005-2015. See Figure 24 for survey locations.

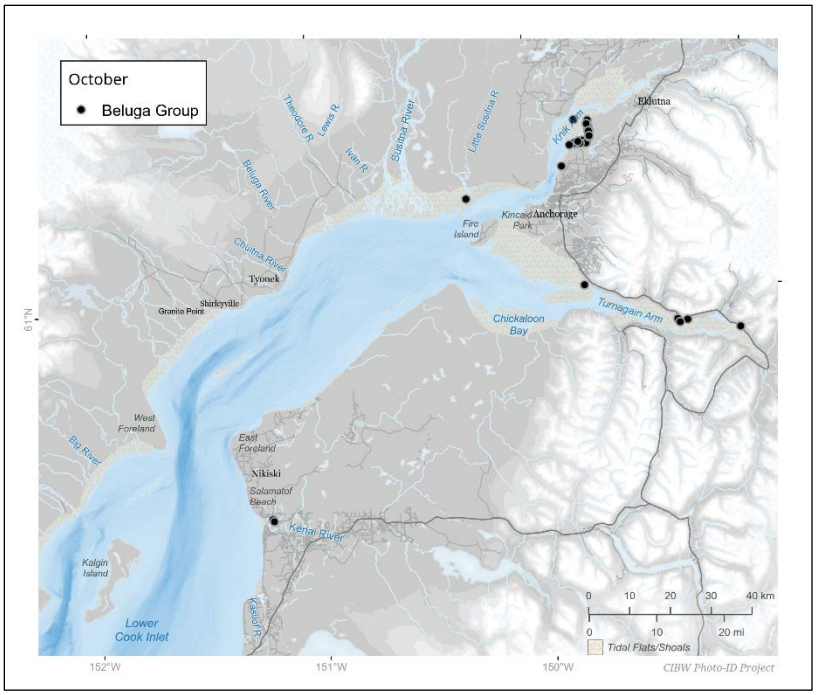


Figure 34. Beluga whale groups encountered during photo-id surveys conducted during the month of October 2005-2015. See Figure 25 for survey locations.

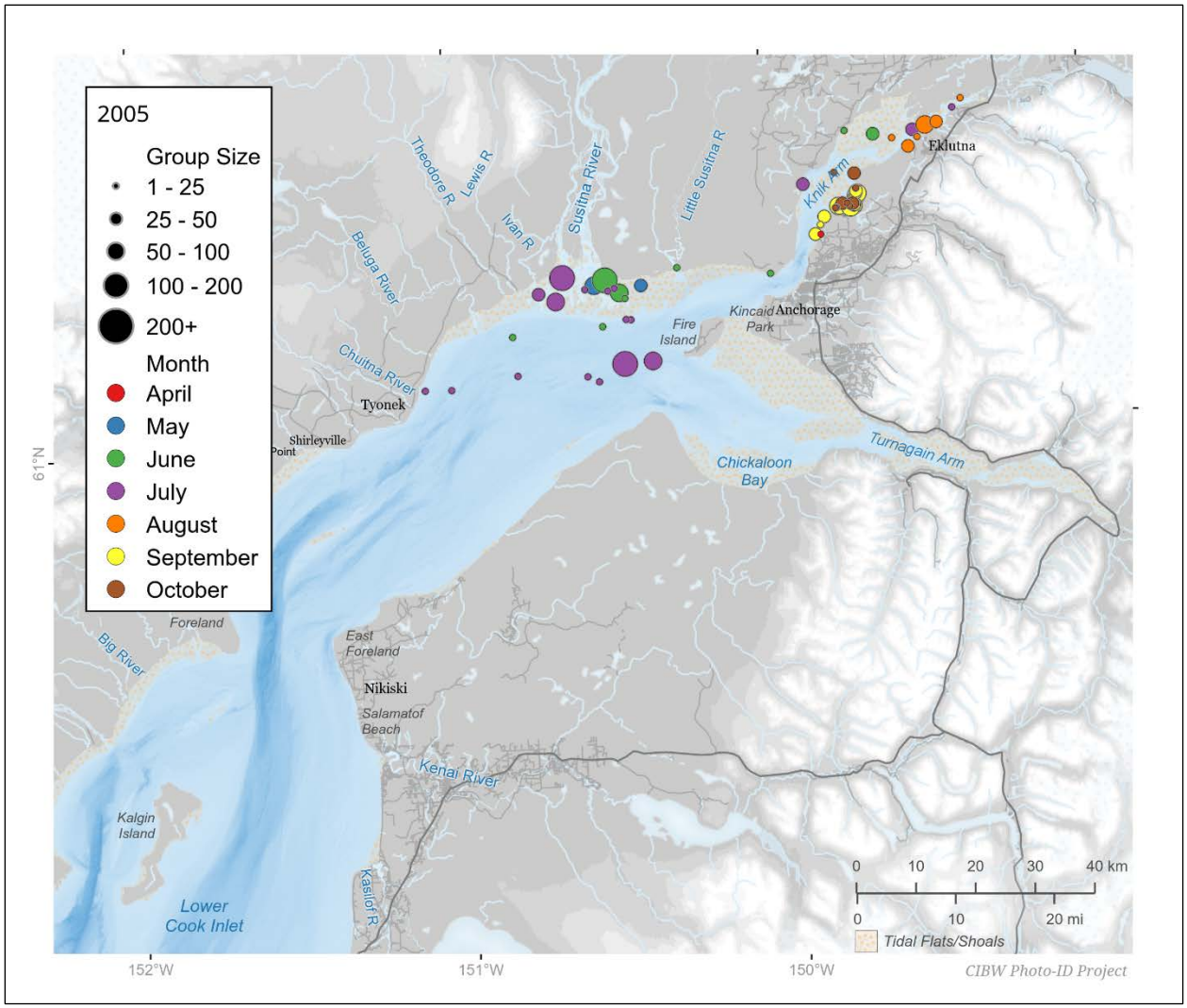


Figure 35. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2005.

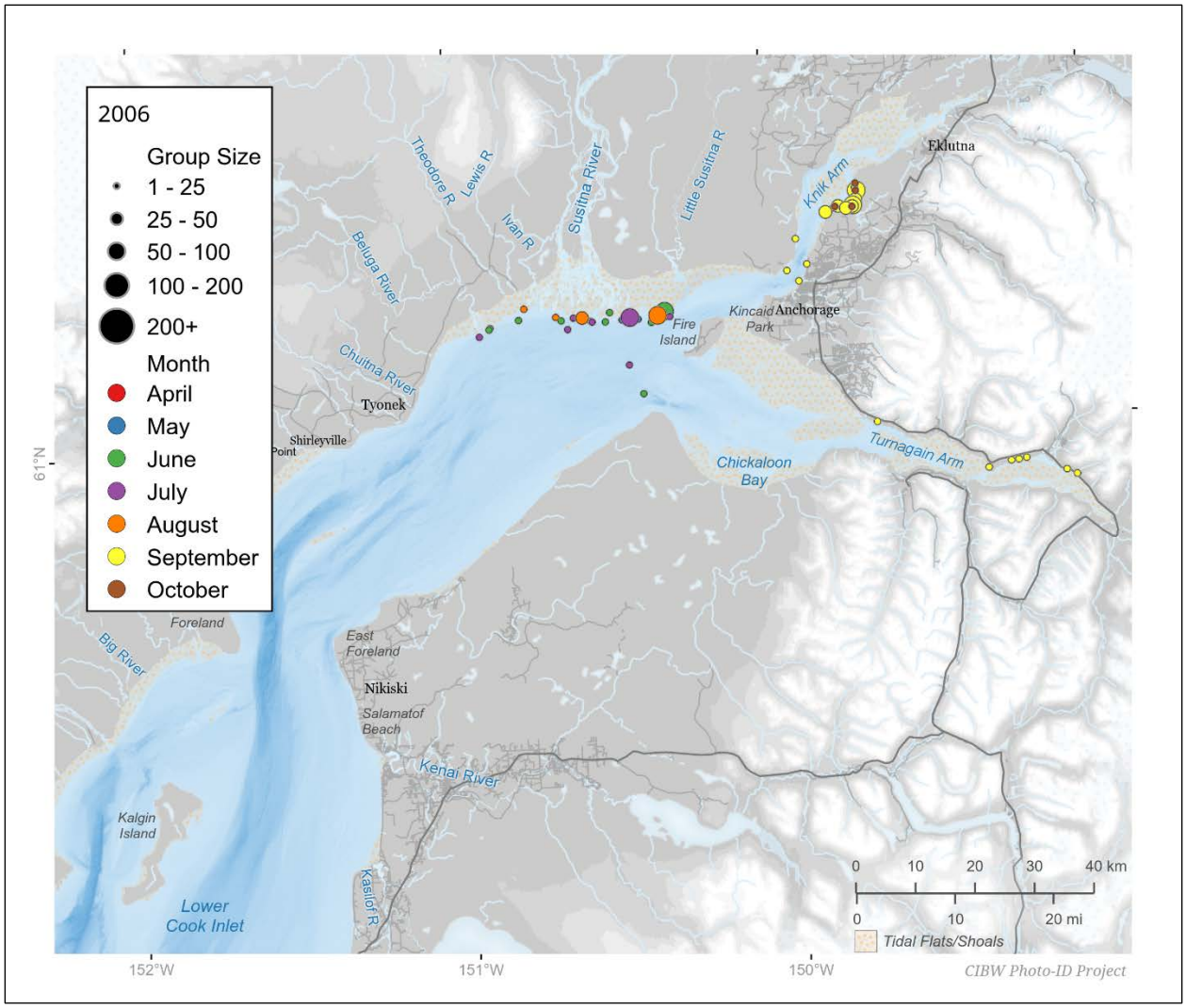


Figure 36. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2006.

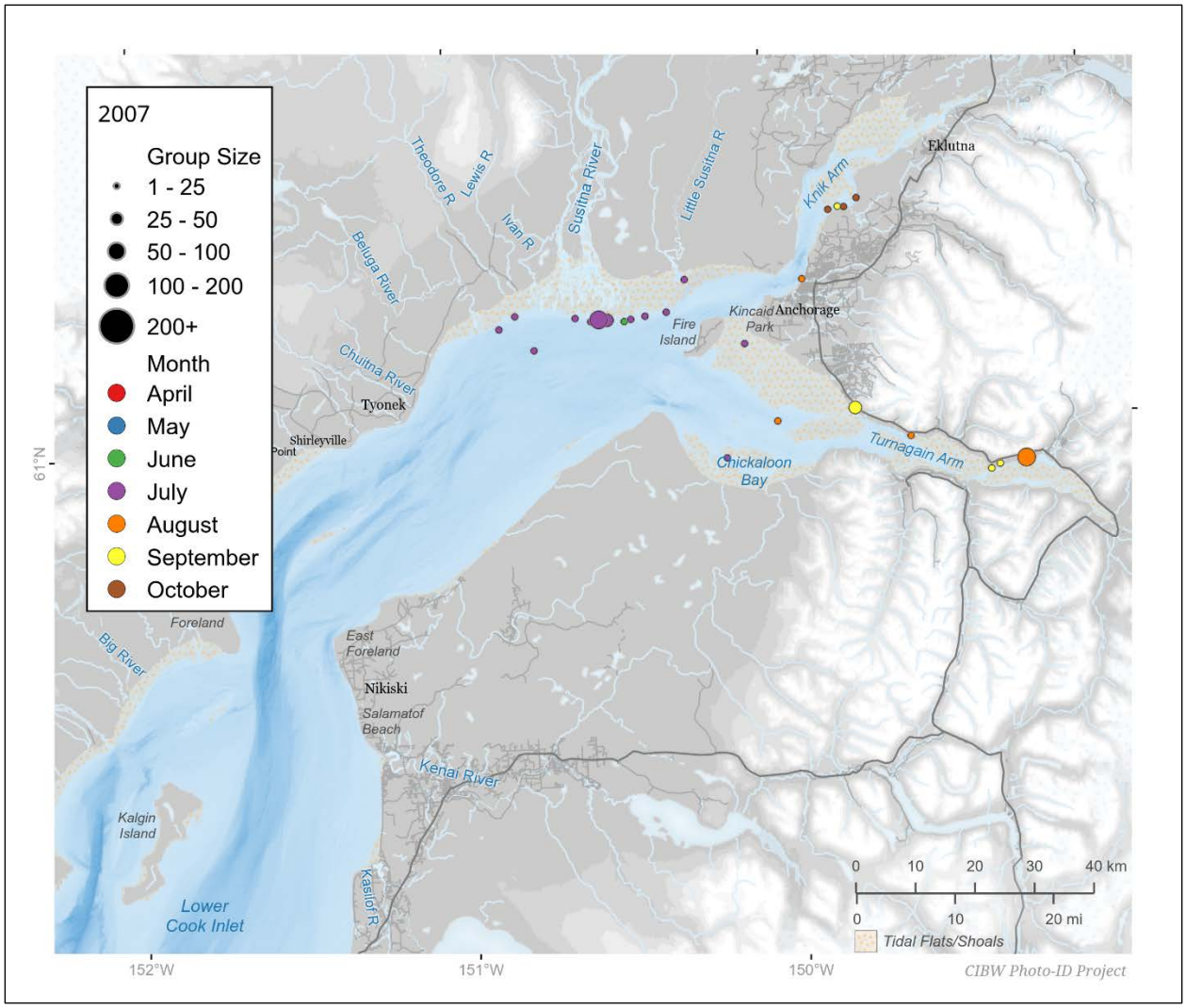


Figure 37. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2007.

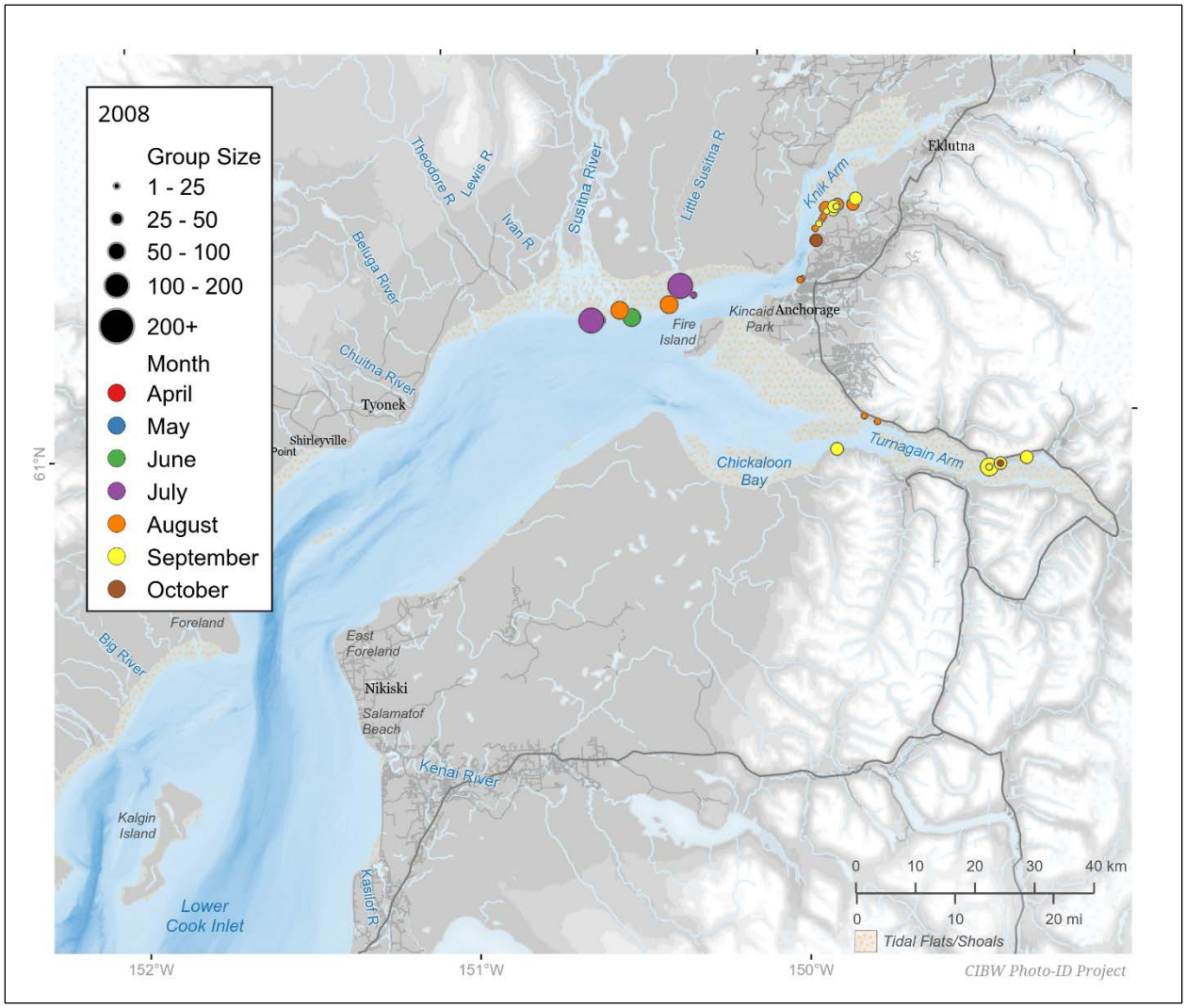


Figure 38. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2008.

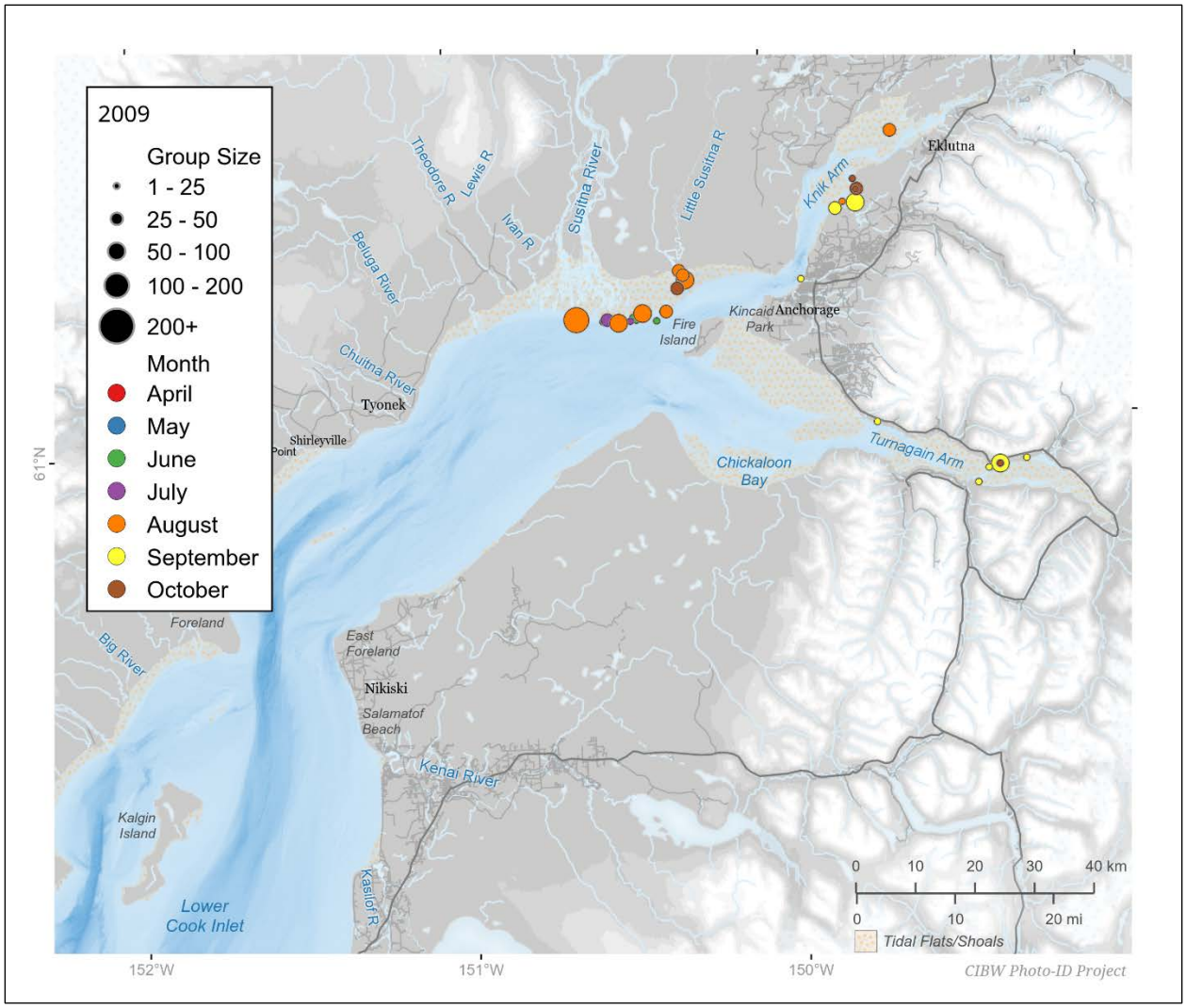


Figure 39. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2009.

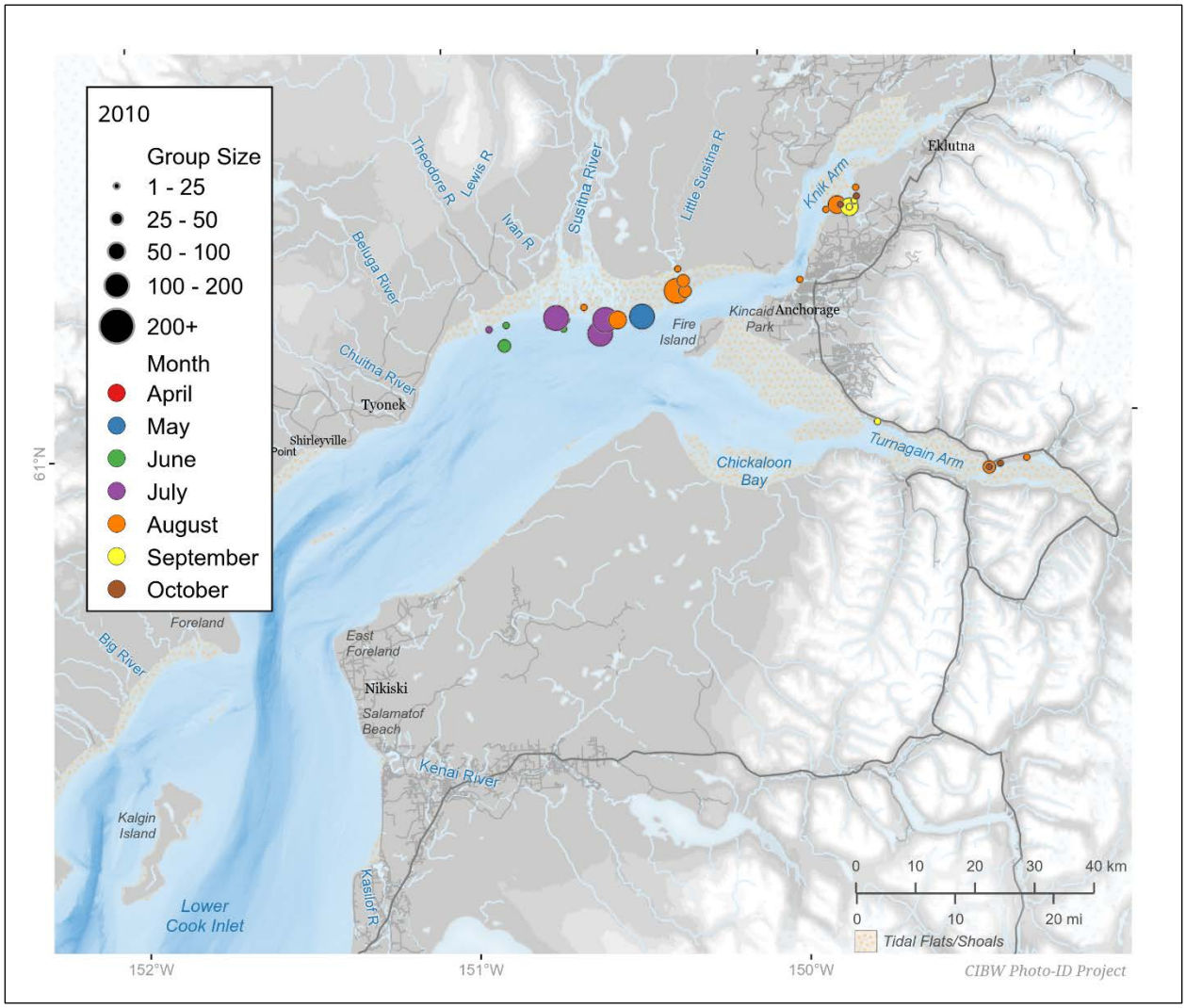


Figure 40. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2010.

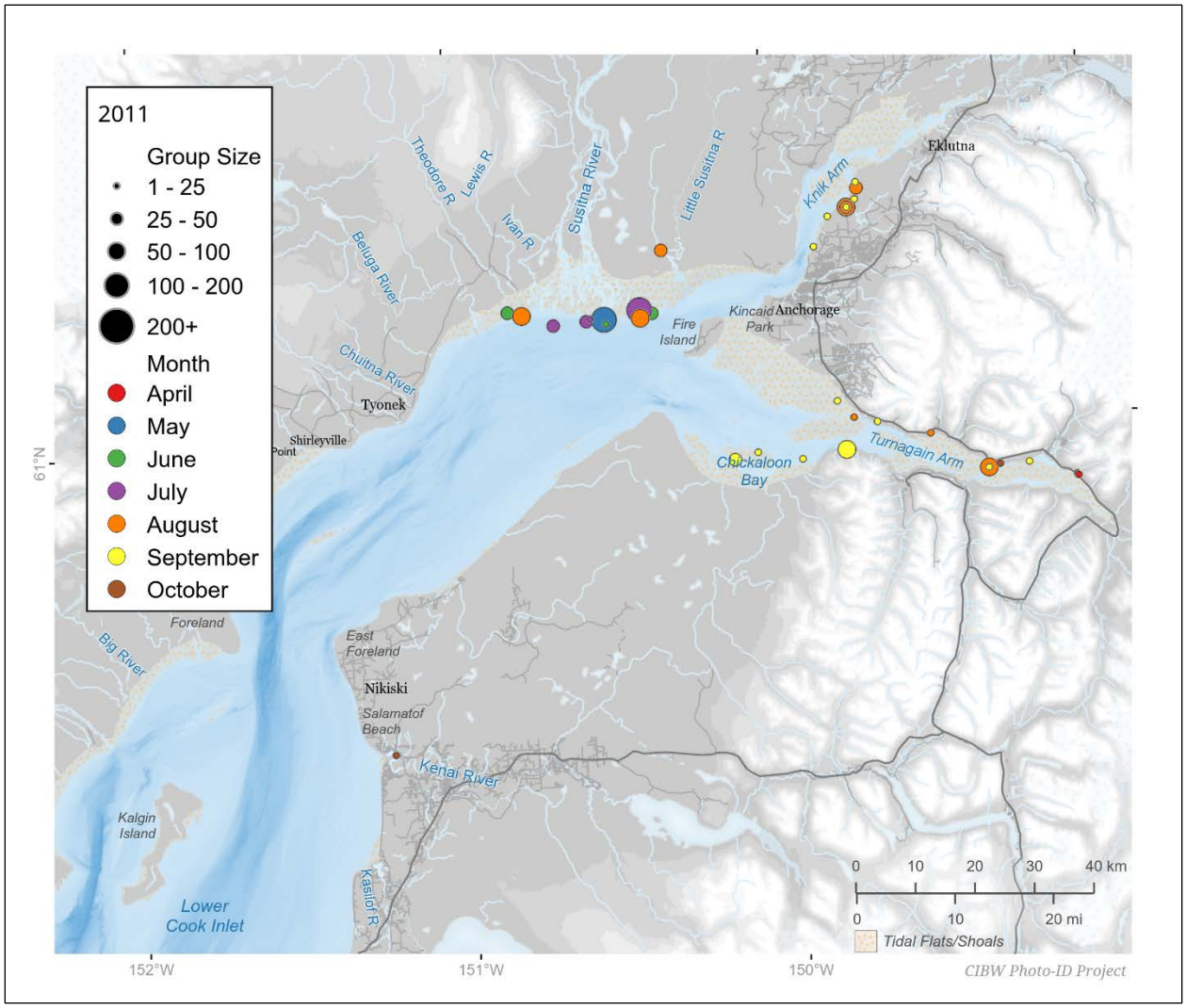


Figure 41. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2011.

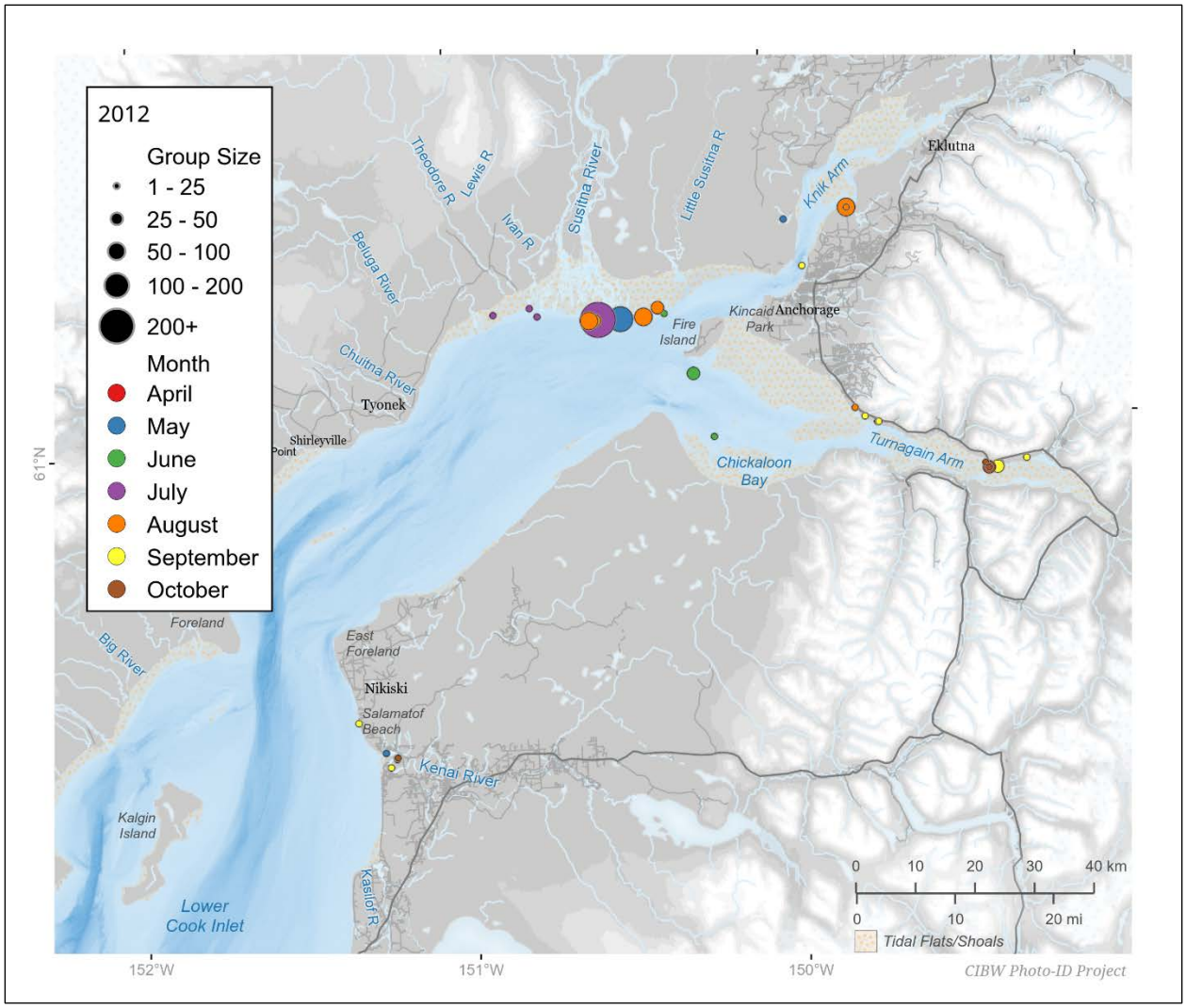


Figure 42. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2012.

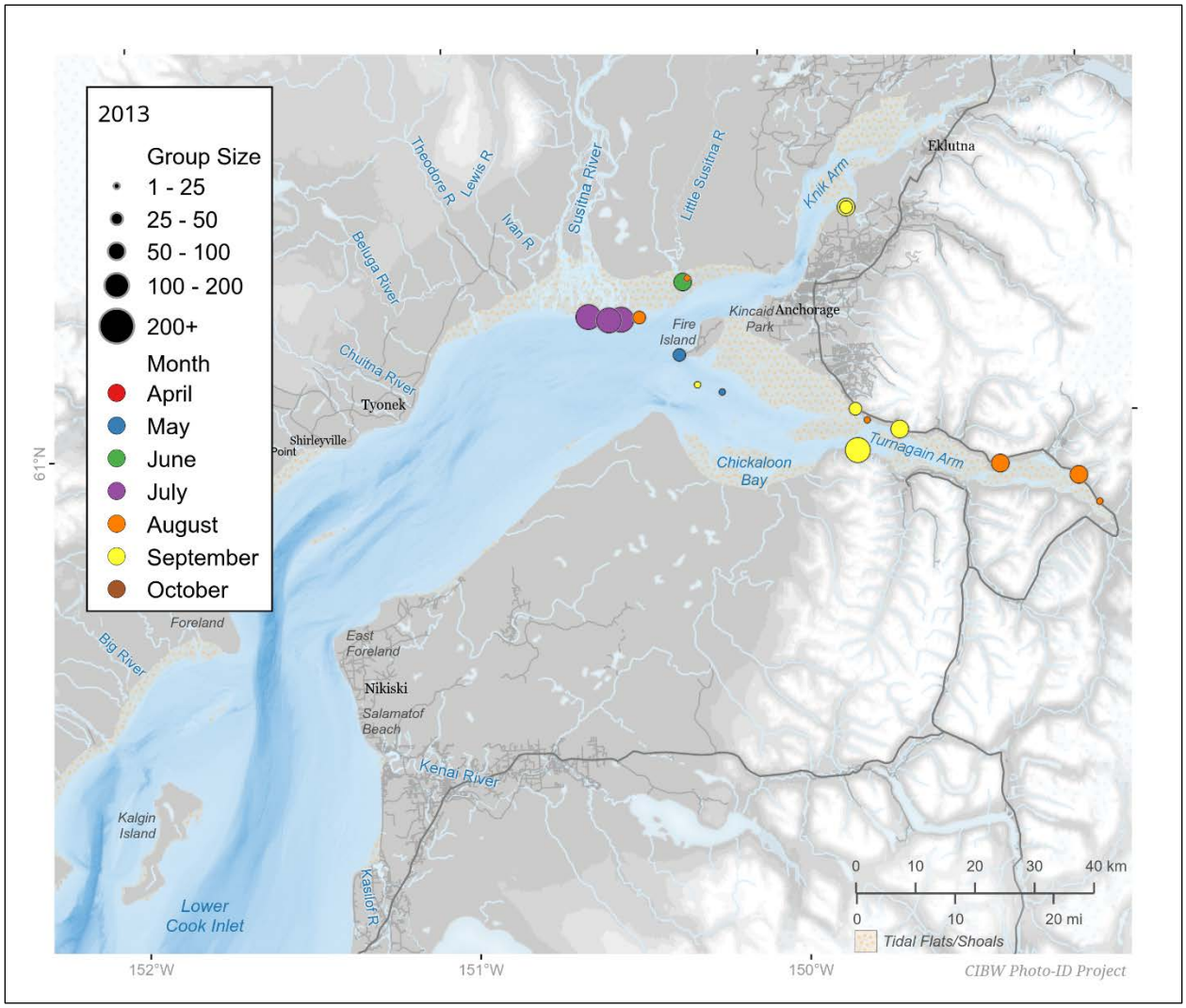


Figure 43. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2013.

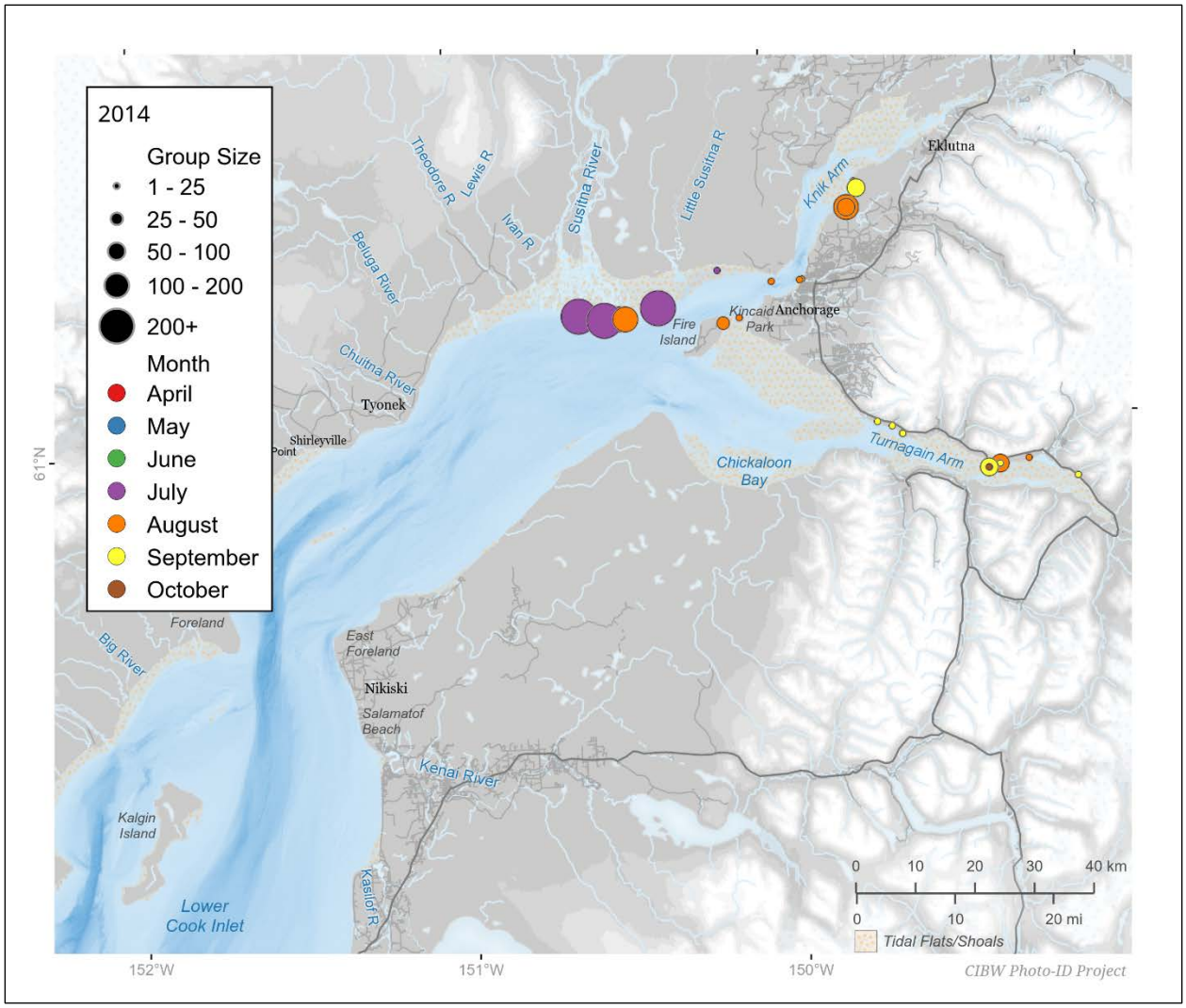


Figure 44. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2014.

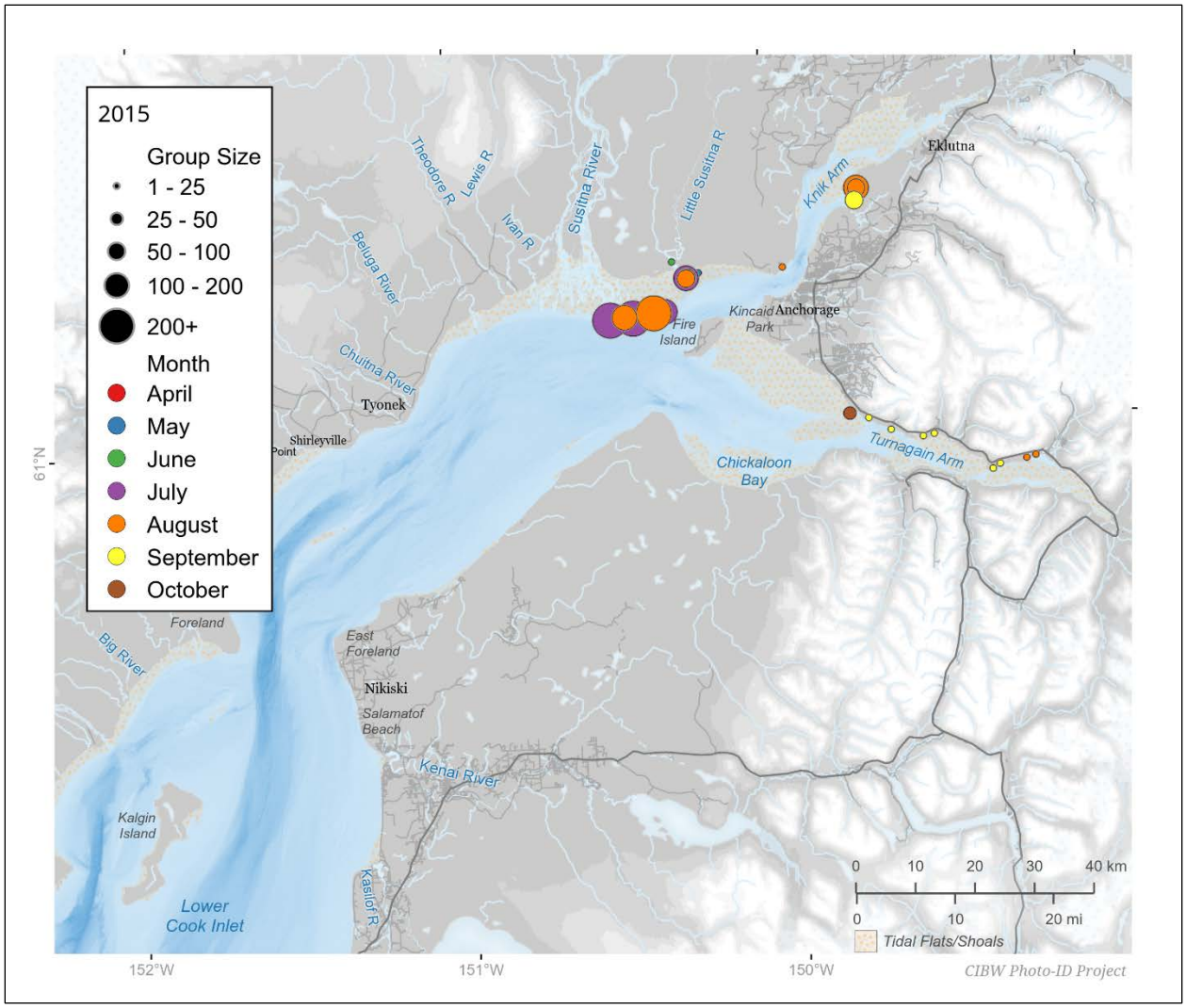


Figure 45. Size, month, and location of beluga whale groups encountered during photo-id surveys conducted in 2015.

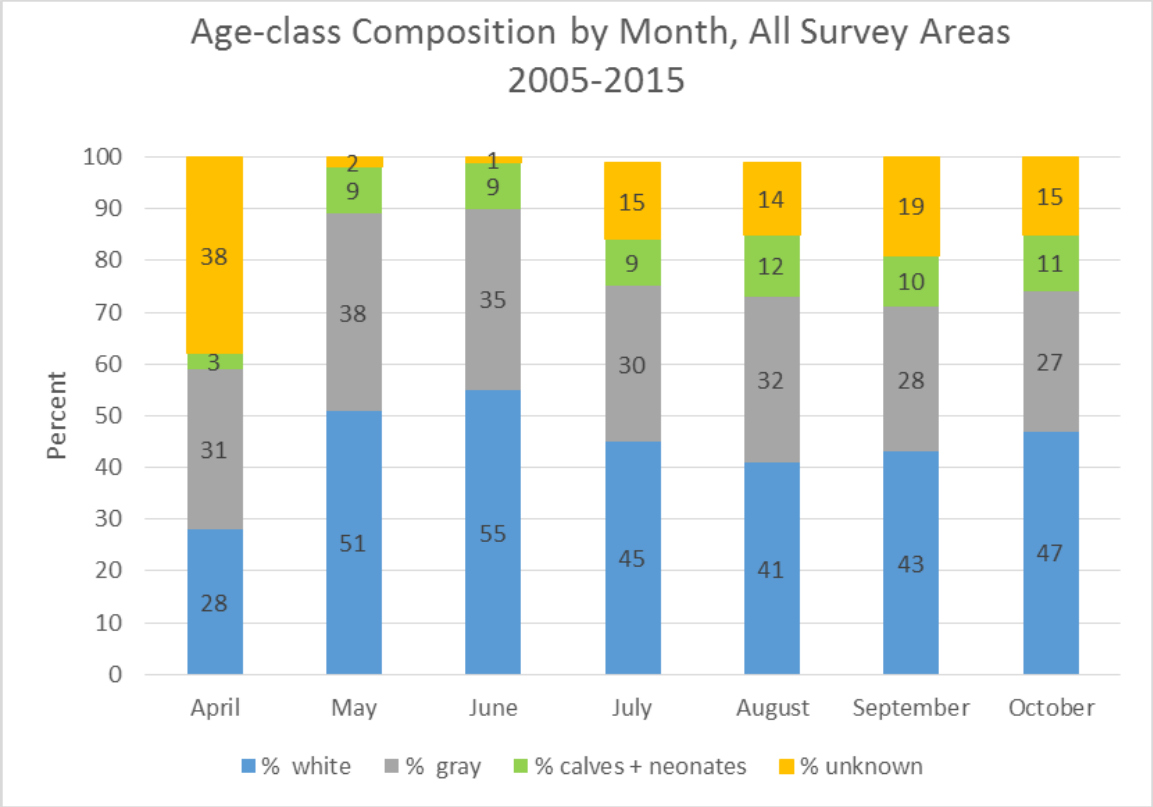


Figure 46. Mean group percent color and age-class composition, by month, for CIBWs encountered during photo-id surveys 2005-2015 (n=496 groups). For example, the average group in April contained 28% white whales, 31% gray whales, 3% calves/neonates, and 38% unknown.

Figure 47. Mean group percent color and age-class composition, by survey area, for CIBWs encountered during photo-id surveys 2005-2015 (n=496 groups). For example, the average group in the Susitna River Delta contained 47% white whales, 32% gray whales, 10% calves/neonates, and 11% unknown.

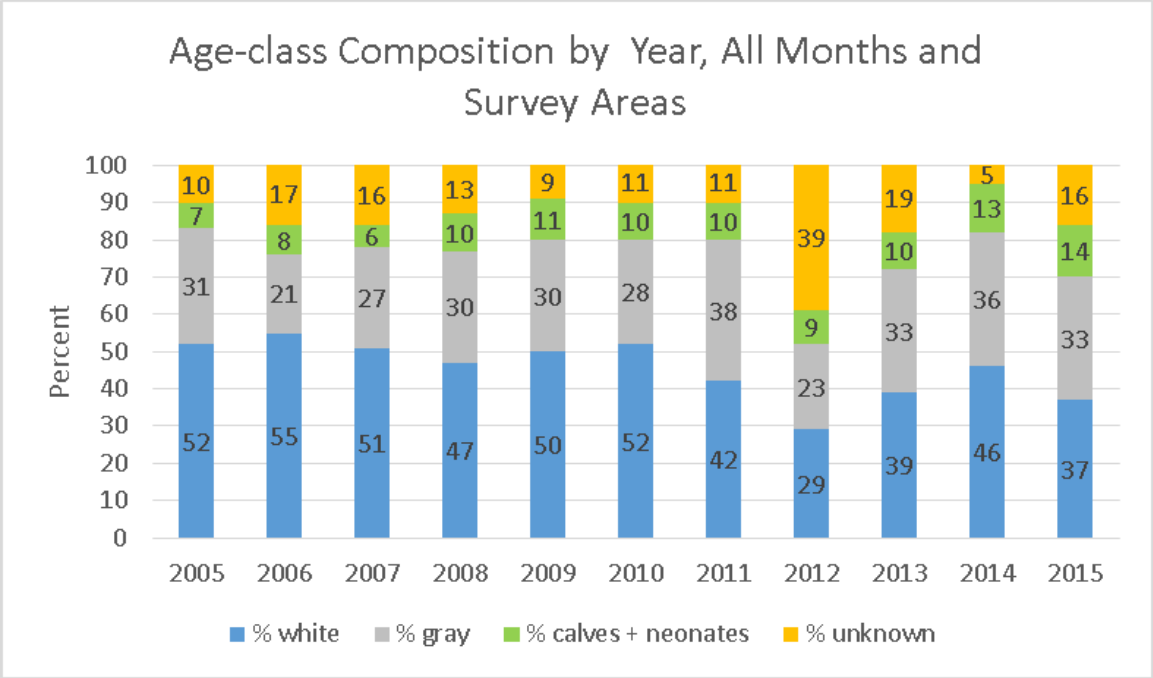


Figure 48. Mean group percent color and age-class composition, by year, for CIBWs encountered during photo-id surveys 2005-2015 (n=496 groups). For example, the average group in 2005 contained 52% white whales, 31% gray whales, 7% calves/neonates, and 10% unknown.

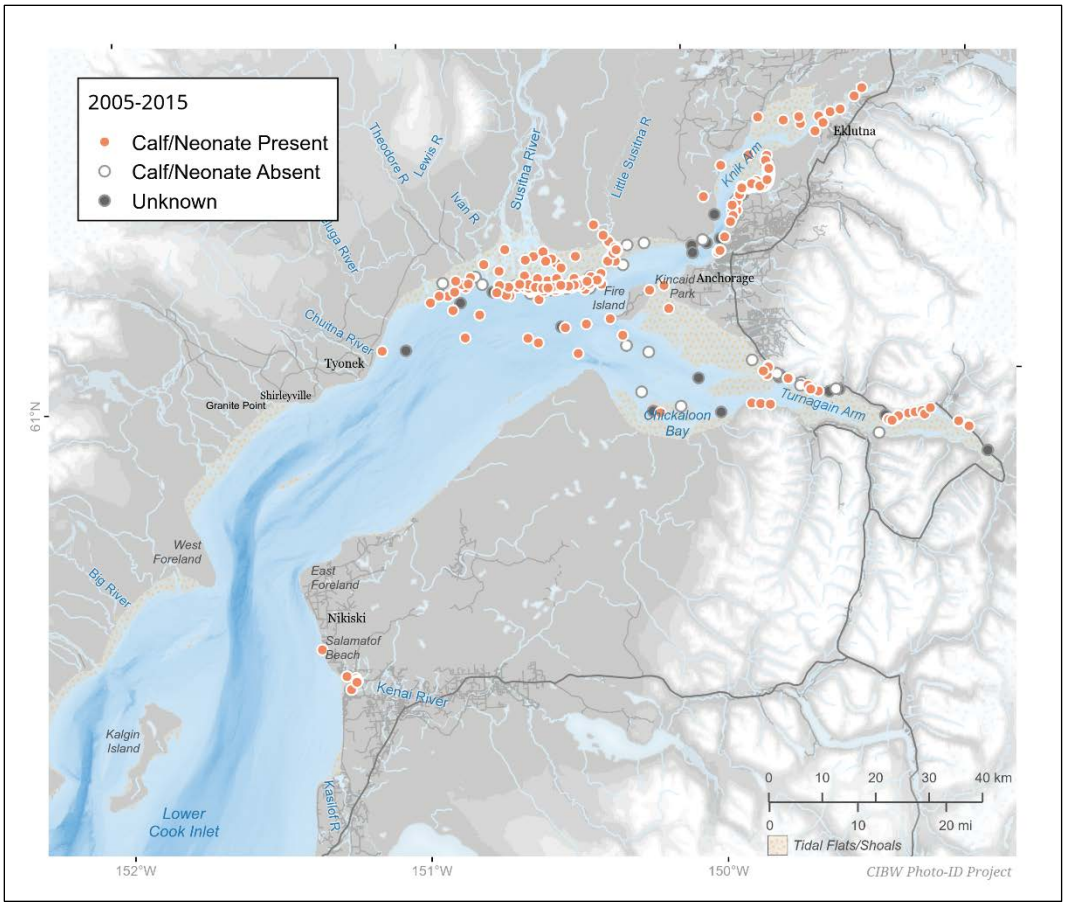


Figure 49. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted 2005-2015.

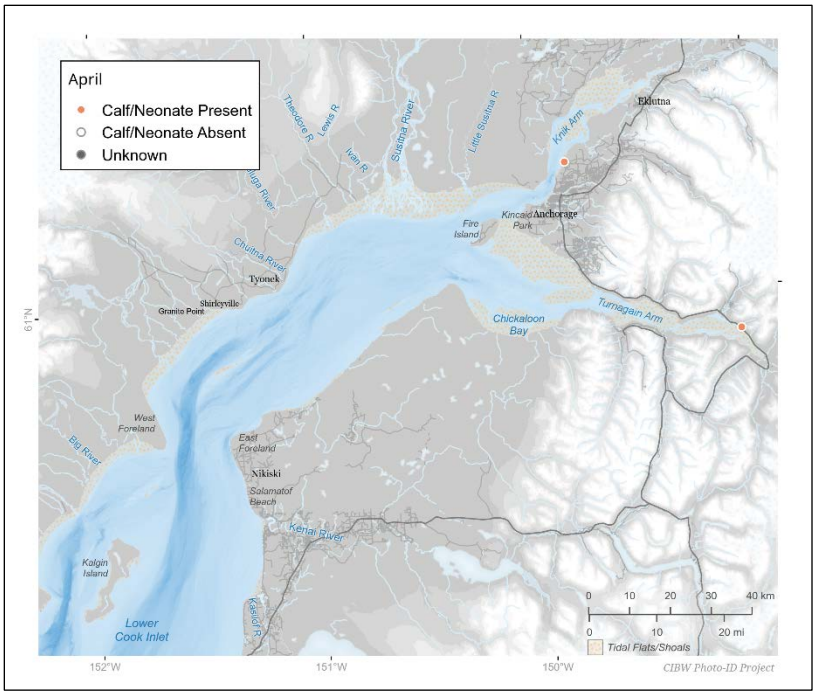


Figure 50. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of April 2005-2015.

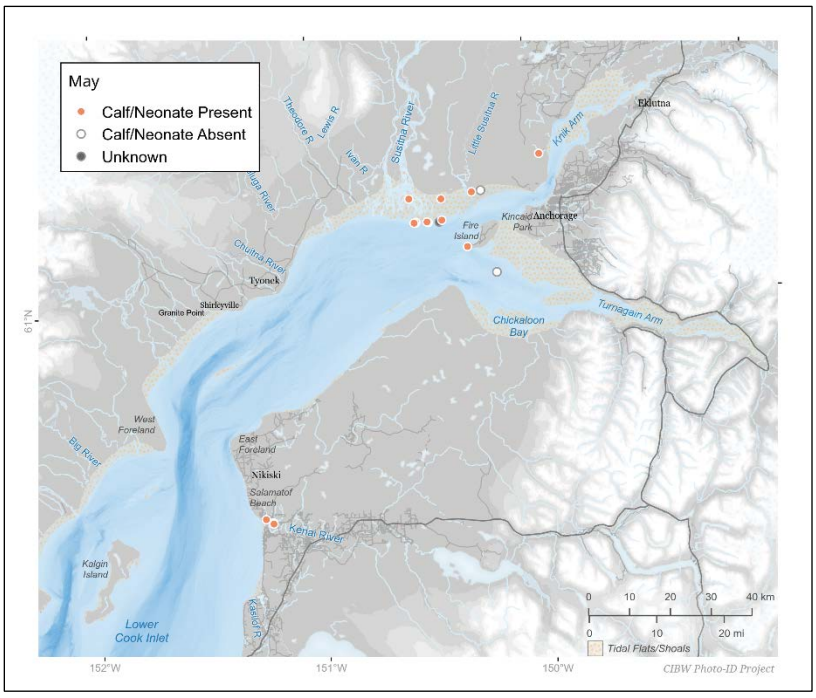


Figure 51. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of May 2005-2015.

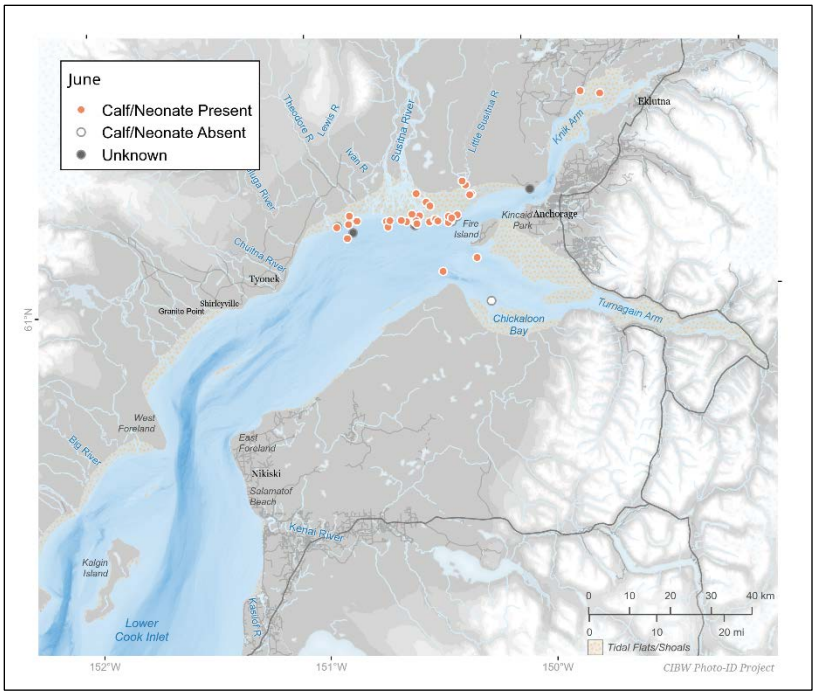


Figure 52. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of June 2005-2015.

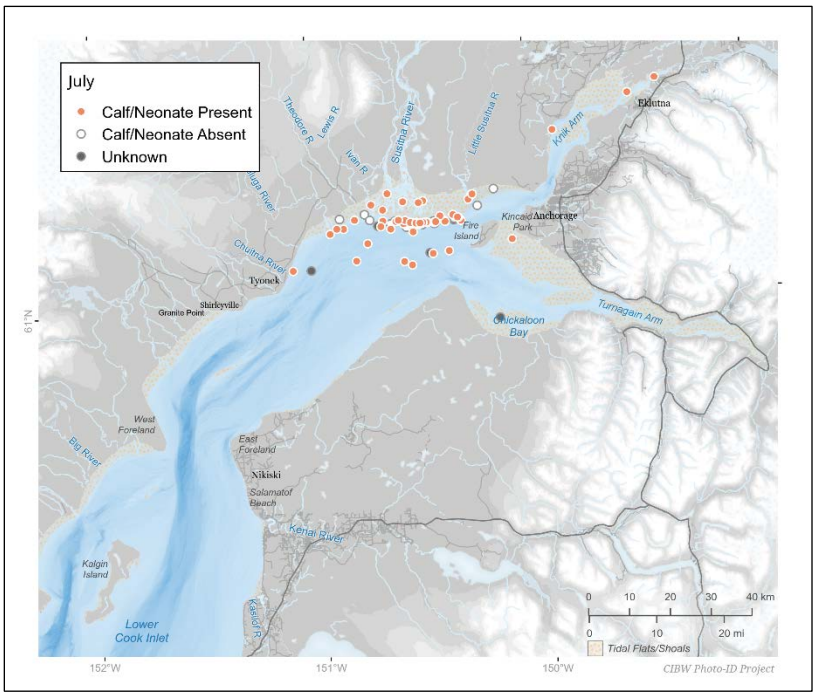


Figure 53. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of July 2005-2015.

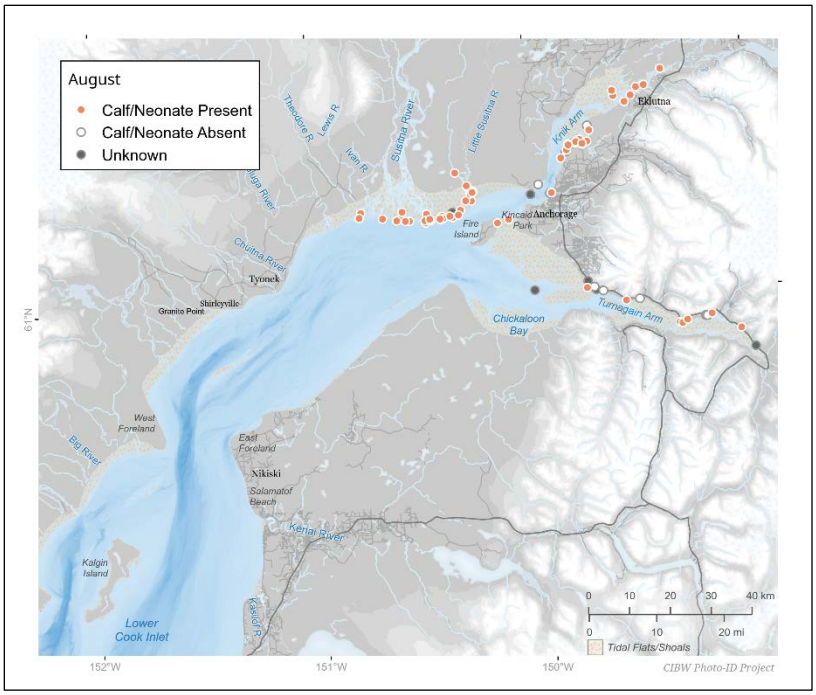


Figure 54. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of August 2005-2015.

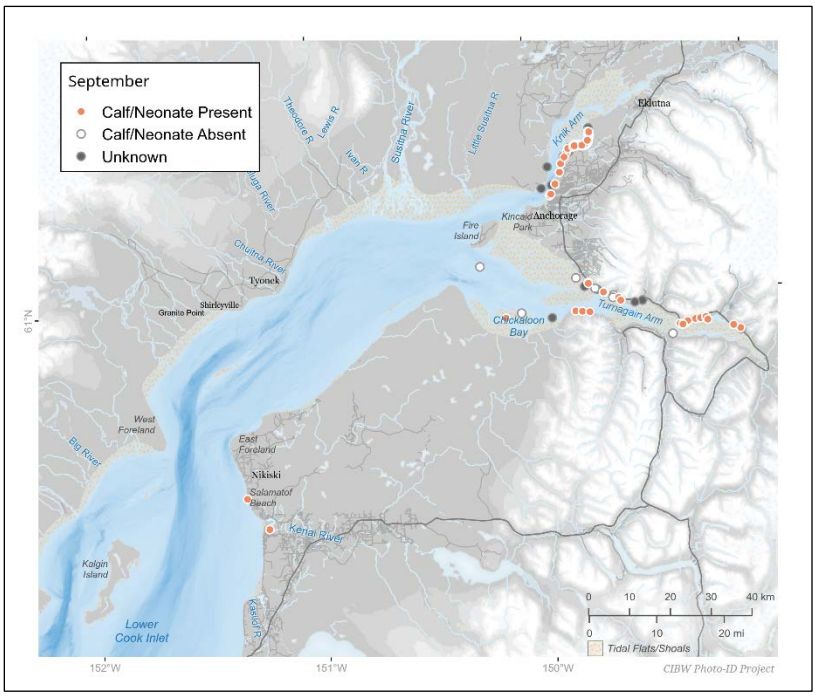


Figure 55. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of September 2005-2015.

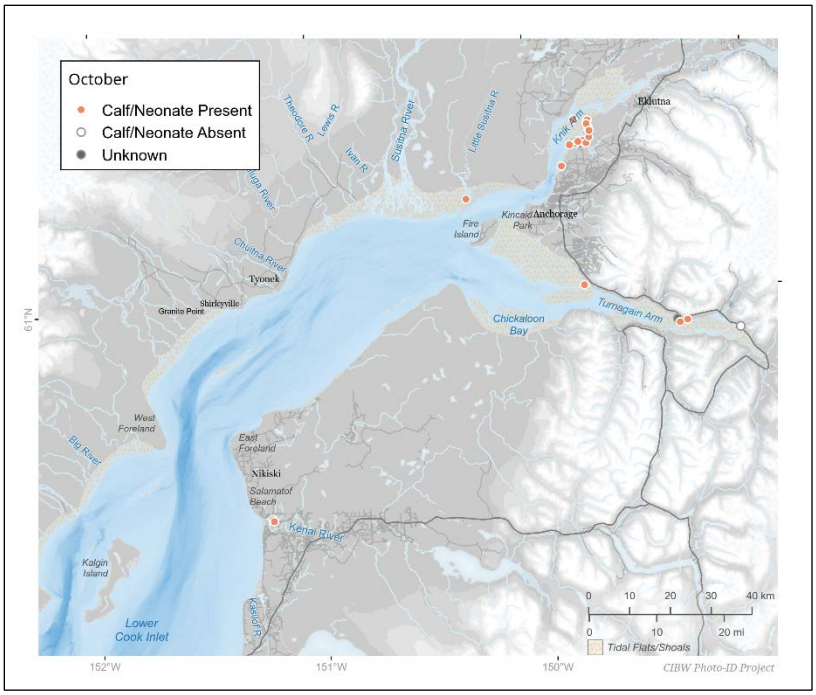


Figure 56. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in the month of October 2005-2015.

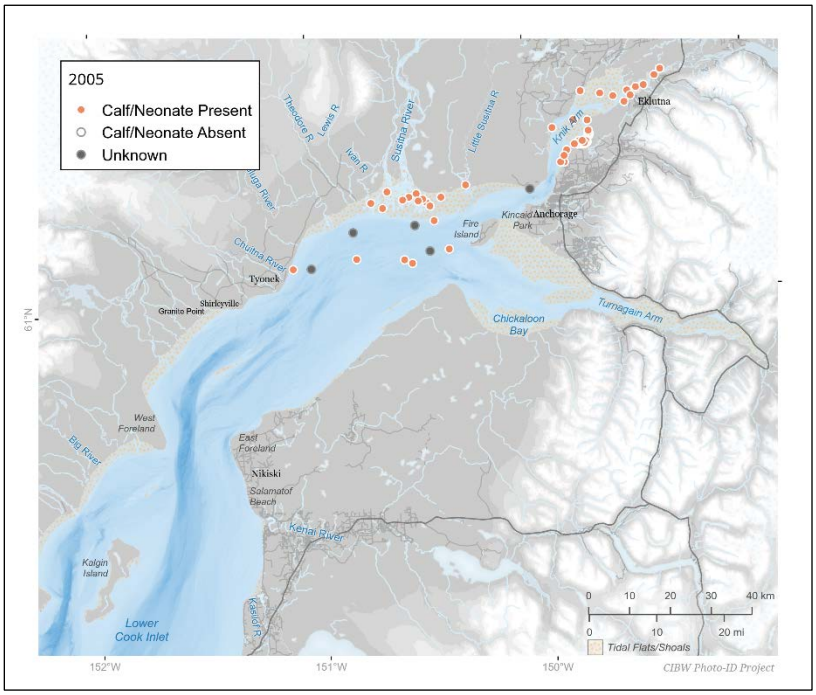


Figure 57. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2005.

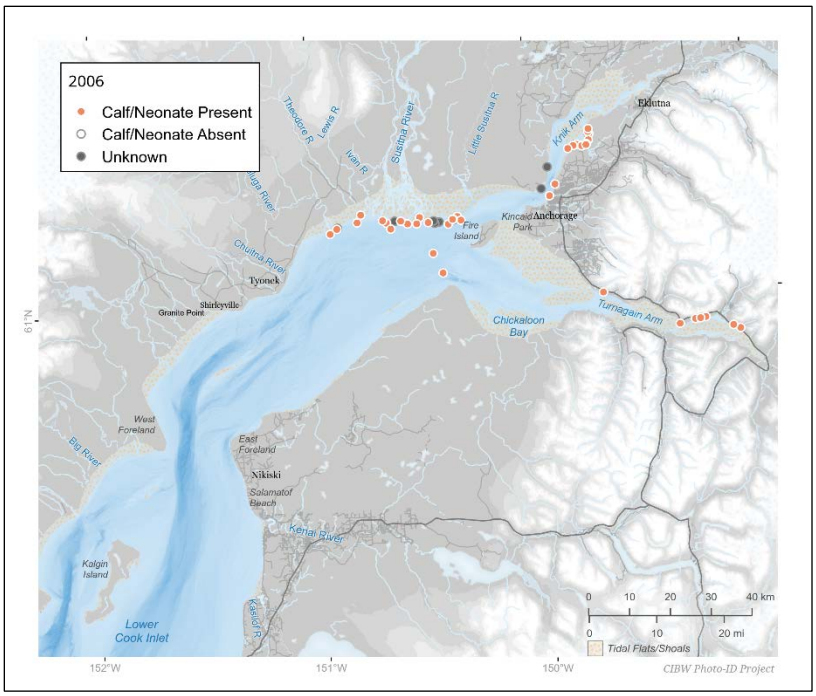


Figure 58. Location of groups with and without calves and neonates/or encountered during photo-id surveys conducted in 2006.

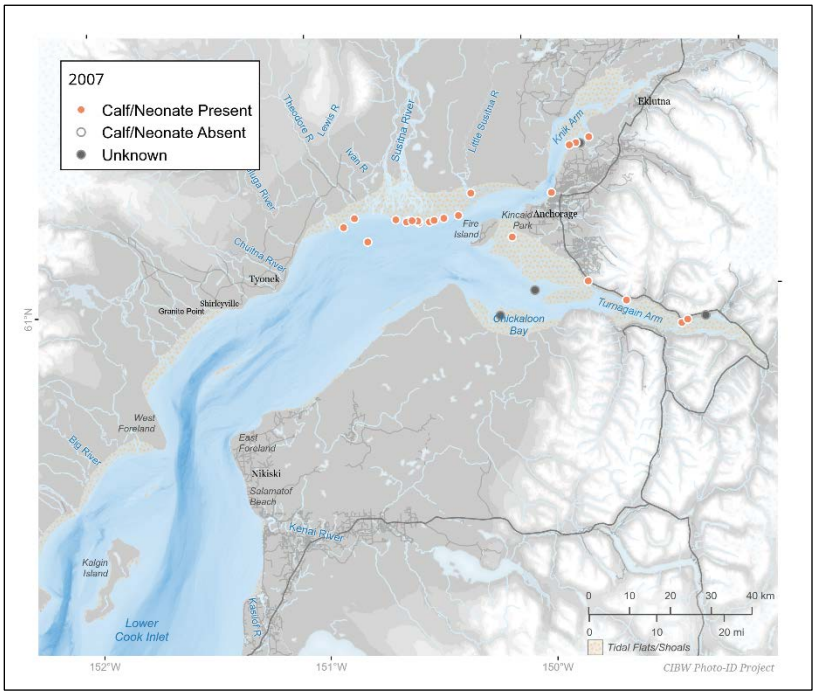


Figure 59. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2007.

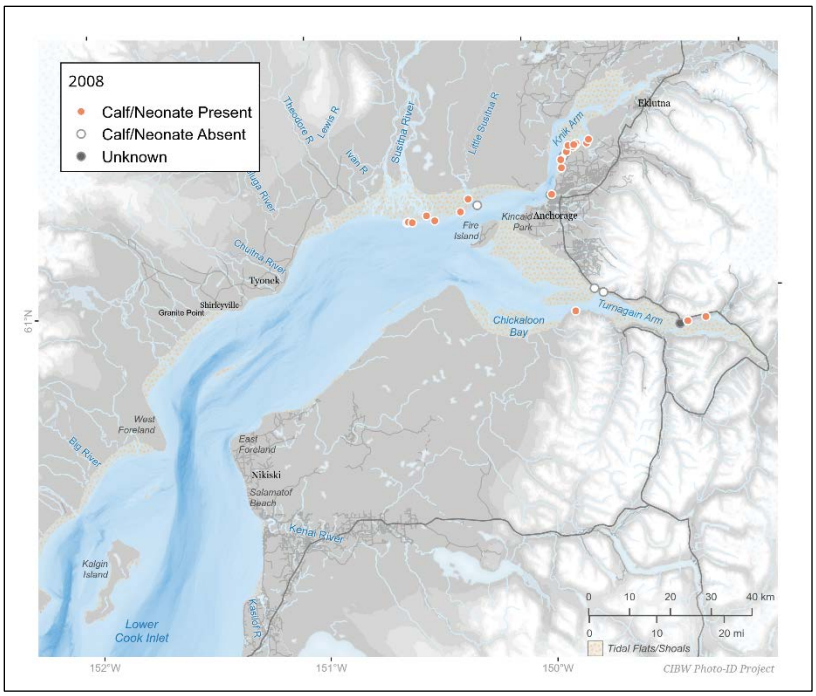


Figure 60. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2008.

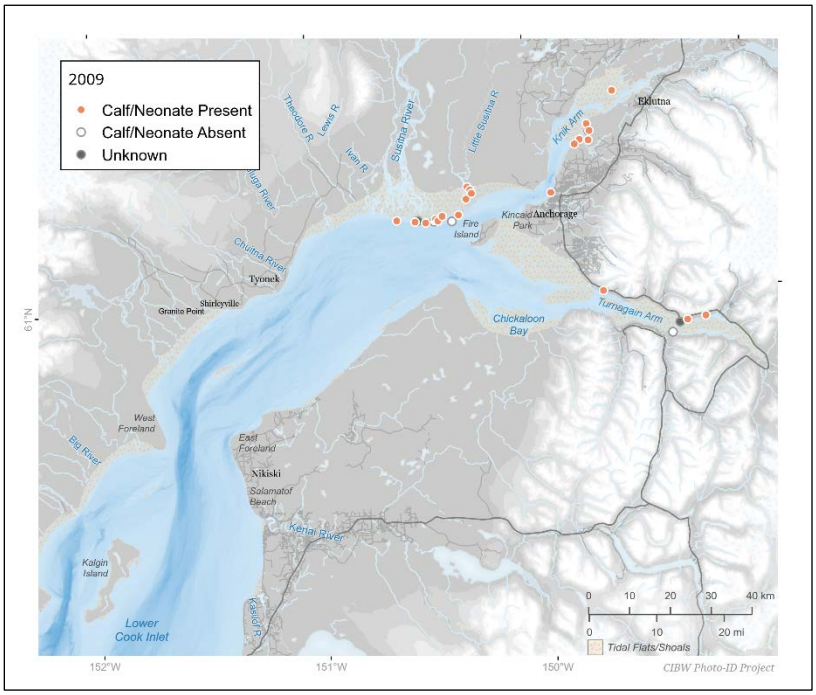


Figure 61. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2009.

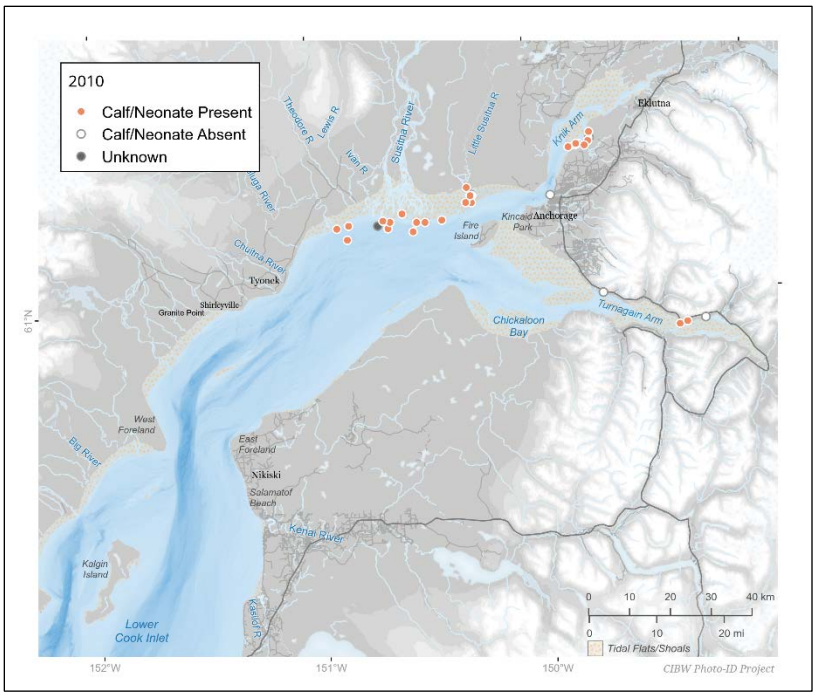


Figure 62. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2010.

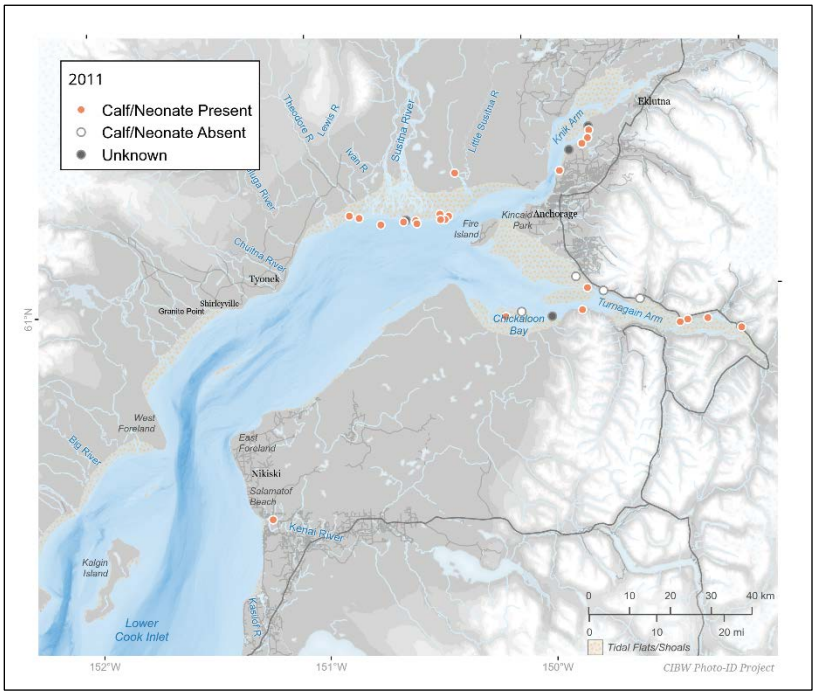


Figure 63. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2011.

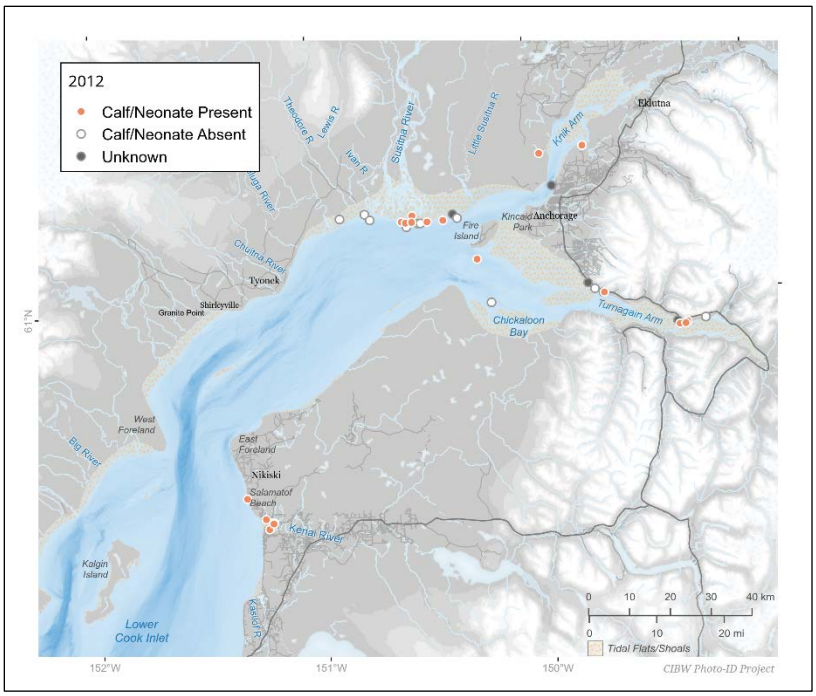


Figure 64. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2012.

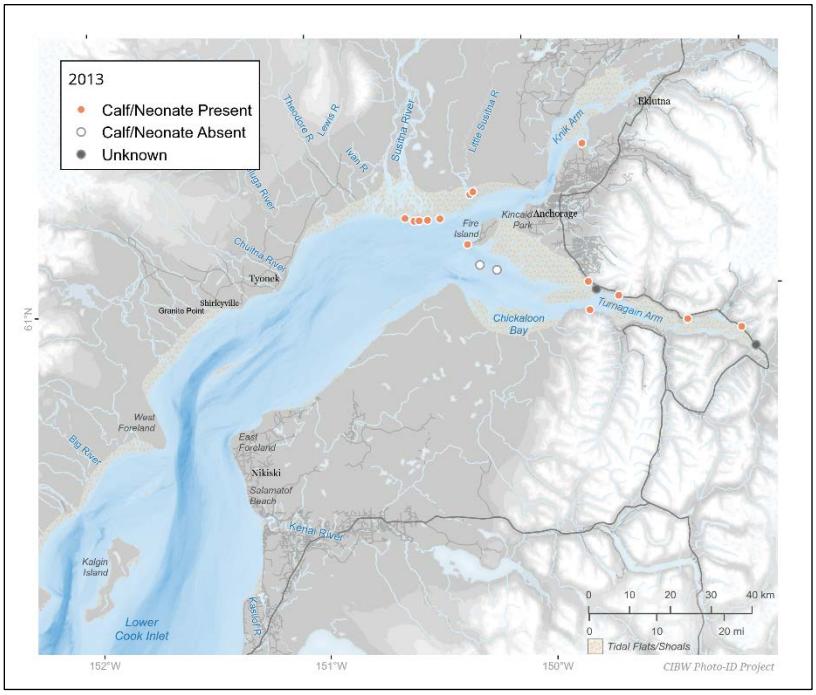


Figure 65. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2013.

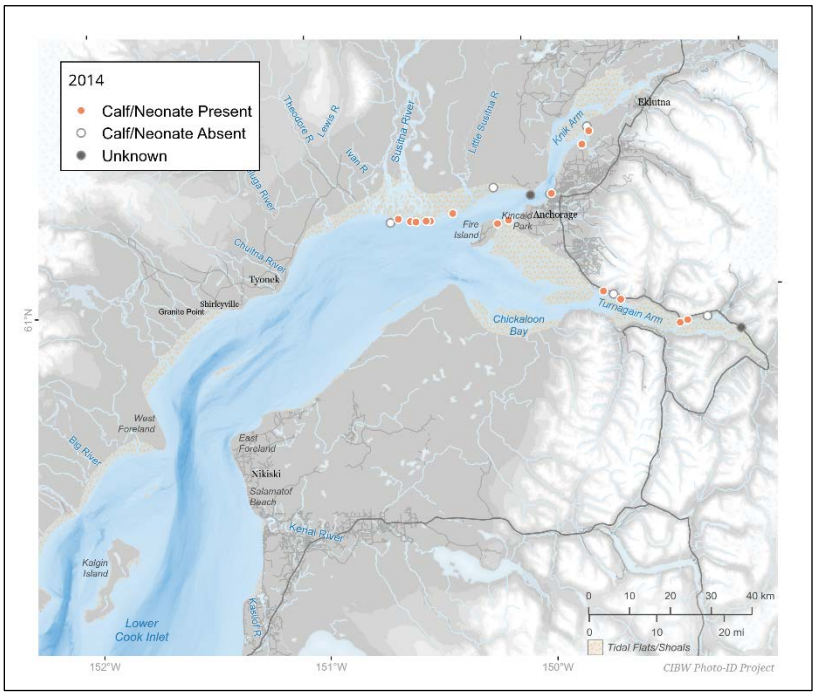


Figure 66. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2014.

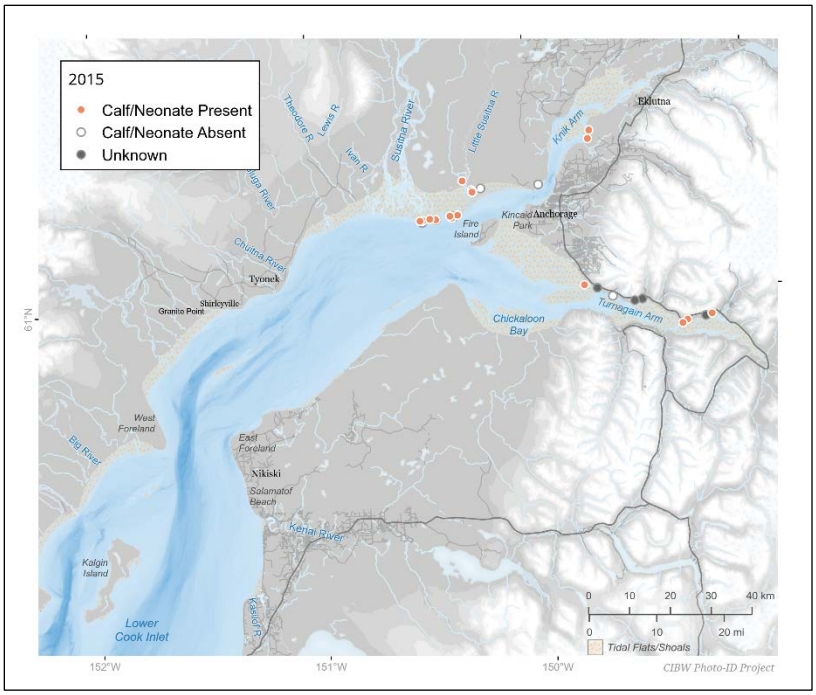


Figure 67. Location of groups with and without calves and/or neonates encountered during photo-id surveys conducted in 2015.

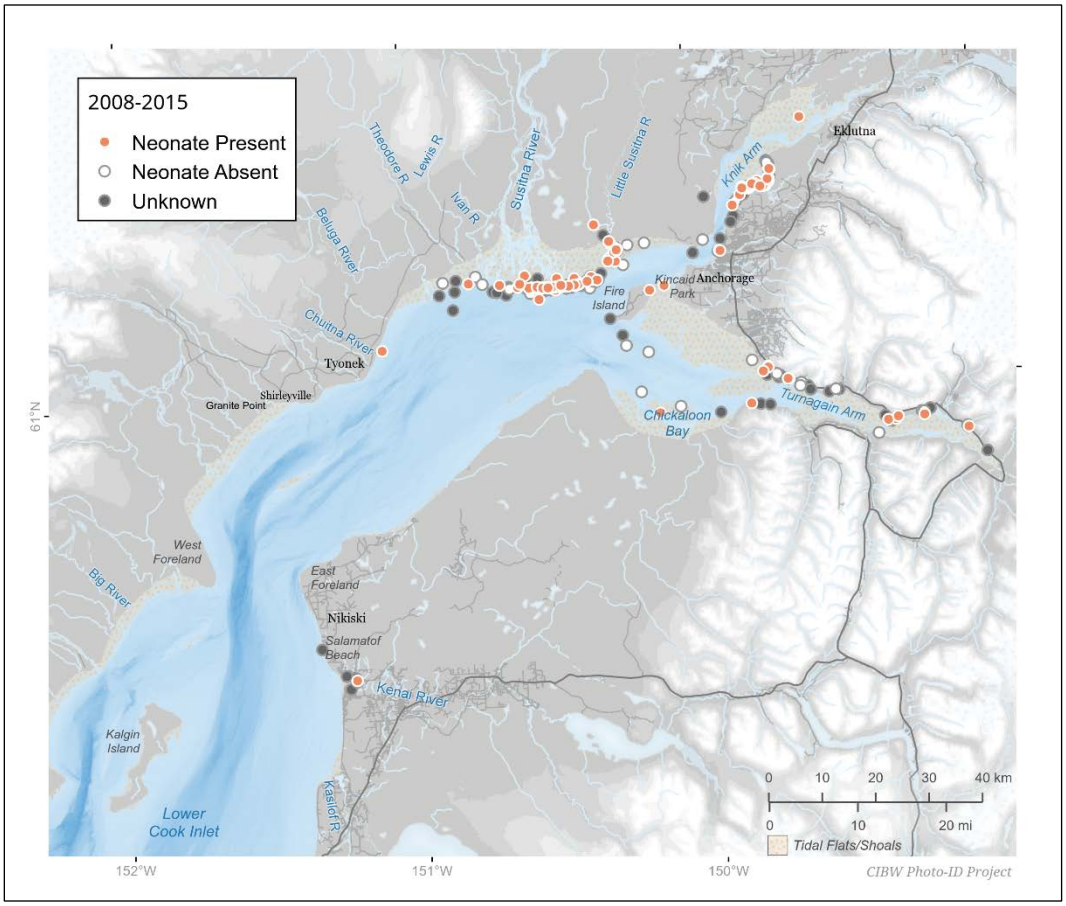


Figure 68. Location of groups with and without neonates encountered during photo-id surveys conducted 2008-2015. The group at the mouth of the Chuitna River was observed in 2005, before neonates were recorded separately from calves, but it is included here because a neonate is clearly visible in photographs taken of this group.

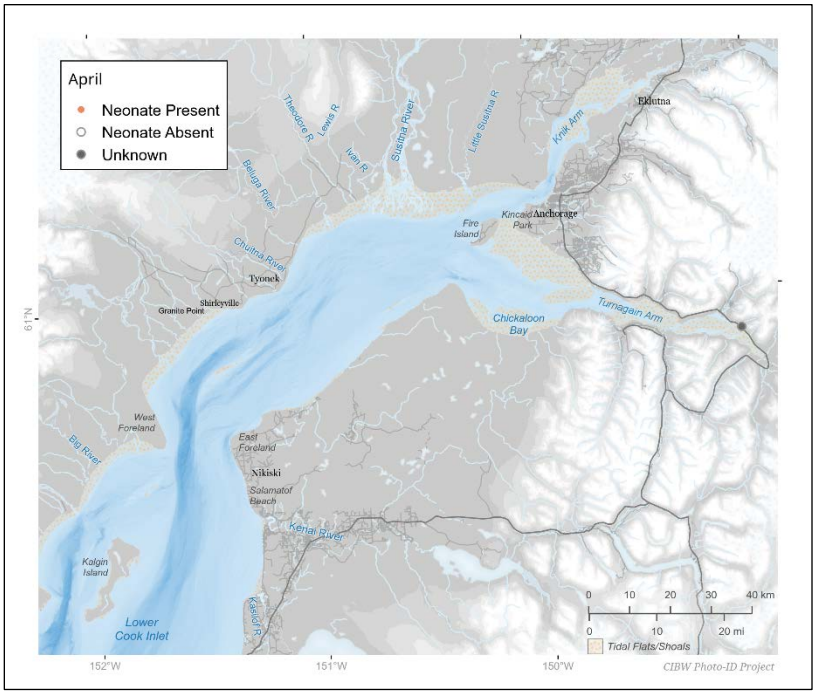


Figure 69. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of April 2008-2015.

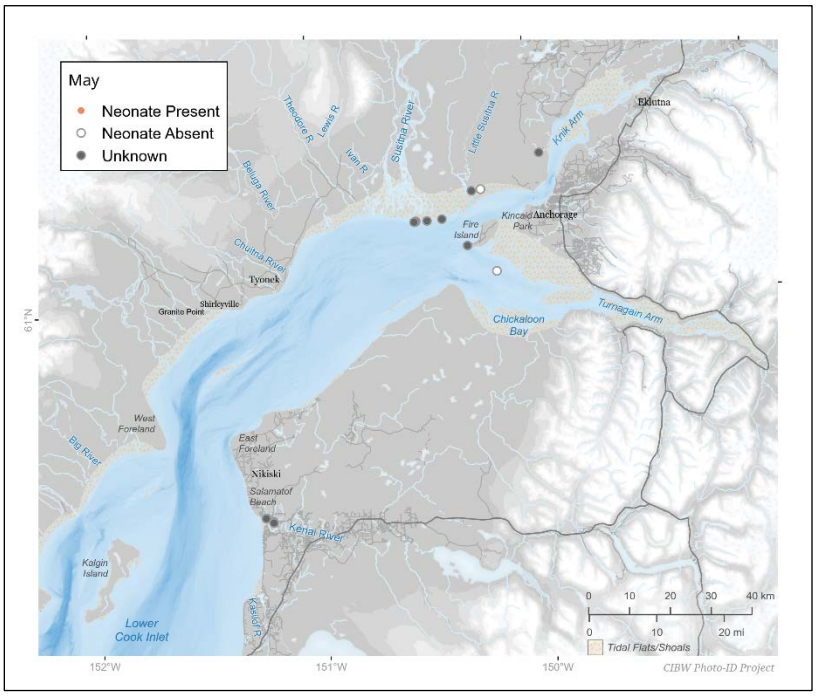


Figure 70. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of May 2008-2015.

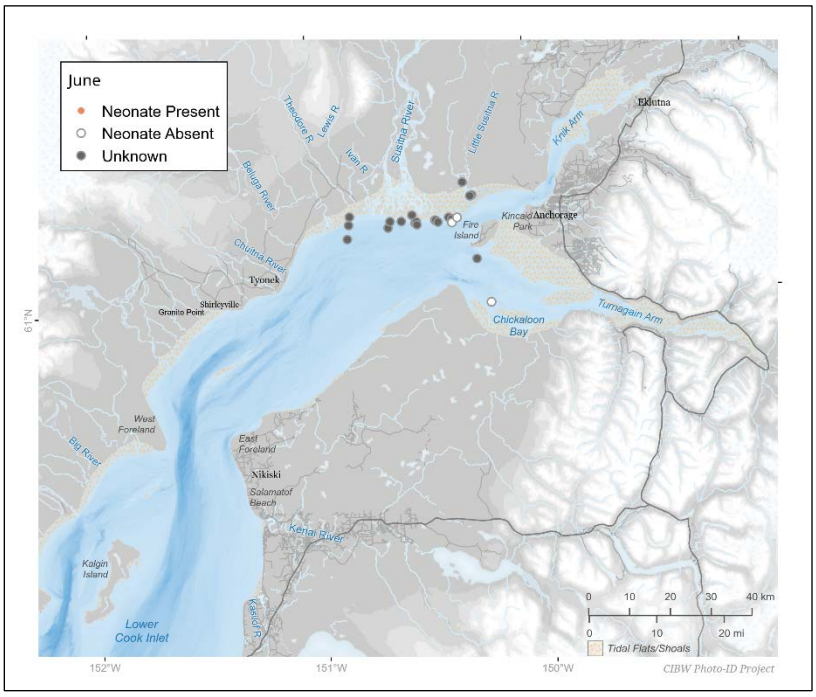


Figure 71. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of June 2008-2015.

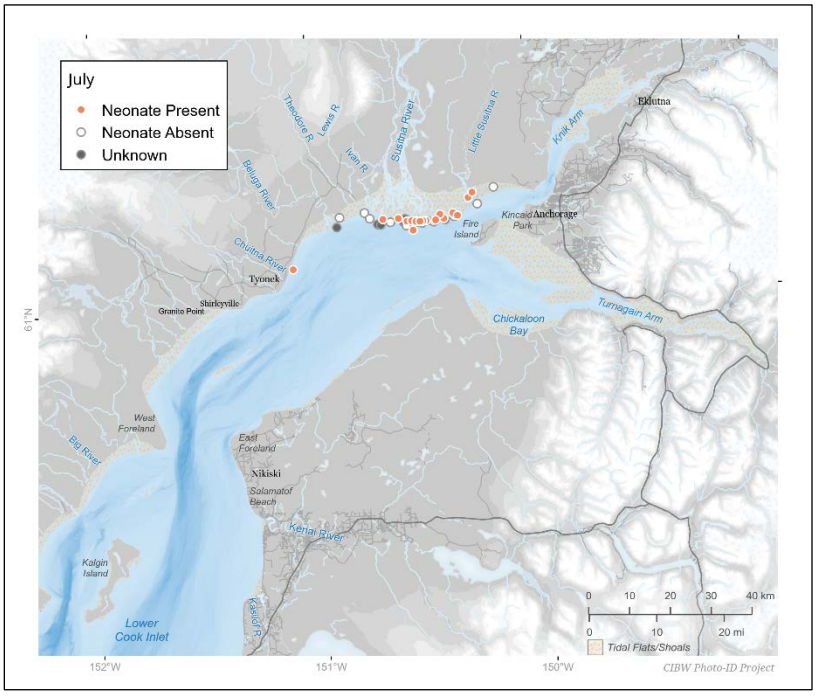


Figure 72. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of July 2008-2015. The group at the mouth of the Chuitna River was observed in 2005, before neonates were recorded separately from calves, but it is included here because a neonate is clearly visible in photographs taken of this group.

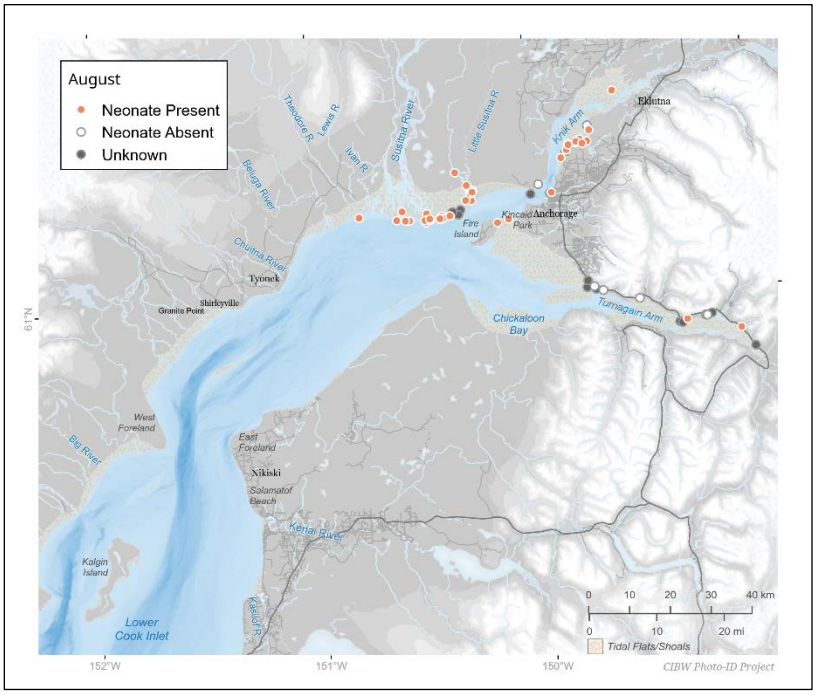


Figure 73. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of August 2008-2015.

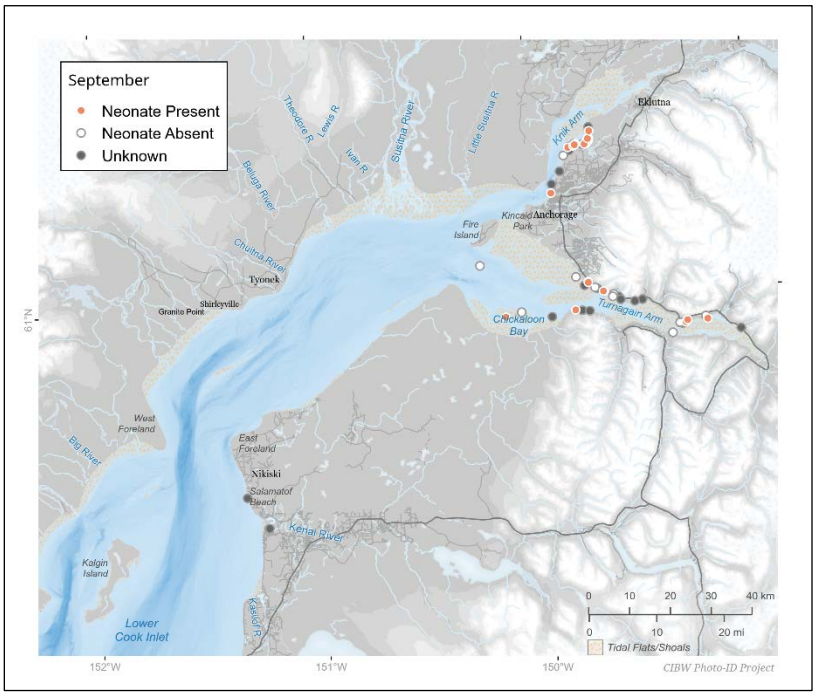


Figure 74. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of September 2008-2015.

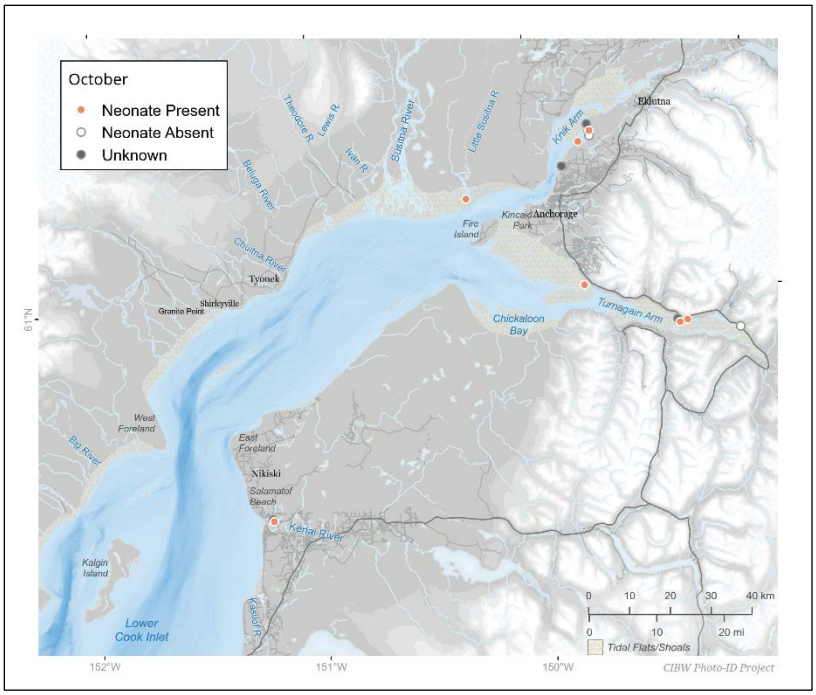


Figure 75. Location of groups with and without neonates encountered during photo-id surveys conducted in the month of October 2008-2015.

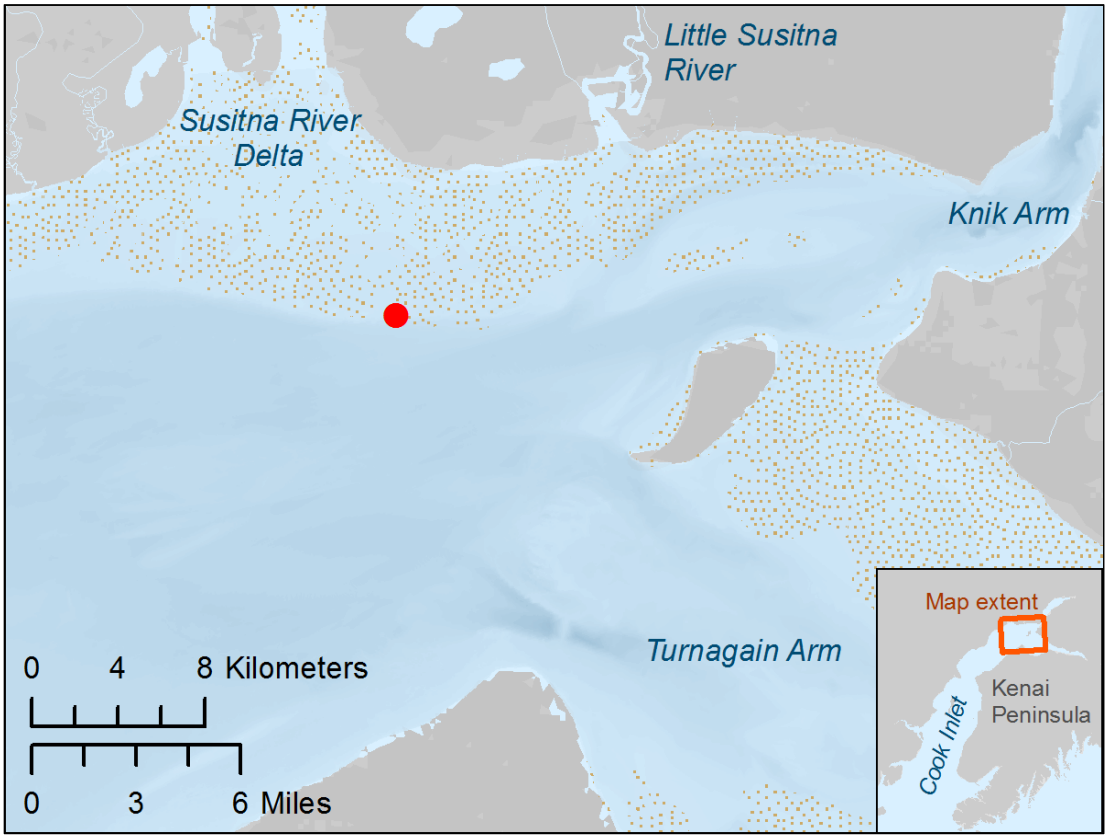


Figure 76. Map showing location of CIBW birth observed and photographed July 20, 2015, Susitna River Delta, Upper Cook Inlet, Alaska.

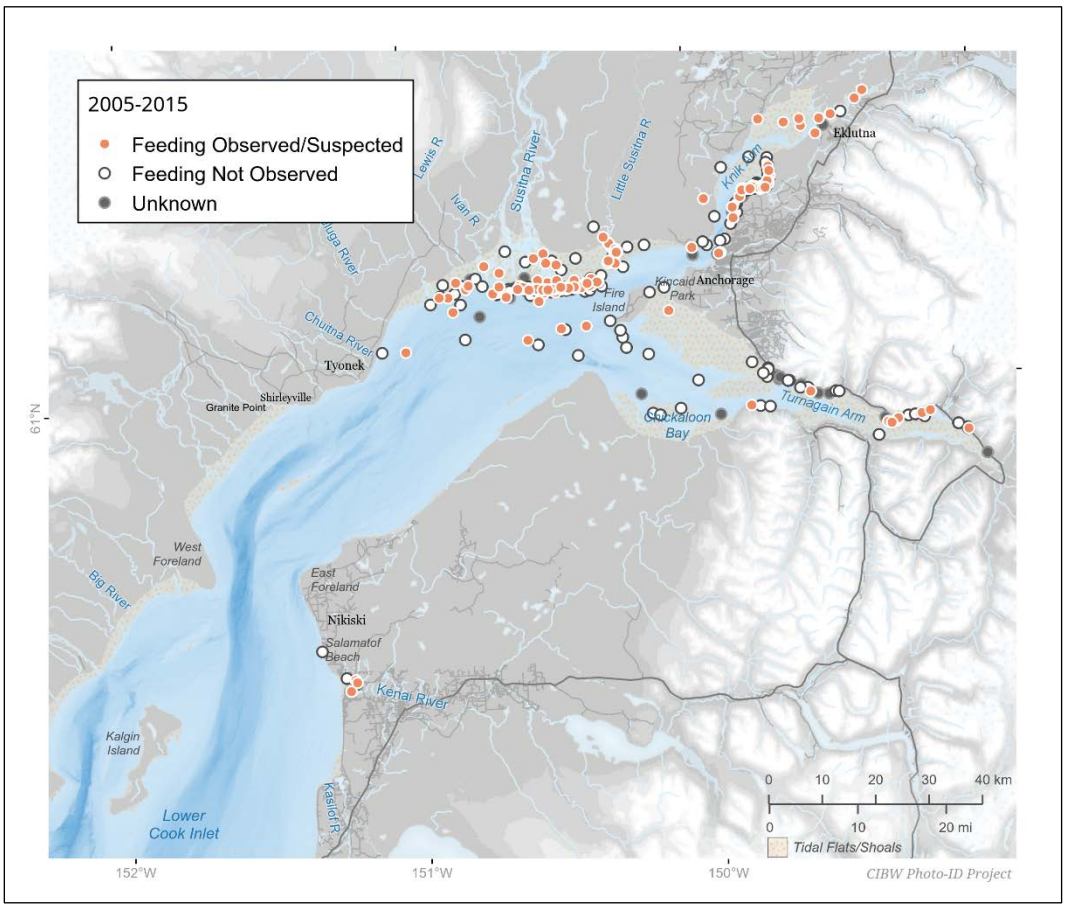


Figure 77. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted 2005-2015.

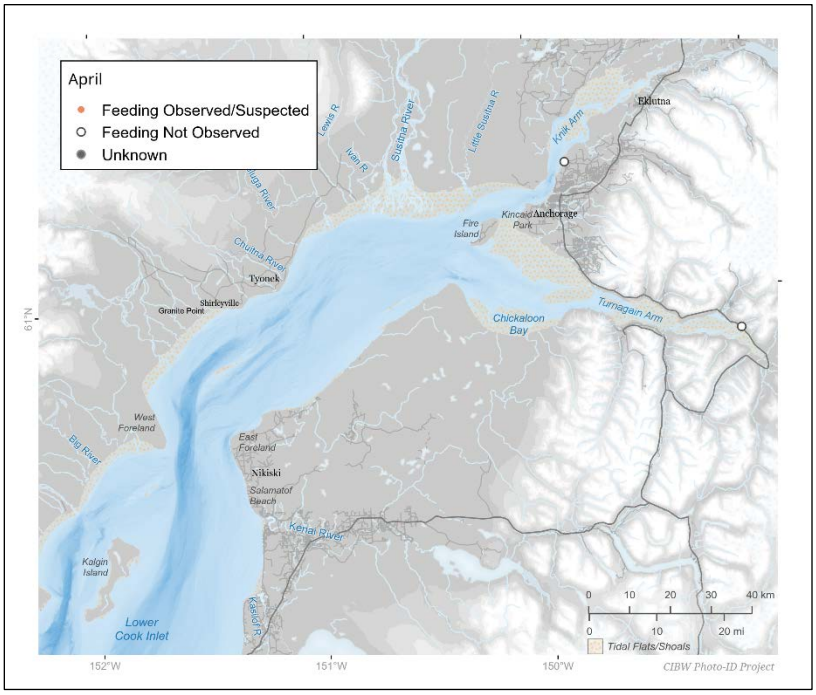


Figure 78. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of April 2005-2015.

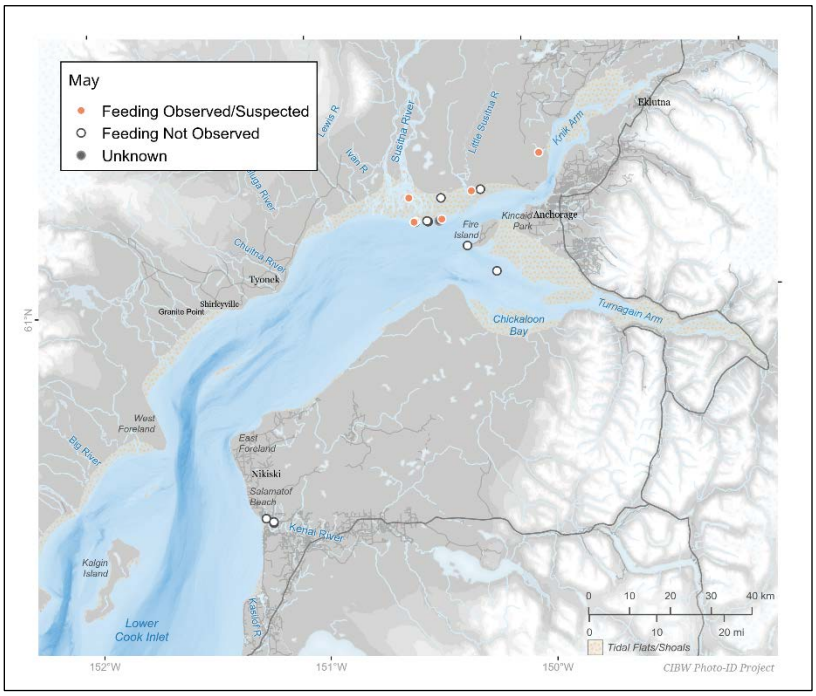


Figure 79. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of May 2005-2015.

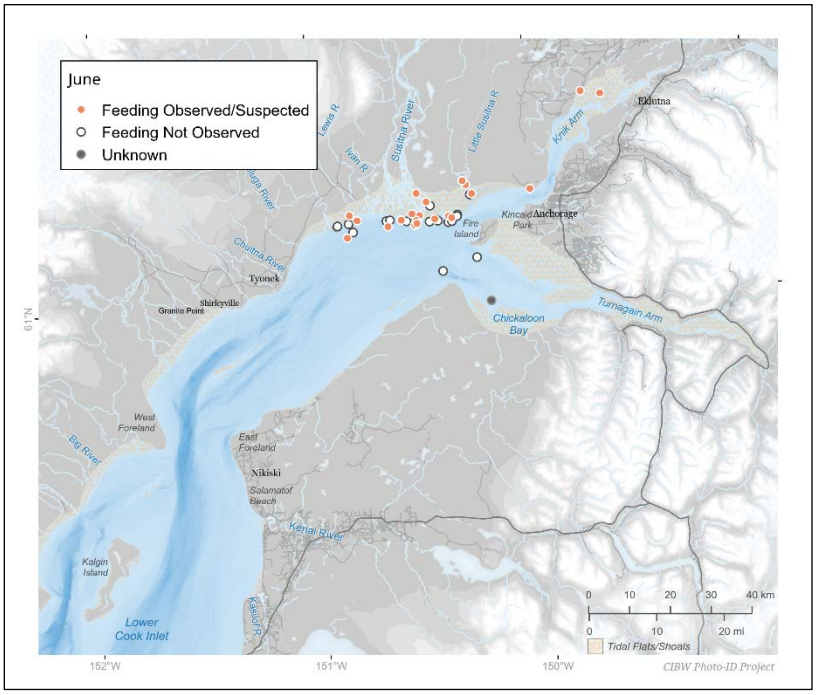


Figure 80. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of June 2005-2015.

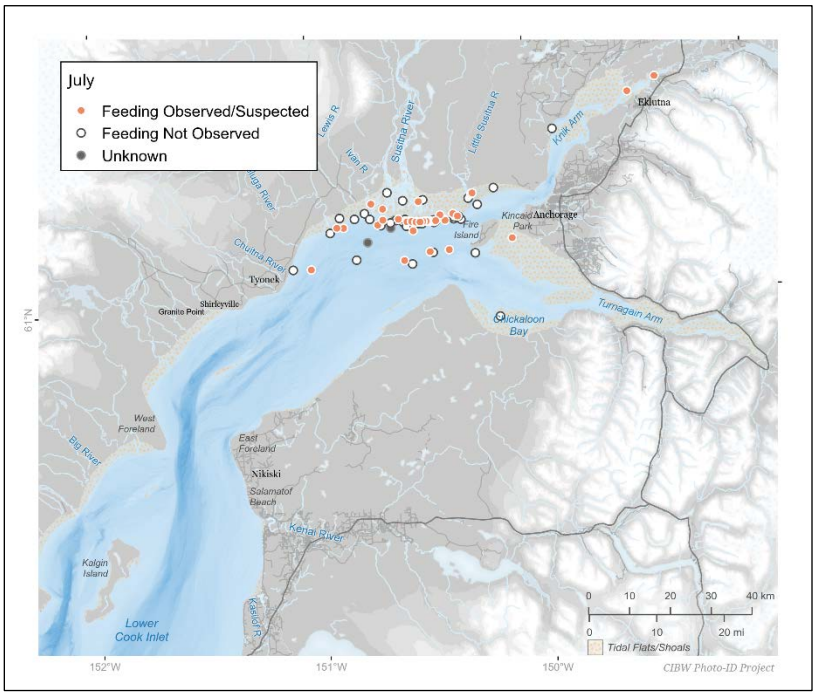


Figure 81. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of July 2005-2015.

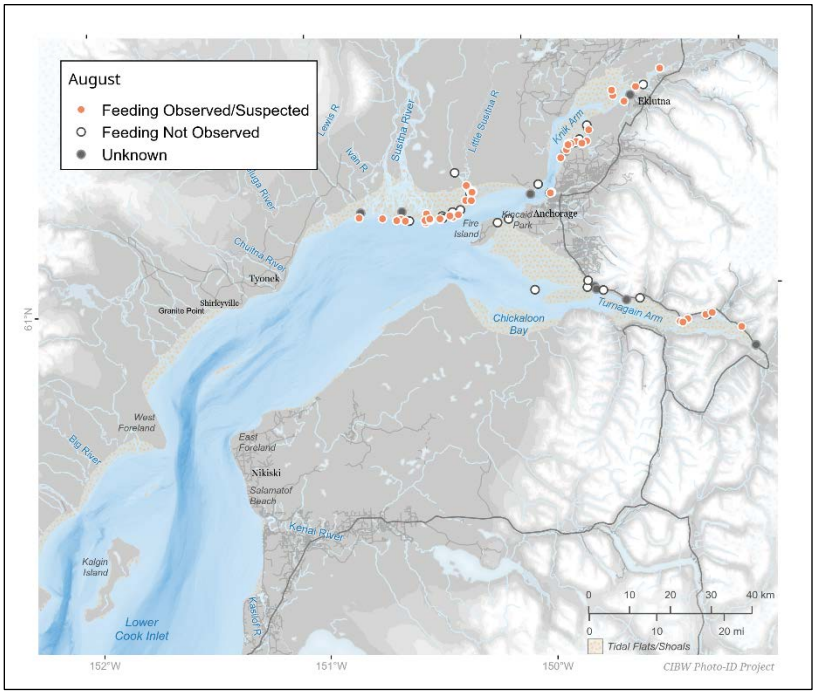


Figure 82. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of August 2005-2015.

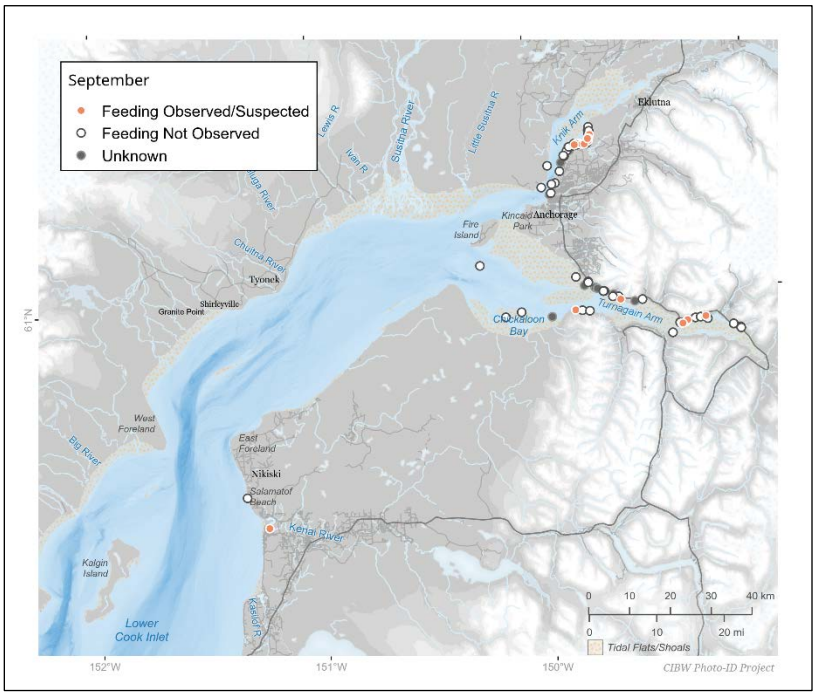


Figure 83. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of September 2005-2015.

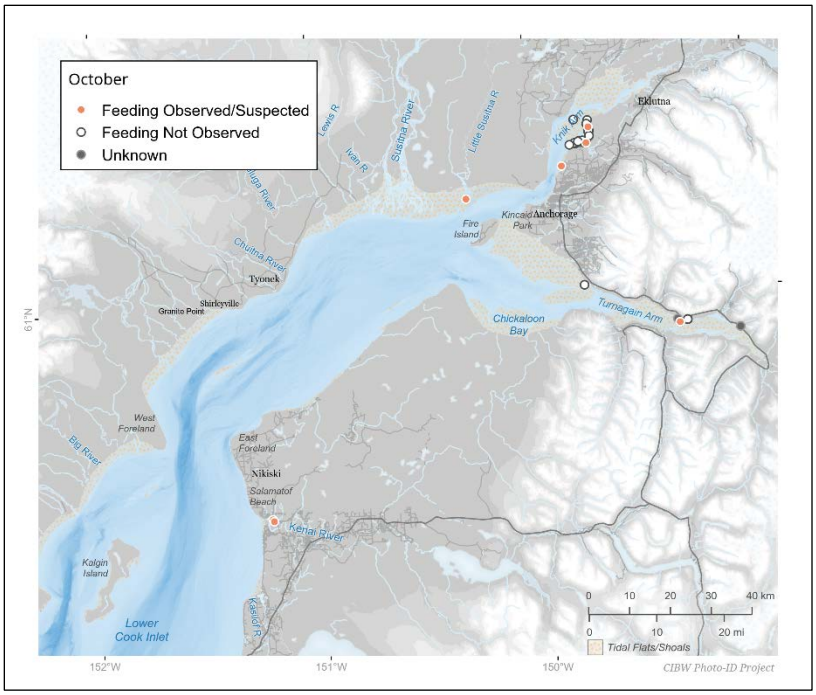


Figure 84. Location of groups with and without observations of feeding behavior (suspected or confirmed) during photo-id surveys conducted in the month of October 2005-2015.

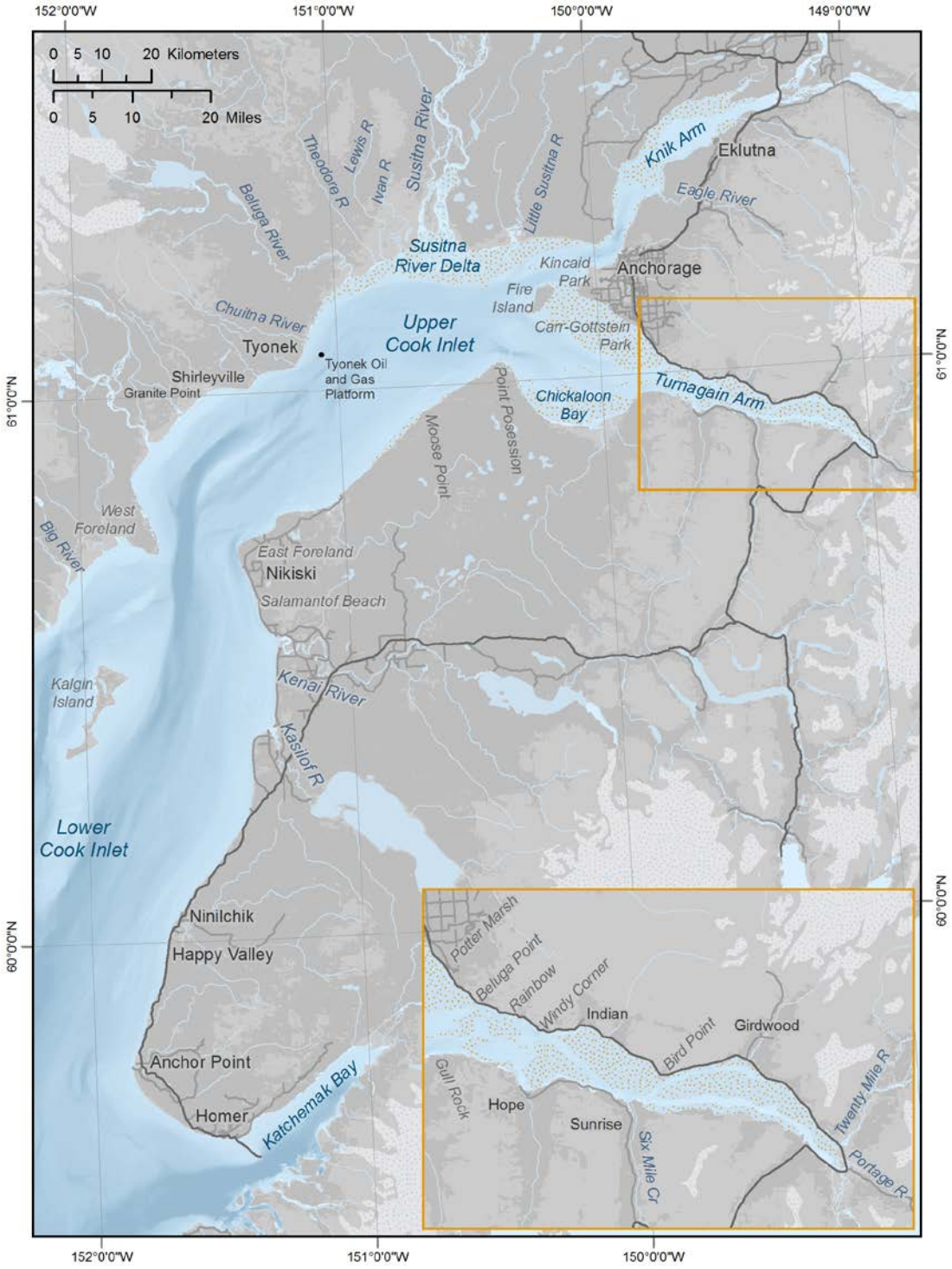


Figure 85. Map showing place names given in stranded and incidental sighting reports for Cook Inlet beluga whales.

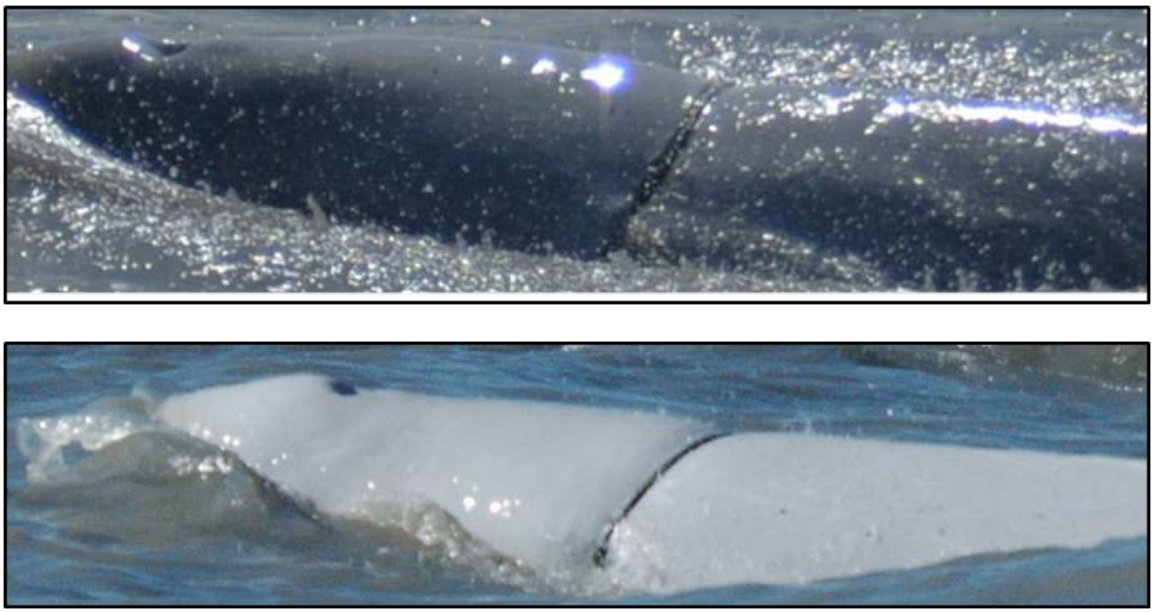


Figure 86. Left-side photographs of an entangled beluga whale, R3846/L804, during the 2005-2015 field season in Cook Inlet, Alaska. Whale color differences are due to different ambient lighting conditions. The whale identification was confirmed by matching scars on the whale's body that are visible in the photo-processing program. This whale was not seen before 2010 or after 2013.

Figure 87. An unidentified entangled beluga whale seen in 2005 in Eagle Bay. This whale was only seen on one occasion, and the object causing the entanglement remains unknown. The top image is of the right side, and the bottom image is of the left side.

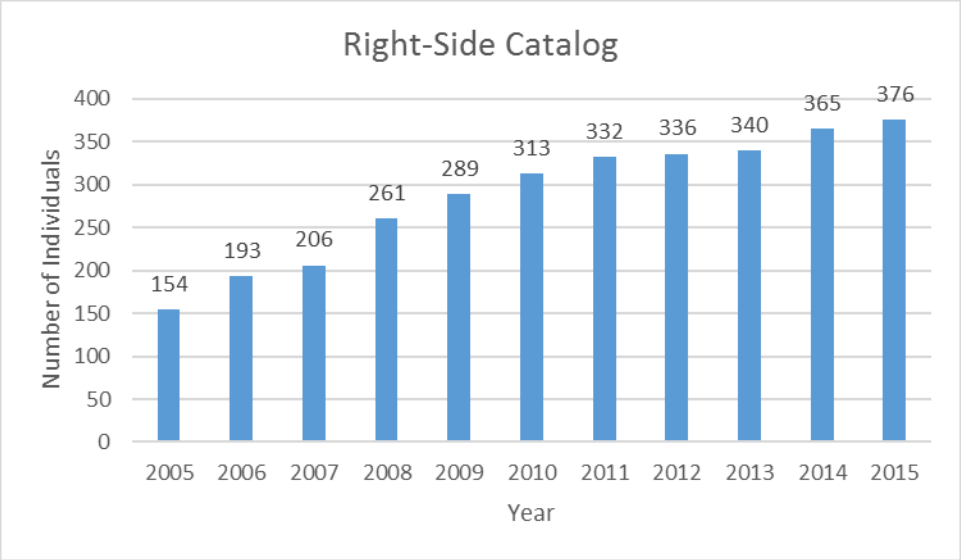


Figure 88. The number of identified individual whales in the right-side catalog, according to the year of the photo-identification study. There were 154 individuals identified in the first year of the catalog, and by 2015 the catalog contained 376 individuals.

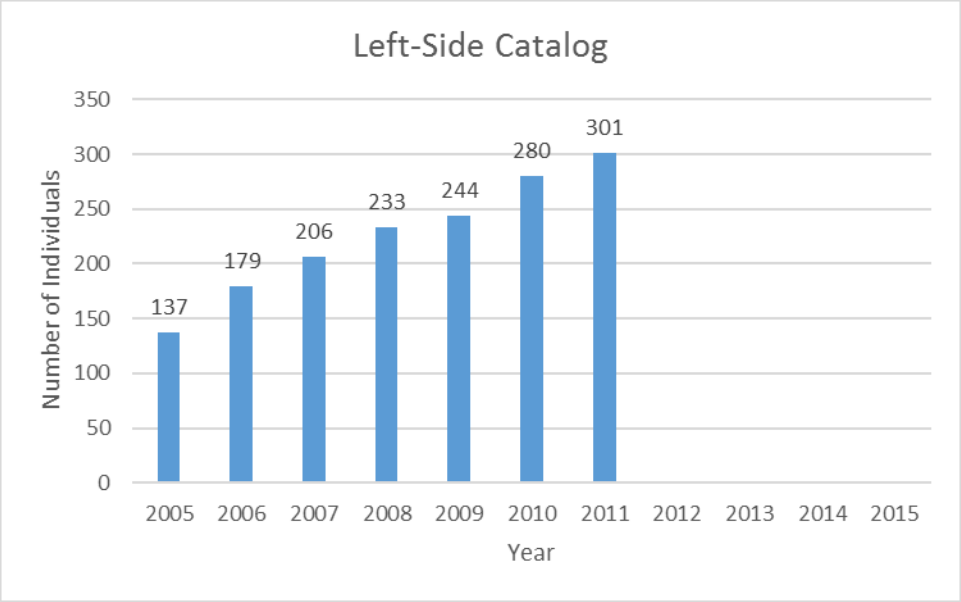
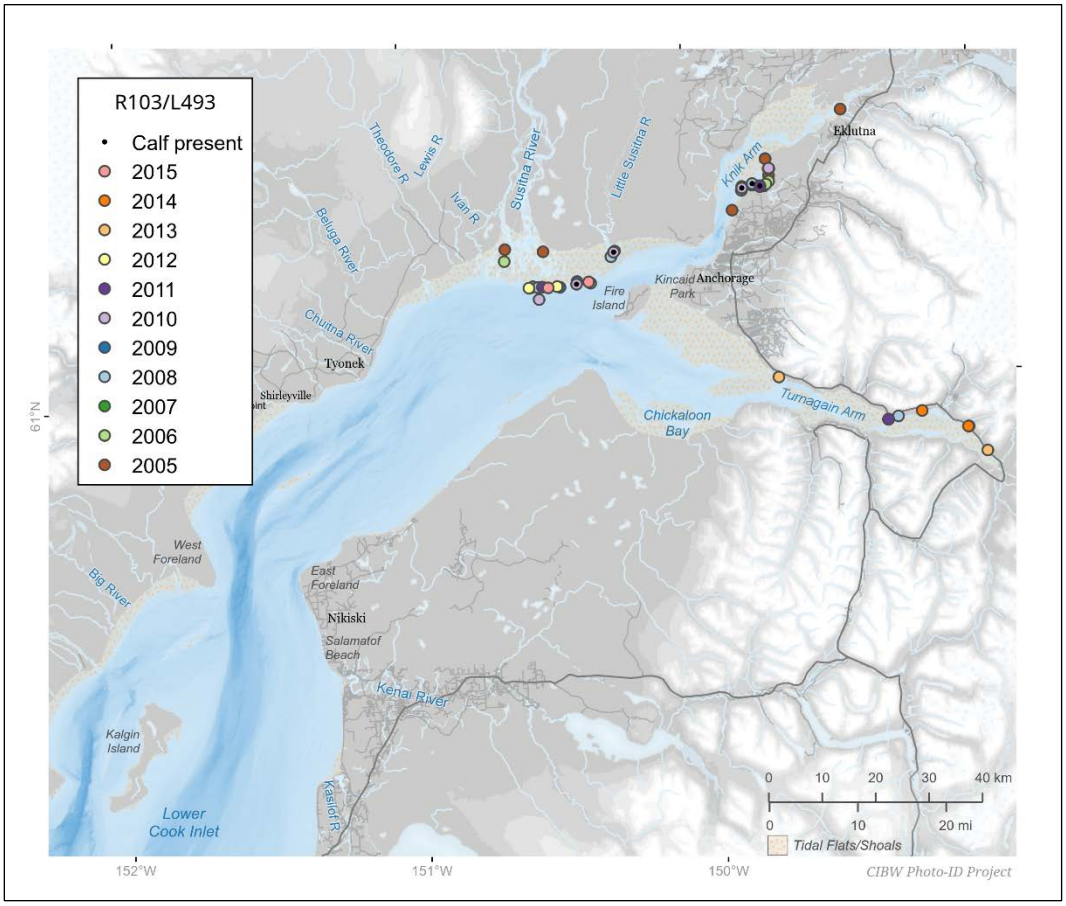


Figure 89. The number of identified individual whales in the left-side catalog, according to the year of the photo-identification study. (Cataloging of photos after 2011 is in progress).



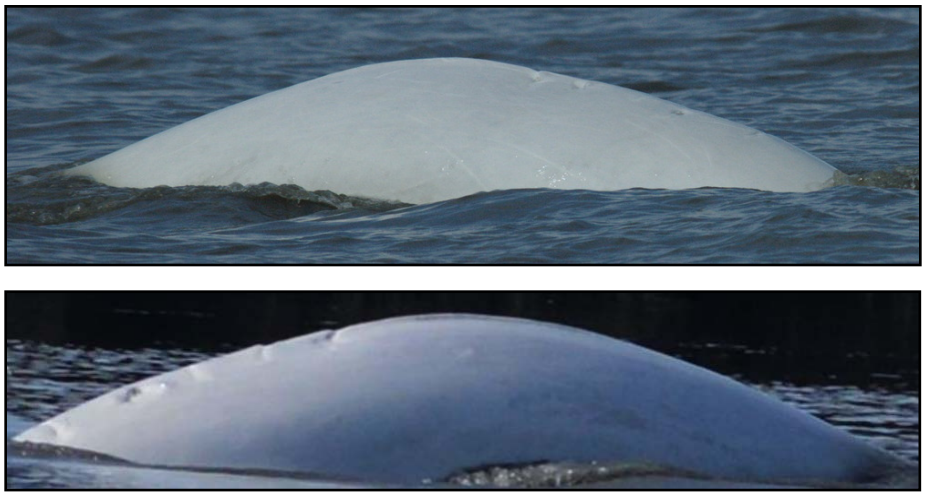


Figure 90. Sighting history and photographs of beluga R103/L493. This whale was photographed in every year of the 2005-2015 study. This whale was tagged by NMFS on August 15, 2001 during their satellite tagging study, and was determined to be a female. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).

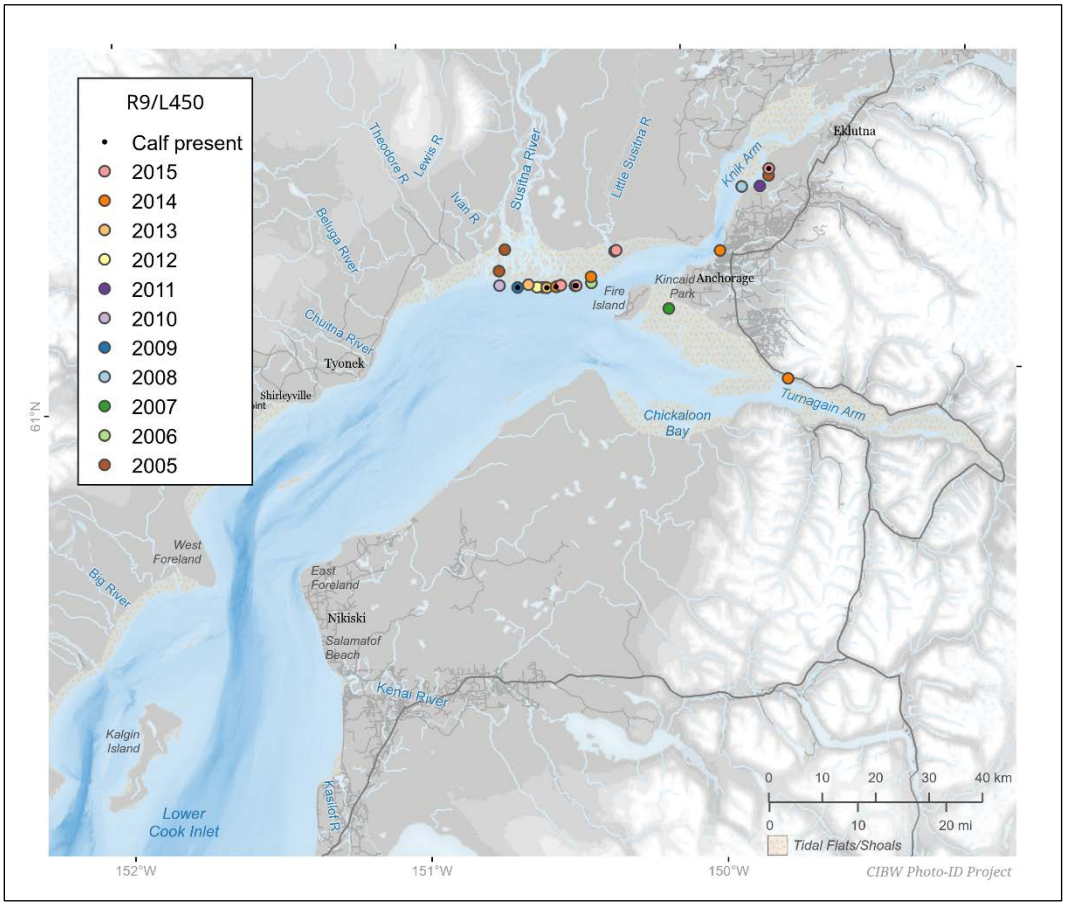
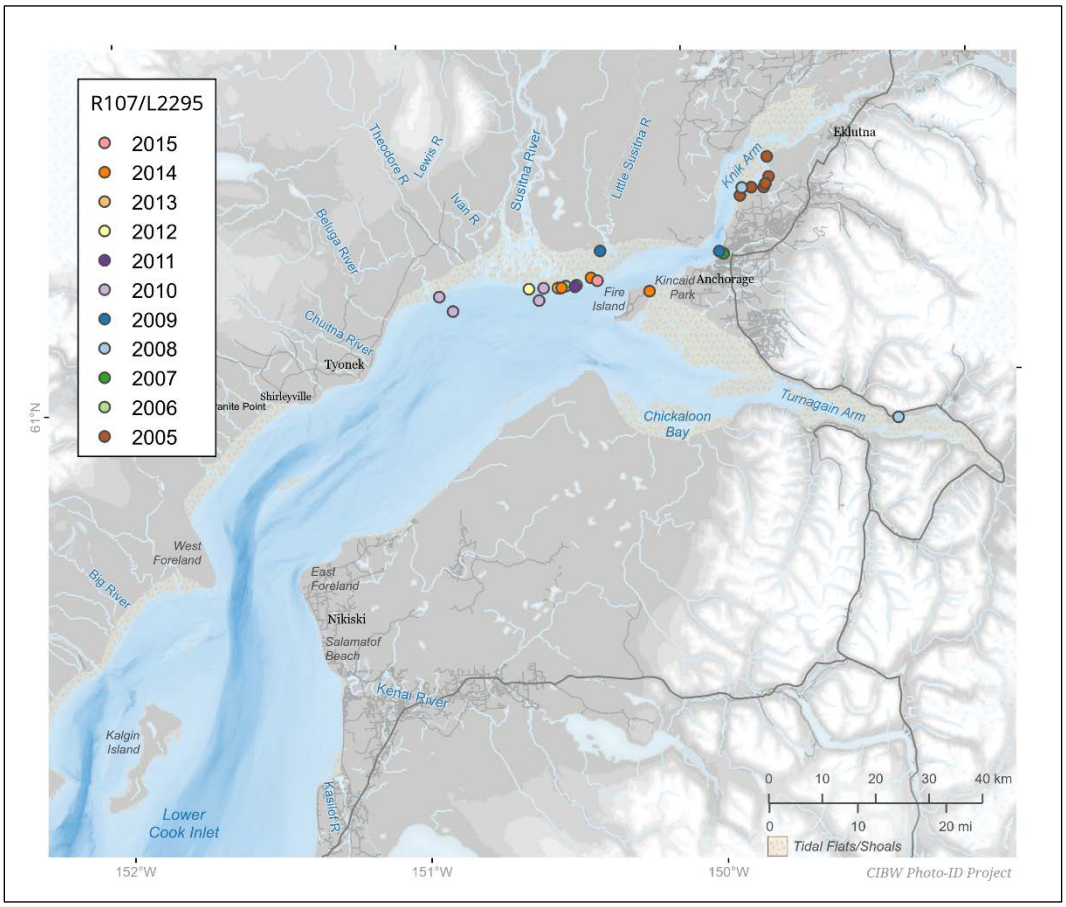


Figure 91. Sighting history of beluga R9/L450. This whale was photographed in every year of the 2005-2015 study. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).



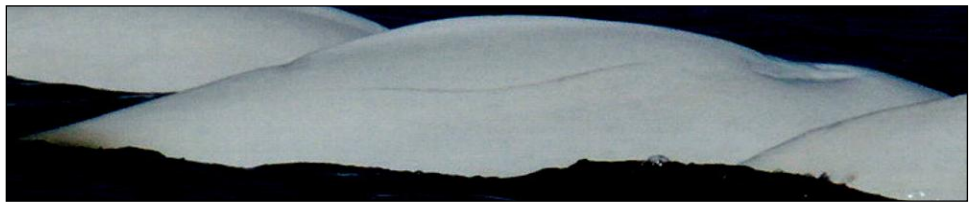


Figure 92. Sighting history of beluga R107/L2295. This whale was photographed in every year of the 2005-2015 study. (Top photo is of the right side; bottom photo is of the left side).

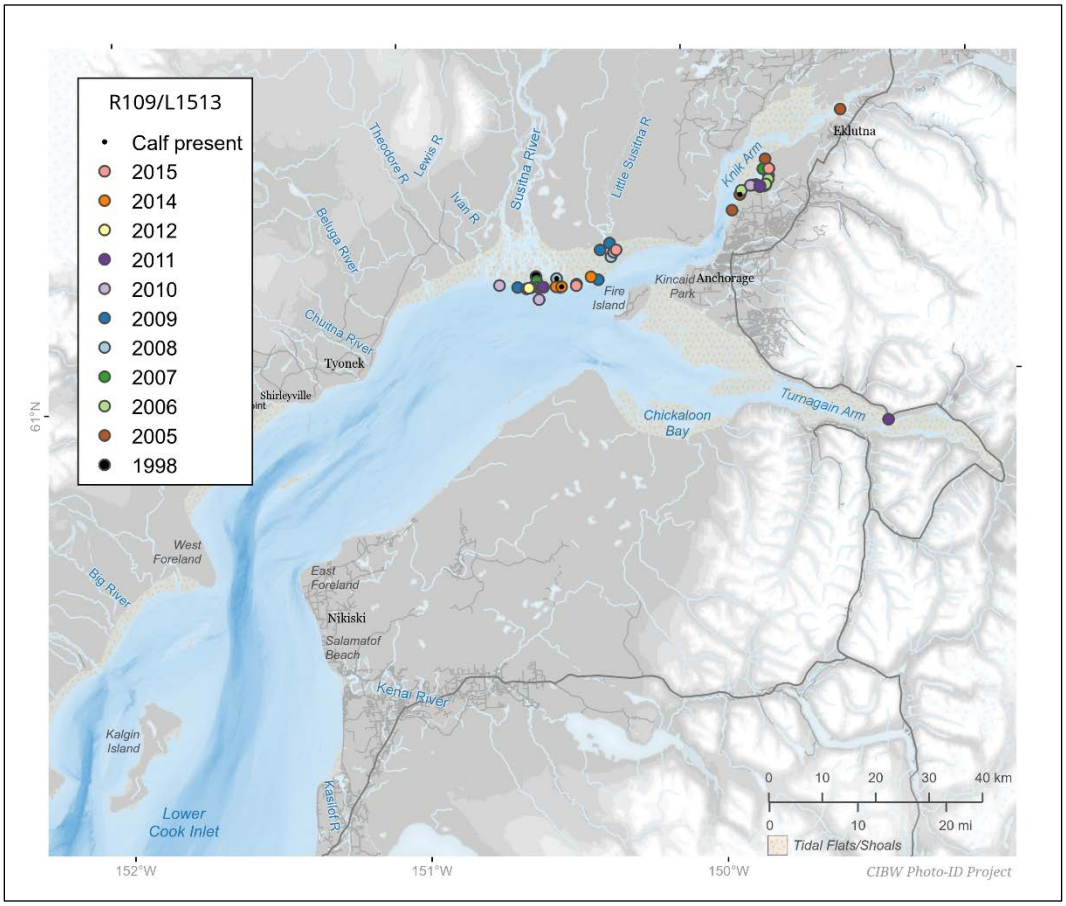


Figure 93. Sighting history of beluga R109/L1513. This whale was first photographed in 1998 by NMFS, indicating it was at least 17 years old when it was last photographed in 2015. This whale is a presumed mother based on photos with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).

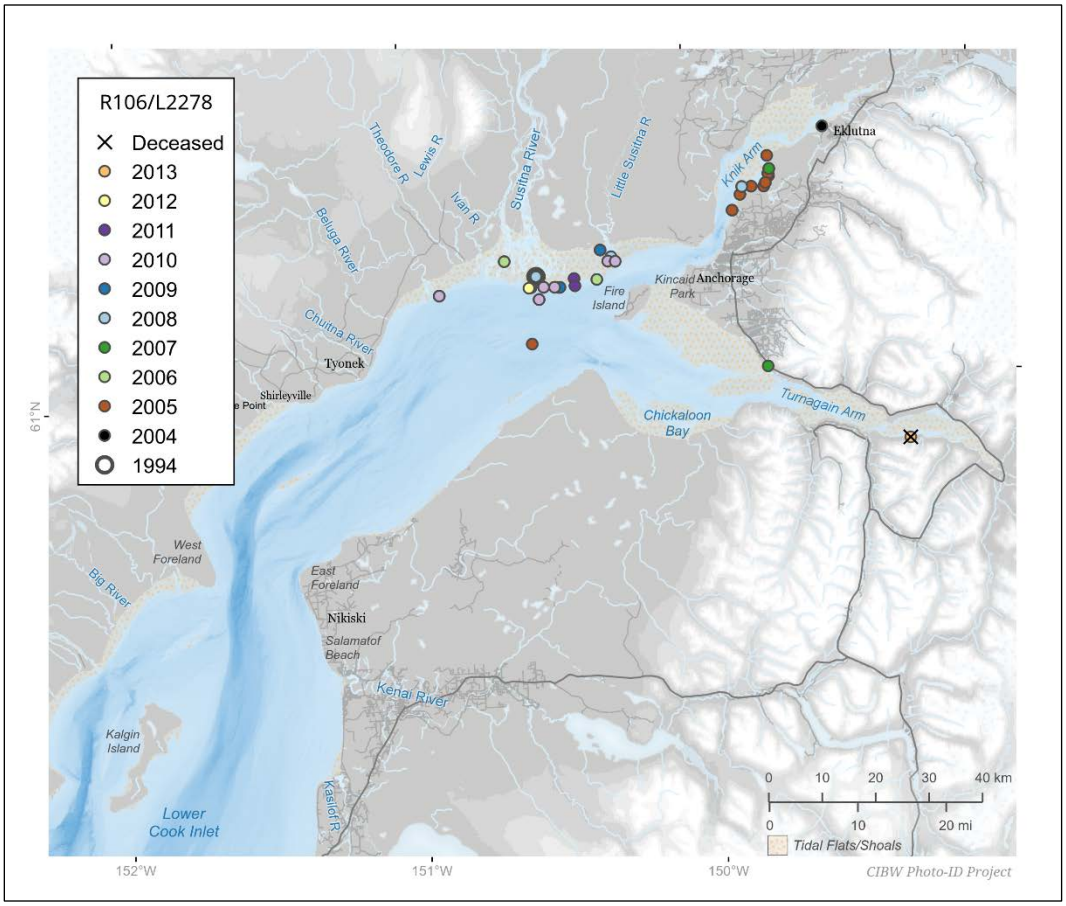


Figure 94. Sighting history and photographs of beluga R106/L2278. This male was first photographed in 1994 by NMFS. It was found dead in Turnagain Arm in 2013, and would have been at least 19 years old, based on its sighting history. (Top photo is of the right side; bottom photo is of the left side).

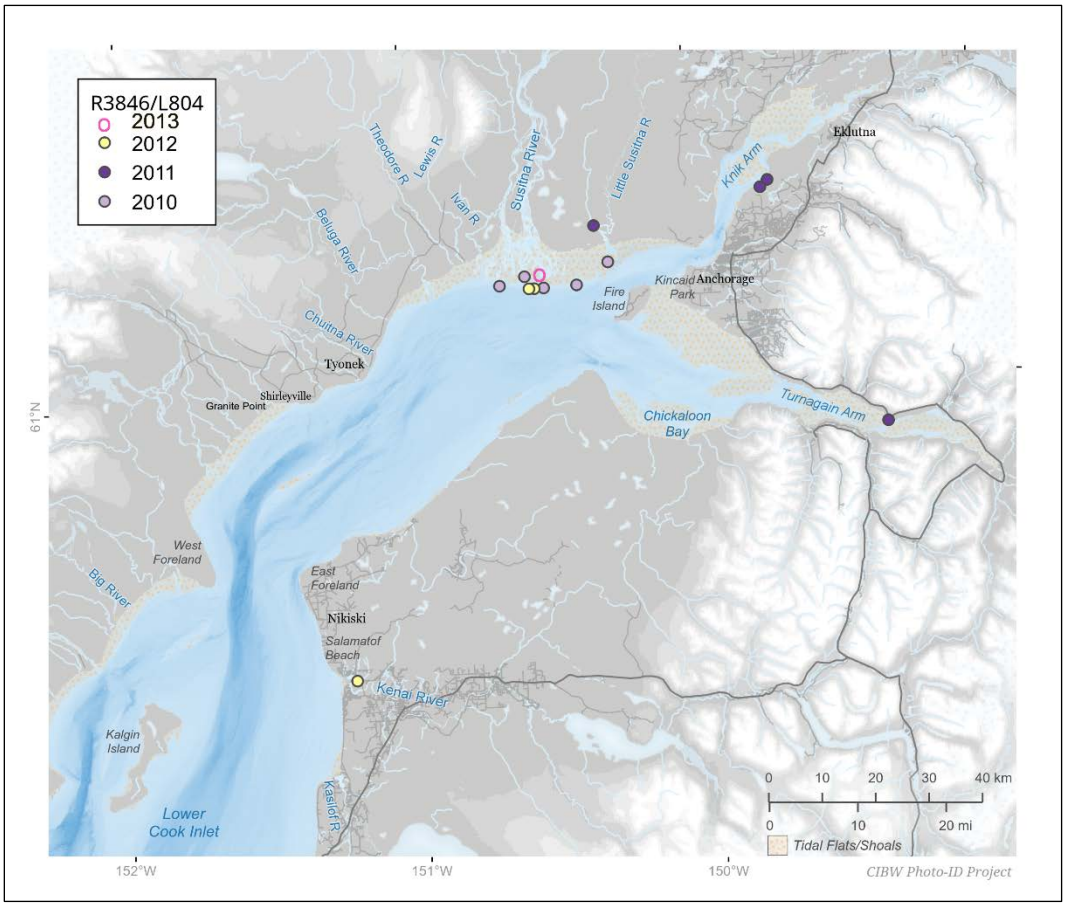


Figure 95. Sighting history and photographs of beluga R3846/L804. This entangled whale was first photographed in 2010 and last photographed in 2013. (Top photo is of the right side; bottom photo is of the left side).

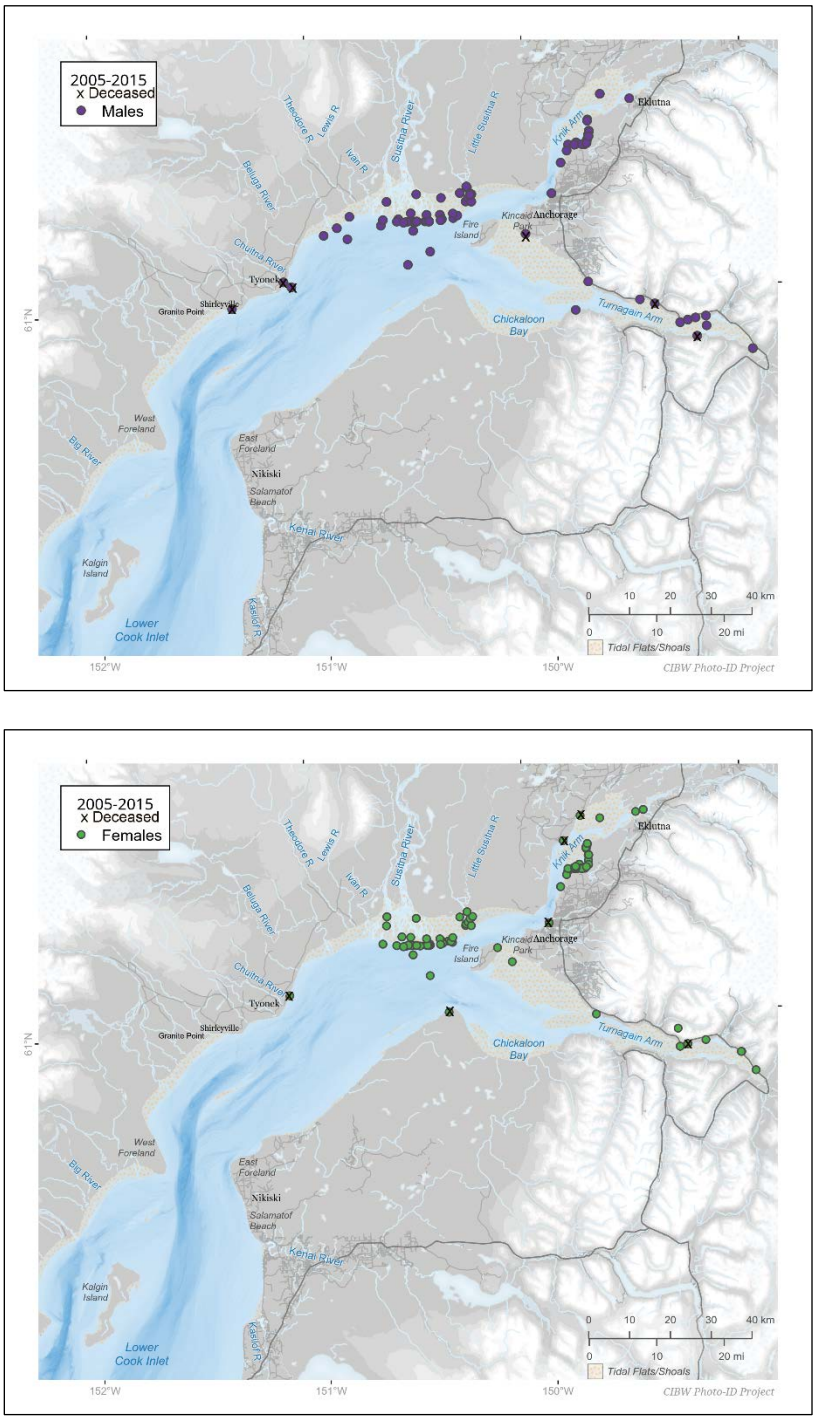


Figure 96. Locations of all confirmed males (top) and all confirmed females (bottom) photographed during the 2005-2015 photo-id surveys.

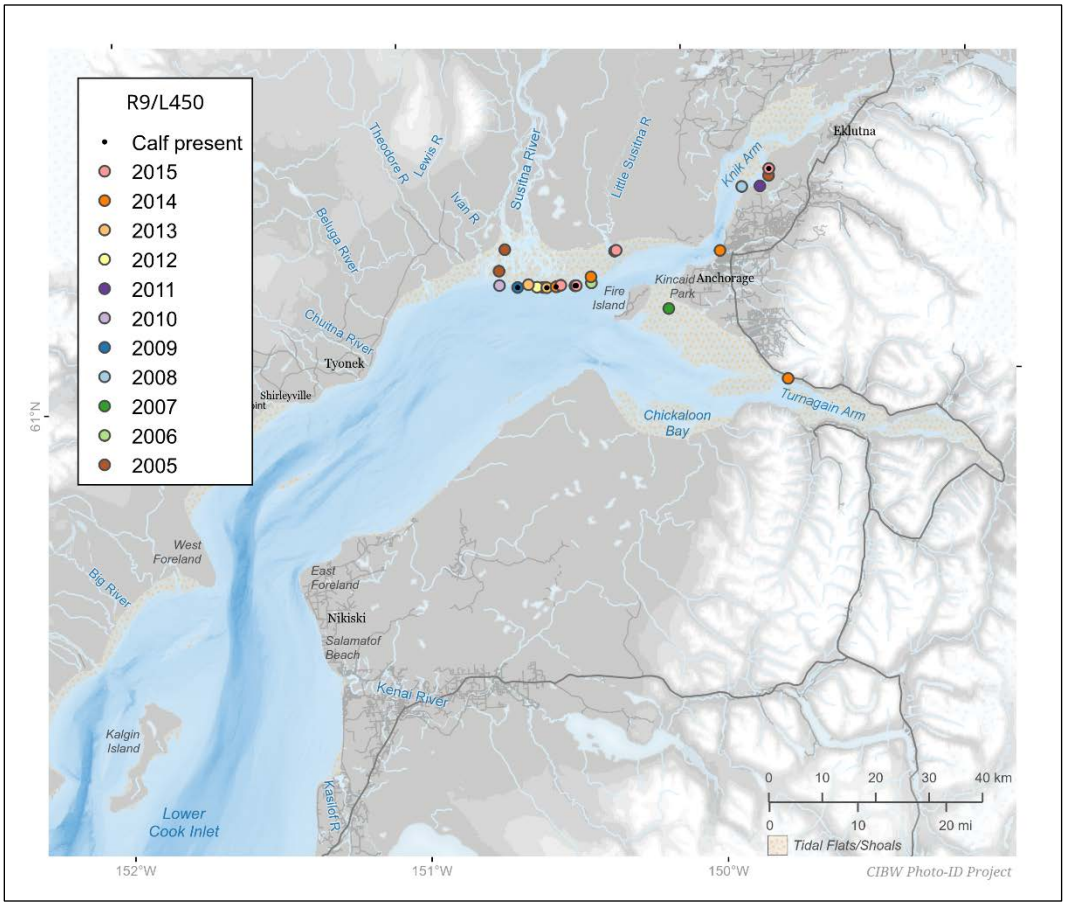


Figure 97. Sighting history and photographs of beluga R9/L450. This whale was photographed in every year of the 2005-2015 study. This whale is a presumed mother based on photos with an accompanying calf in 2007, 2009, 2010, 2011, 2013, 2014, and 2015. (Top photo is of the right side with a calf; bottom photo is of the left side with a calf).

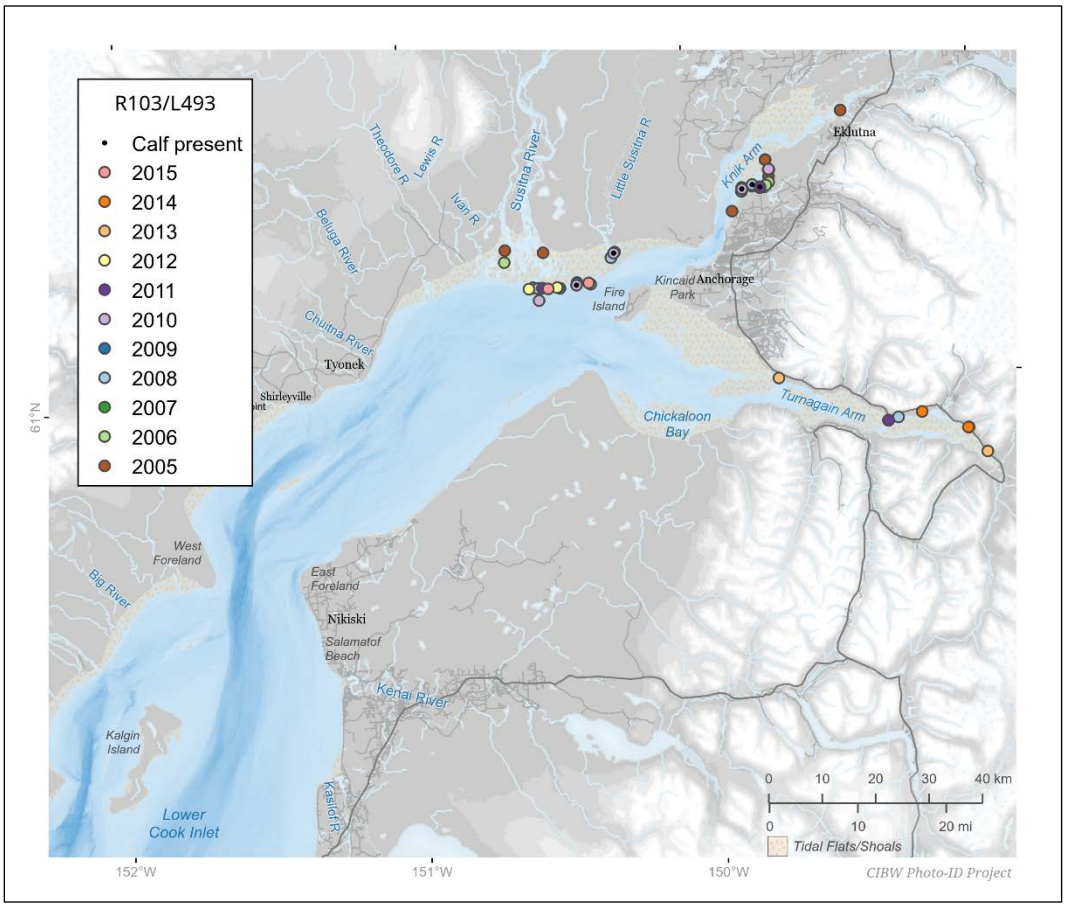


Figure 98. Sighting history and photographs of beluga R103/L493. This whale was photographed in every year of the 2005-2015 study. This whale was tagged by NMFS on August 15, 2001 during their satellite tagging study. R103/L493 is a presumed mother based on photographs with an accompanying calf in 2008, 2010, and 2011. (Top photo is of the right side with a calf; bottom photo is of the left side).

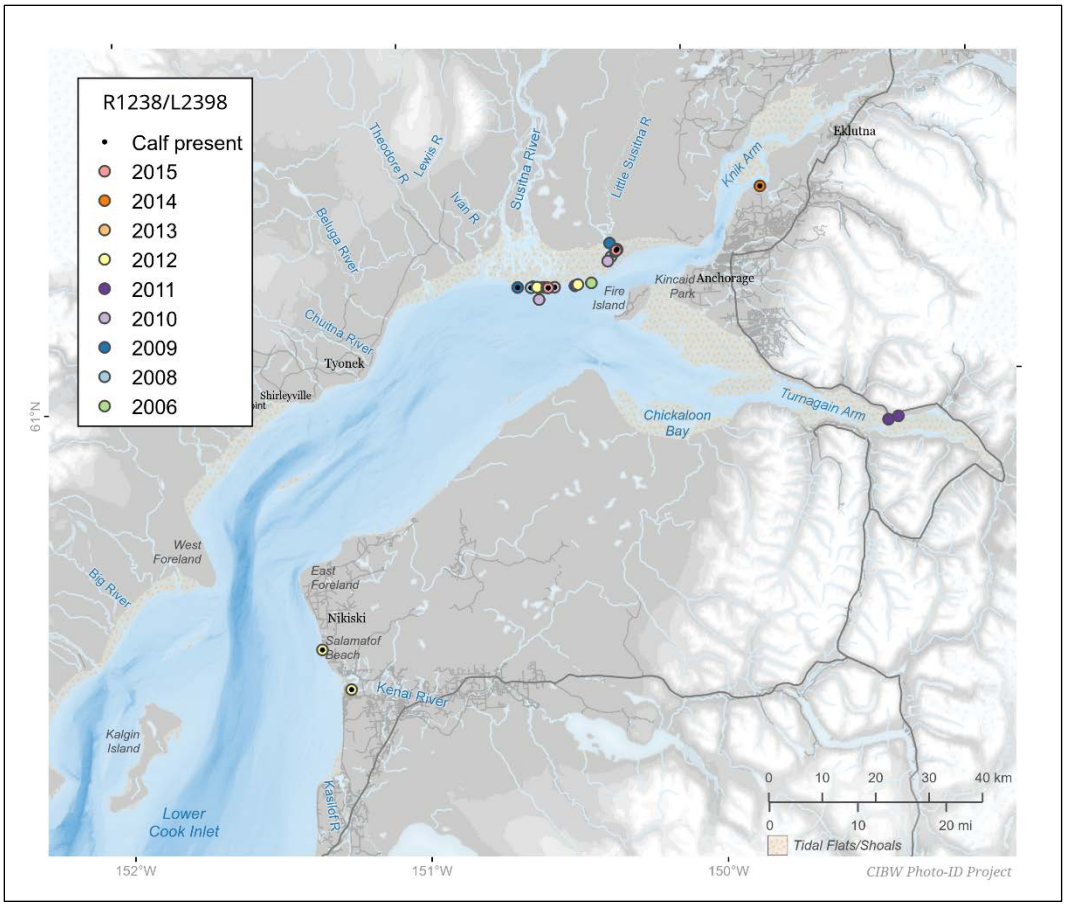
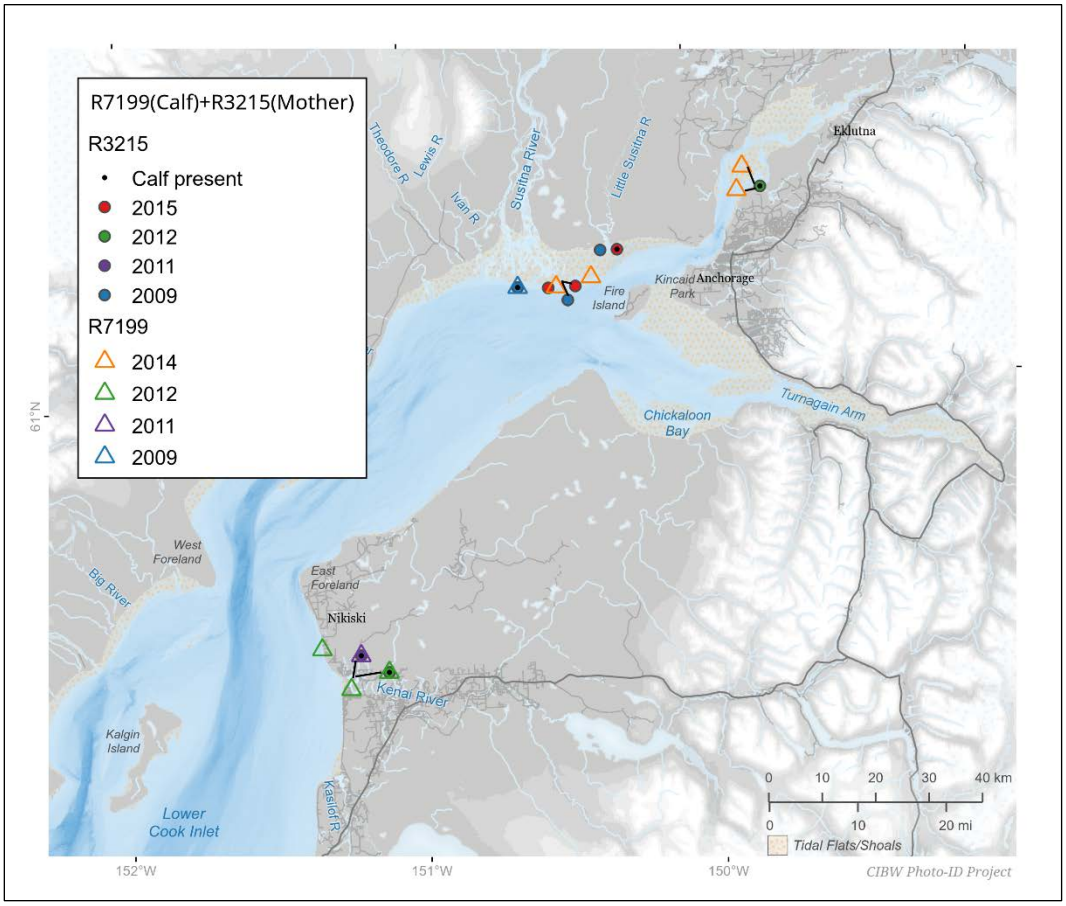


Figure 99. Sighting history and photographs of beluga R1238/L2398. This whale is a presumed mother based on photos with an accompanying calf in 2008, 2009, 2010, 2011, 2012, 2013, 2014, and 2015. (Top photo is of the left side with a neonate in 2010; bottom photo is of the right side with a different neonate in 2014).



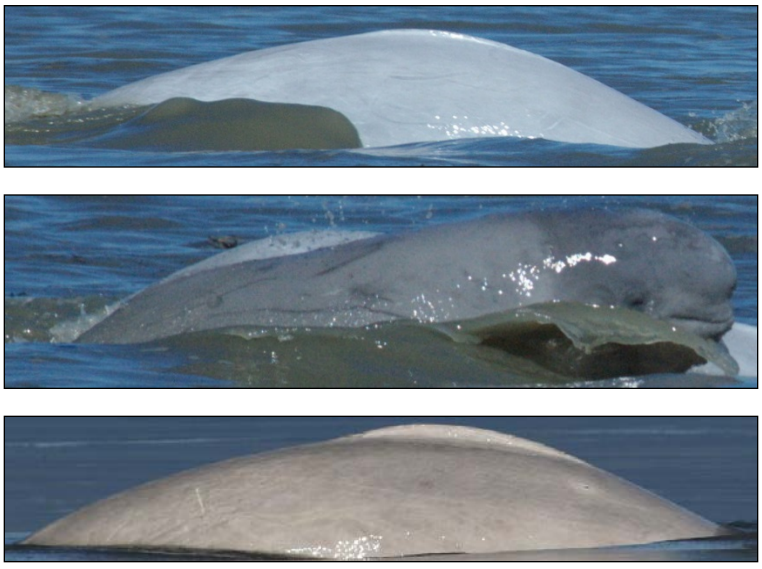


Figure 100. Sighting history and photographs of belugas R7199 and R3215. R7199 is a whale that we have photographically tracked since it was a calf in 2009. R3215 is the mother of R7199 and a known individual in the catalog. (Top photo is of the right side of R3215 just before R7199 surfaces in middle photo; bottom is of the right side of R7199 as an older individual).

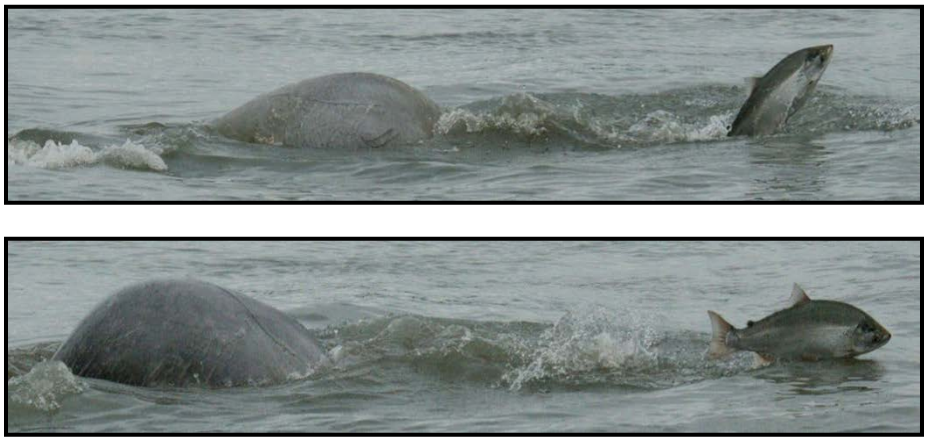
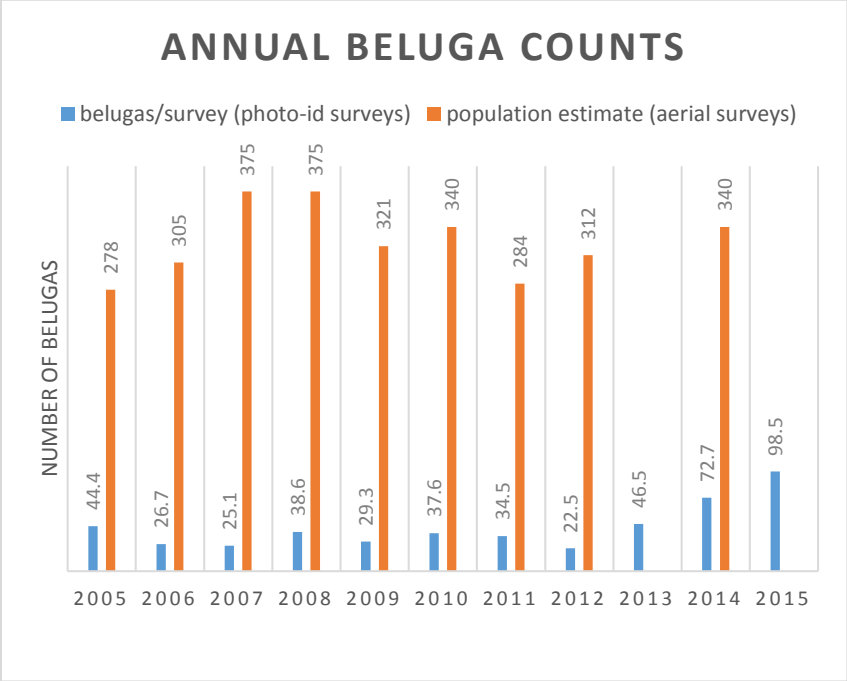
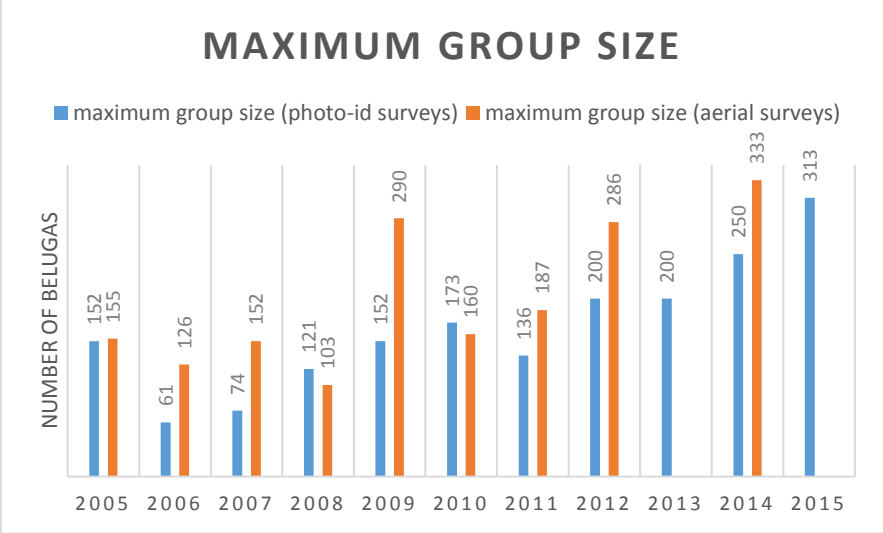


Figure 101. Beluga observed pursuing and later feeding on salmon in the Kenai River, September 2012.

Figure 102. This photograph demonstrates the difficulty in assigning maternity based on physical proximity and differences in relative color and size. The middle animal has been classified as the mother of the small calf in the foreground; it is possible the white animal is the grandmother. It is also possible this is a photograph of a mother (white whale in background) and young calf (foreground) with an older sibling (middle).



A.



B.

Figure103. Comparison of results from NMFS aerial surveys and CIBW Photo-ID Project surveys, 2005-2015. Figure A compares the number of belugas per photo-id survey to the annual abundance estimate obtained from aerial surveys (Shelden et al. 2015b). Figure B compares the annual maximum group sizes observed in the Susitna River Delta during photo-id surveys (observed in July) and during aerial surveys (conducted in June; Shelden et al. 2013, 2015b). Aerial surveys were not conducted in 2013 or 2015.

APPENDICES

Appendix A: Funding for the 2005-2016 Cook Inlet Beluga Whale Photo-ID Project

Table A1. Funding for the 2005-2015 Cook Inlet Beluga Whale Photo-ID Catalog. NFWF = National Fish and Wildlife Foundation (with non-Federal match from Chevron, ConocoPhillips, Unocal, Donlin Gold, Royal Caribbean Cruise Lines, and Wells Fargo); NPRB = North Pacific Research Board; JBER = Joint Base Elmendorf Richardson, Department of Defense; ADF&G = Alaska Department of Fish and Game; KPB = Kenai Peninsula Borough; NMFS AKR = National Marine Fisheries Service, Alaska Region

Year	Left-side Photos Cataloged and Analyzed?	Left-side Funding*	Right-side Photos Cataloged and Analyzed?	Right-side Funding*	Funding for Fieldwork*
2005	Yes	NPRB	Yes	NFWF	NFWF
2006	Yes	NPRB	Yes	NFWF	NFWF
2007	Yes	NPRB	Yes	NFWF	NFWF
2008	Yes	NPRB	Yes	NFWF	NFWF
2009	Yes	NPRB	Yes	NFWF	NFWF
2010	Yes	NPRB	Yes	NFWF	NFWF
2011	Yes	NPRB	Yes	NFWF, JBER/ADF&G, KPB	NFWF
2012	in progress	NMFS AKR	Yes	NMFS AKR, KPB	NFWF
2013	in progress	NMFS AKR	Yes	NFWF, KPB	NFWF; KPB
2014	in progress	NMFS AKR	Yes	NFWF , NMFS AKR	NFWF; NMFS AKR
2015	No	NPRB (grant to begin September 2017)	Yes	NFWF/NMFS AKR (cooperative agreement)	NFWF/NMFS AKR

* LGL = LGL Alaska Research Associates and the CIBW Photo-ID Project donated staff time for all years and components

Appendix B. Sighting Histories of Previously Satellite Tagged Individuals

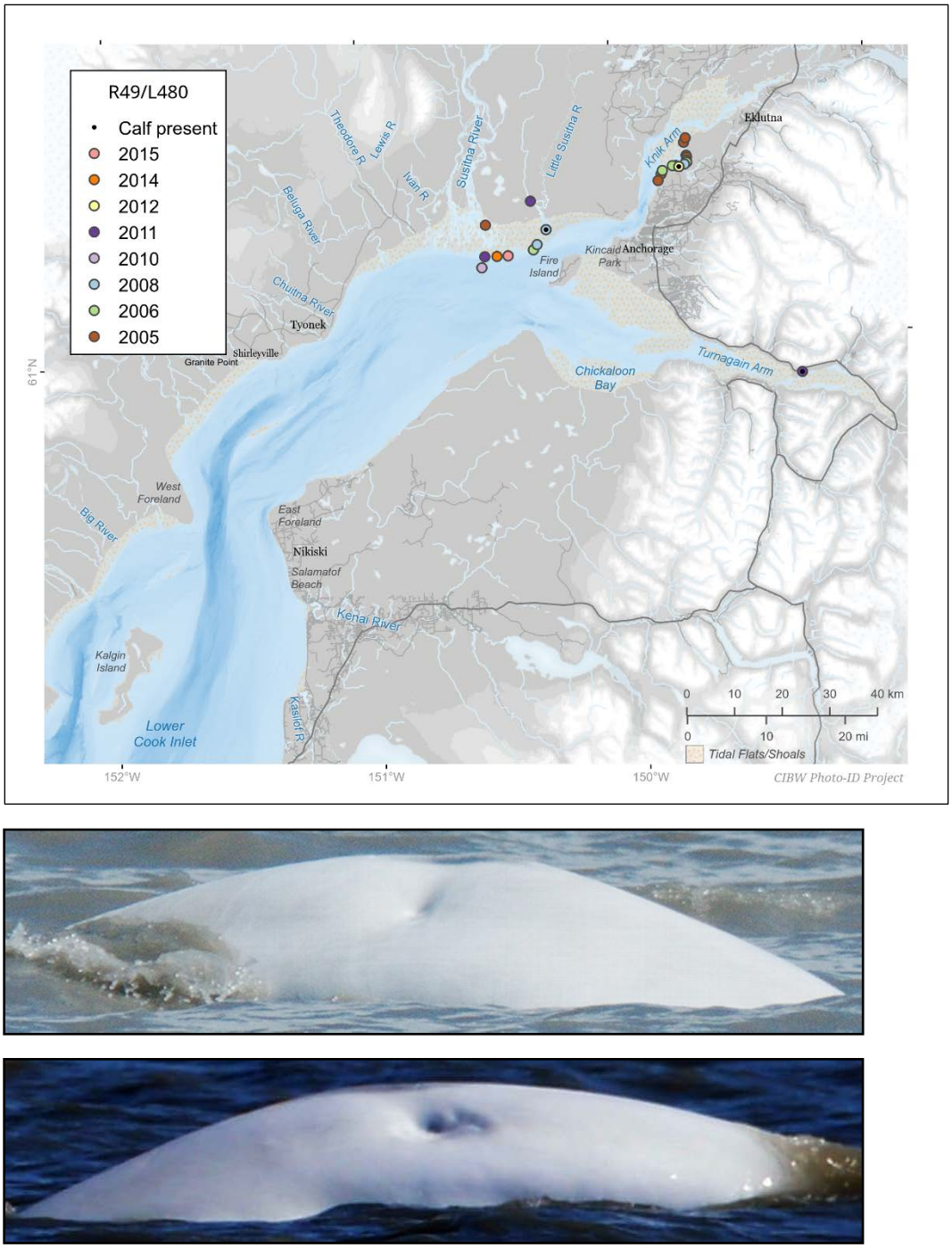


Figure B1. Sighting history and photographs of beluga R49/L480. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).

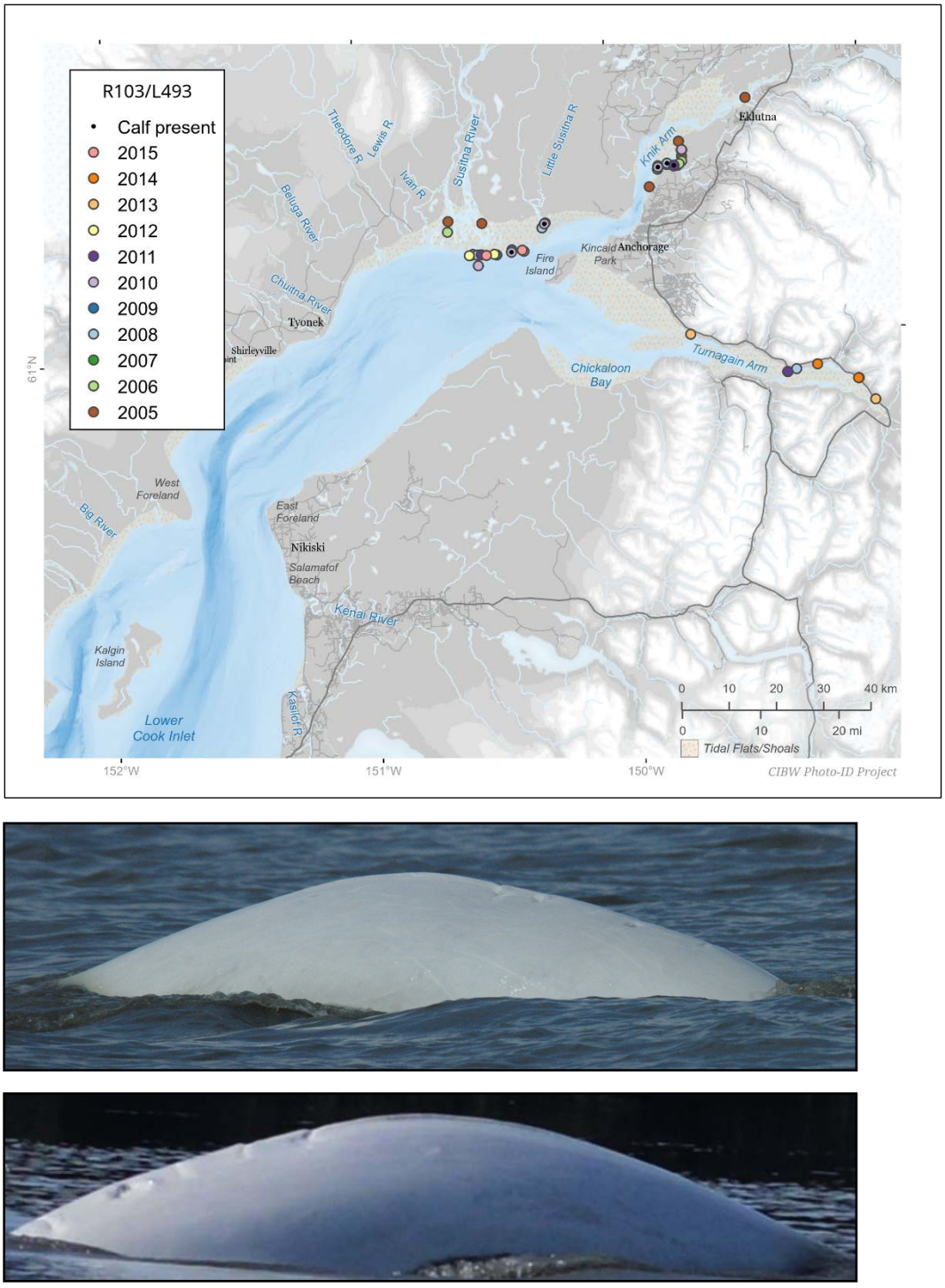
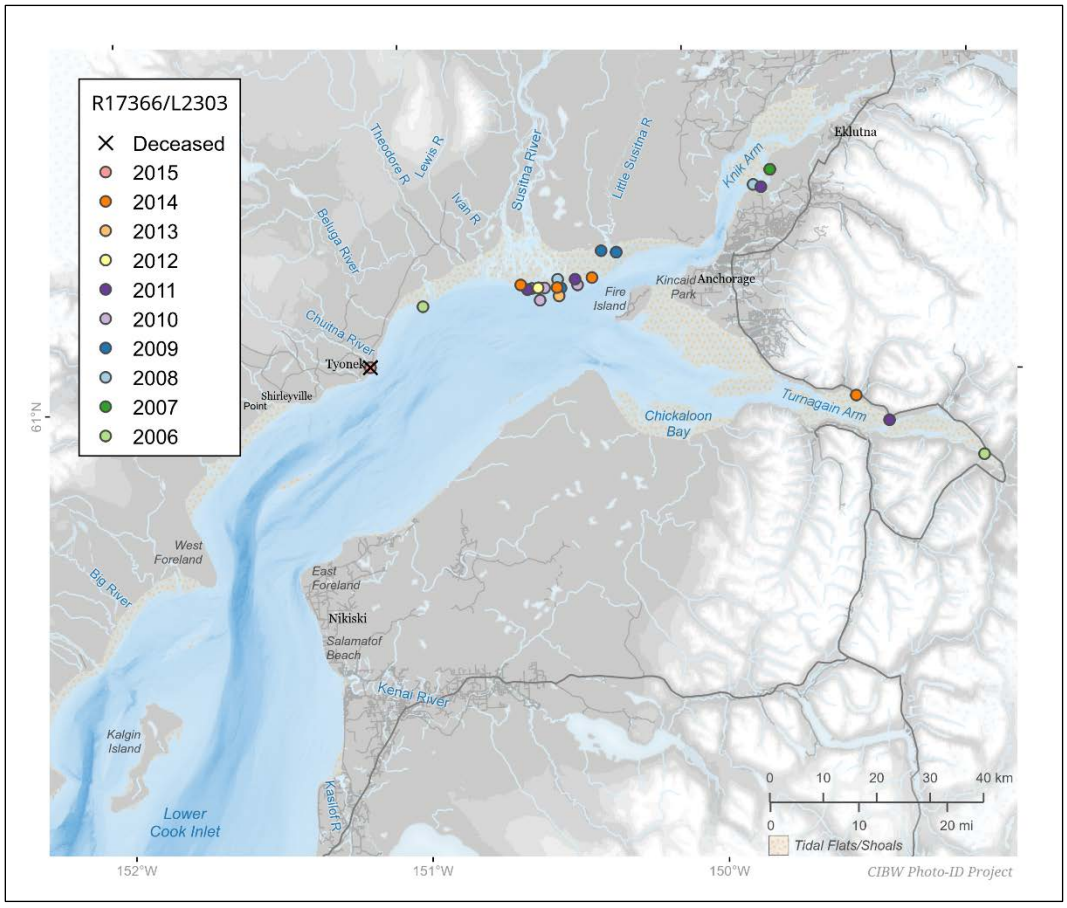


Figure B2. Sighting history and photographs of beluga R103/L493. This whale was photographed in every year of the 2005-2015 study. This whale was tagged by NMFS on August 15, 2001 during their satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).



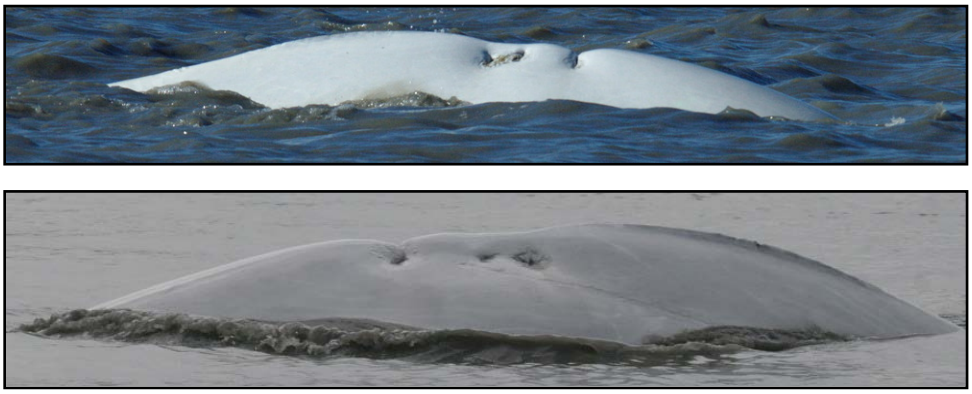


Figure B3. Sighting history and photographs of beluga R17366/L2303. This whale was tagged by NMFS on August 2, 2002 during their satellite tagging study. This whale is a male and was found dead in 2015. (Top photo is of the right side; bottom photo is of the left side).

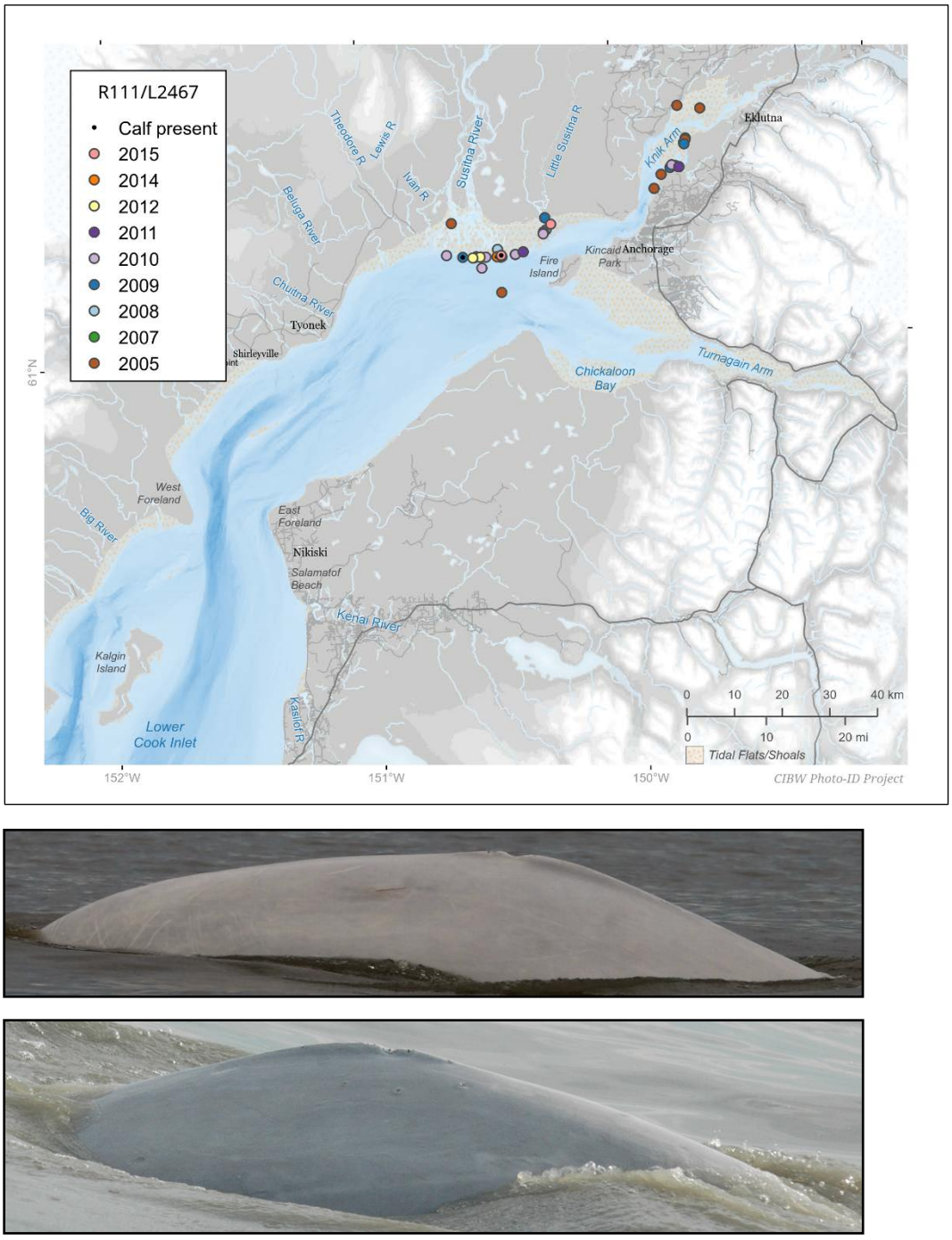
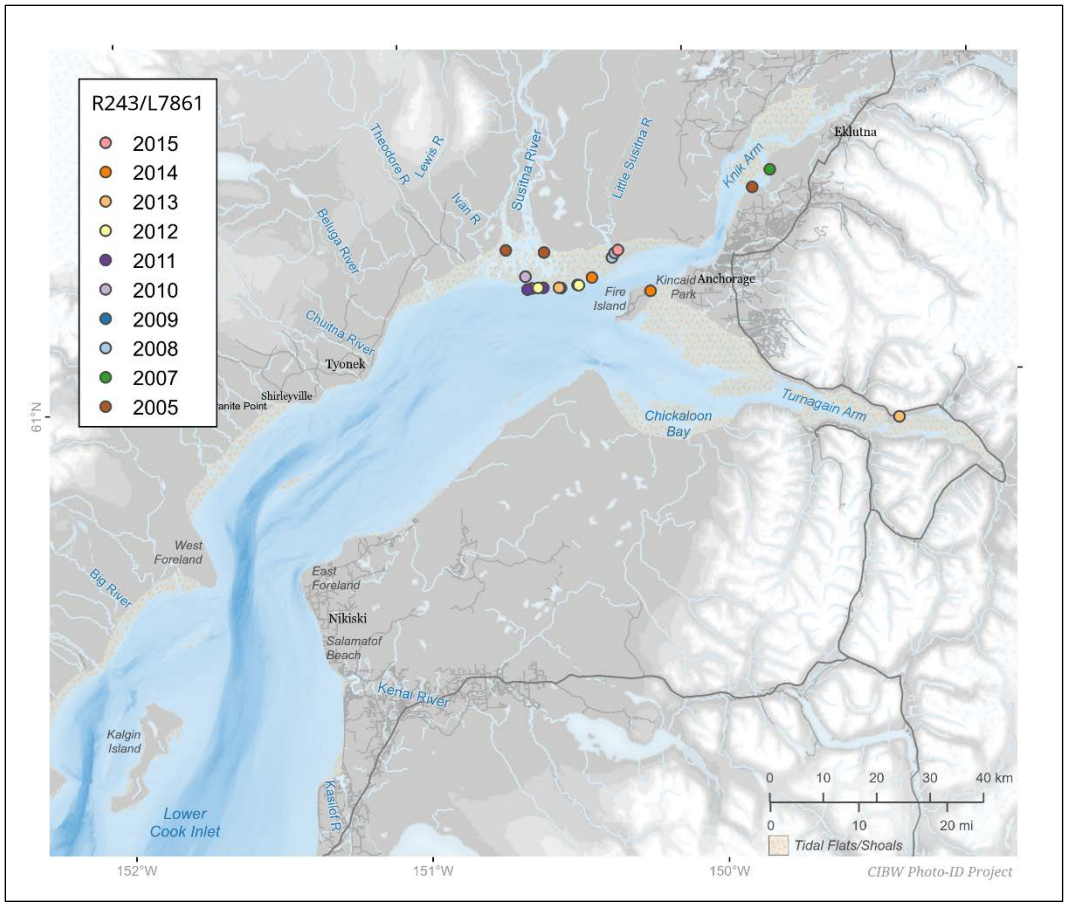


Figure B4. Sighting history and photographs of beluga R111/L2467. This whale was tagged by NMFS on September 13, 2000 during their satellite tagging study. This whale is a female and a presumed mother based on photographs taken with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).



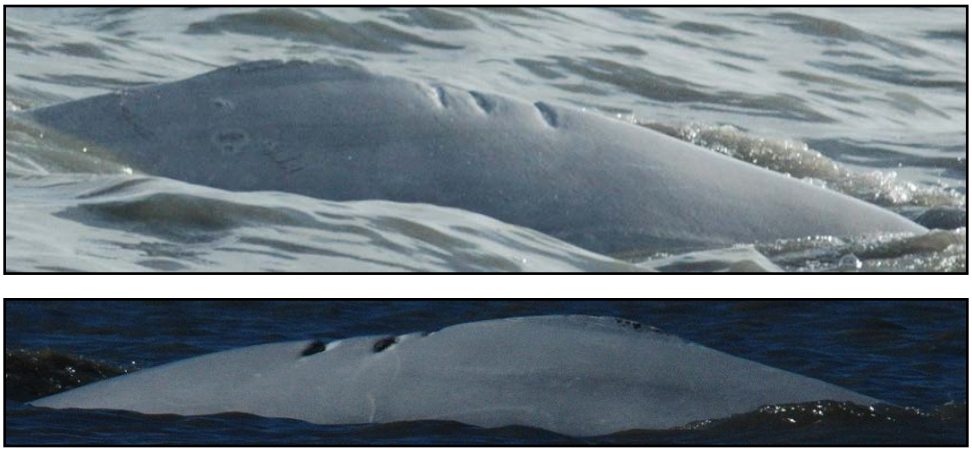


Figure B5. Sighting history and photographs of beluga R243/L7861. This whale was tagged by NMFS on August 10, 2001 during their satellite tagging study. This whale is a female but has never been photographed with a calf. (Top photo is of the right side; bottom photo is of the left side).

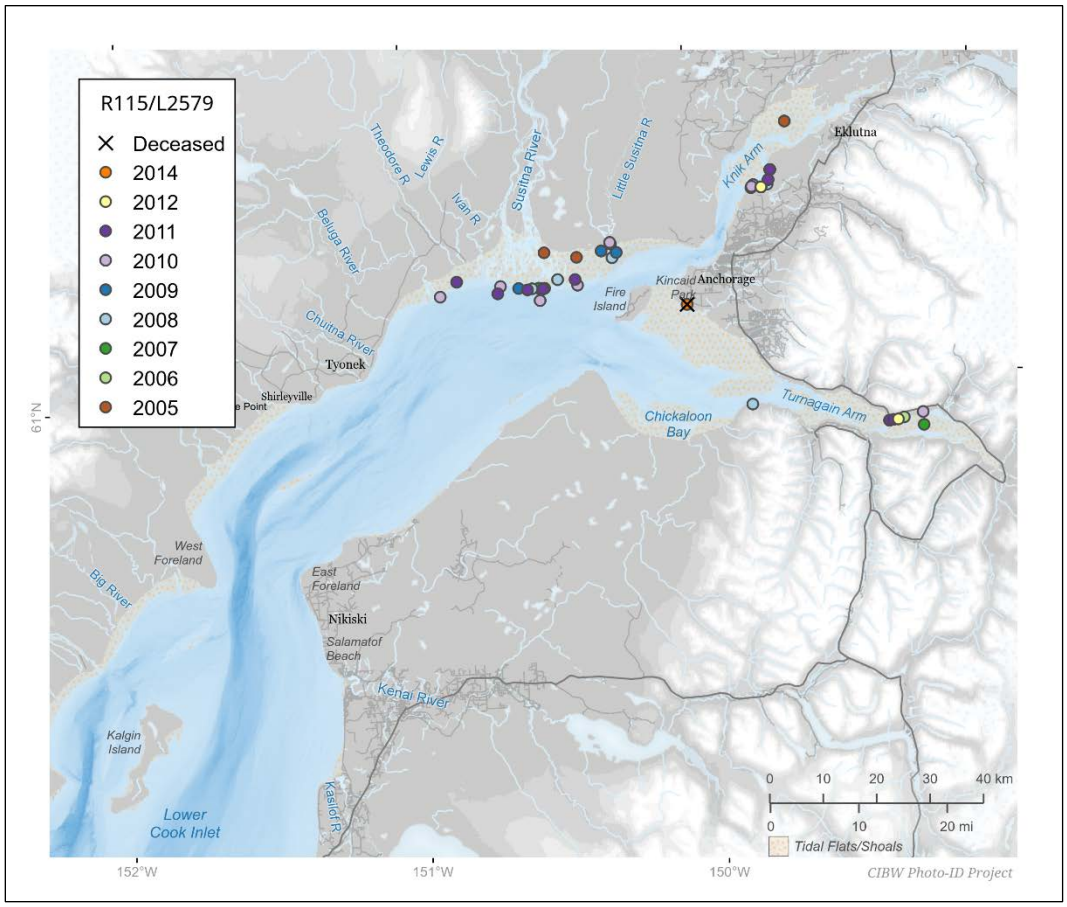


Figure B6. Sighting history and photographs of beluga R115/L2579. This whale was tagged by NMFS on August 4, 2002 during their 1999-2002 satellite tagging study. This whale is a male and was found dead in 2014. (Top photo is of the right side; bottom photo is of the left side).

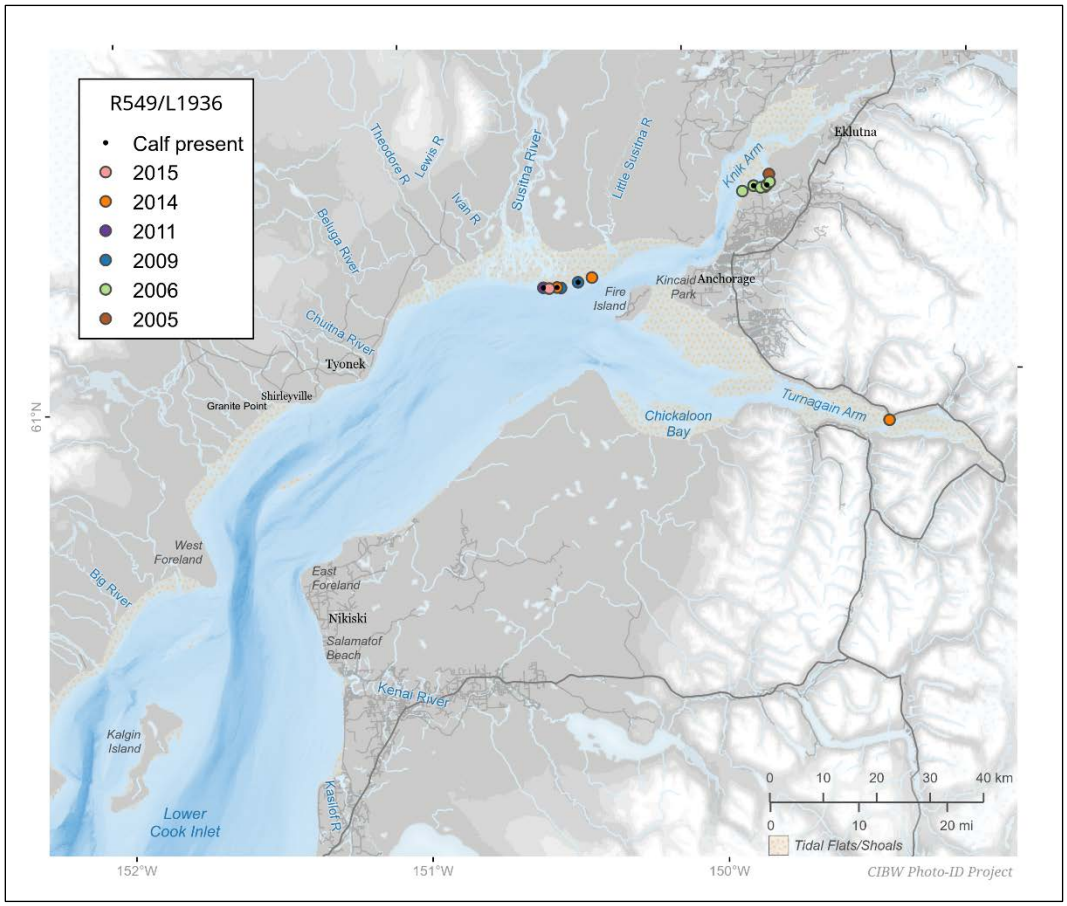


Figure B7. Sighting history and photographs of beluga R549/L1936. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).

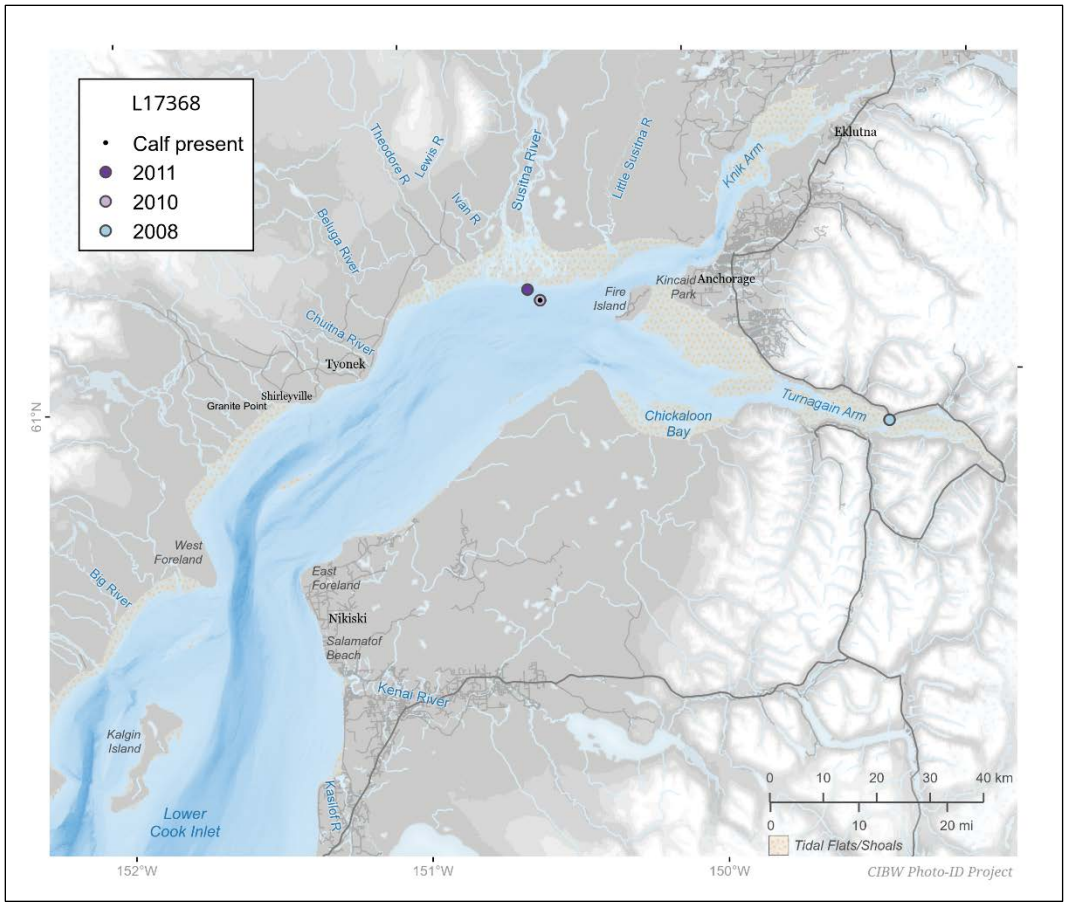
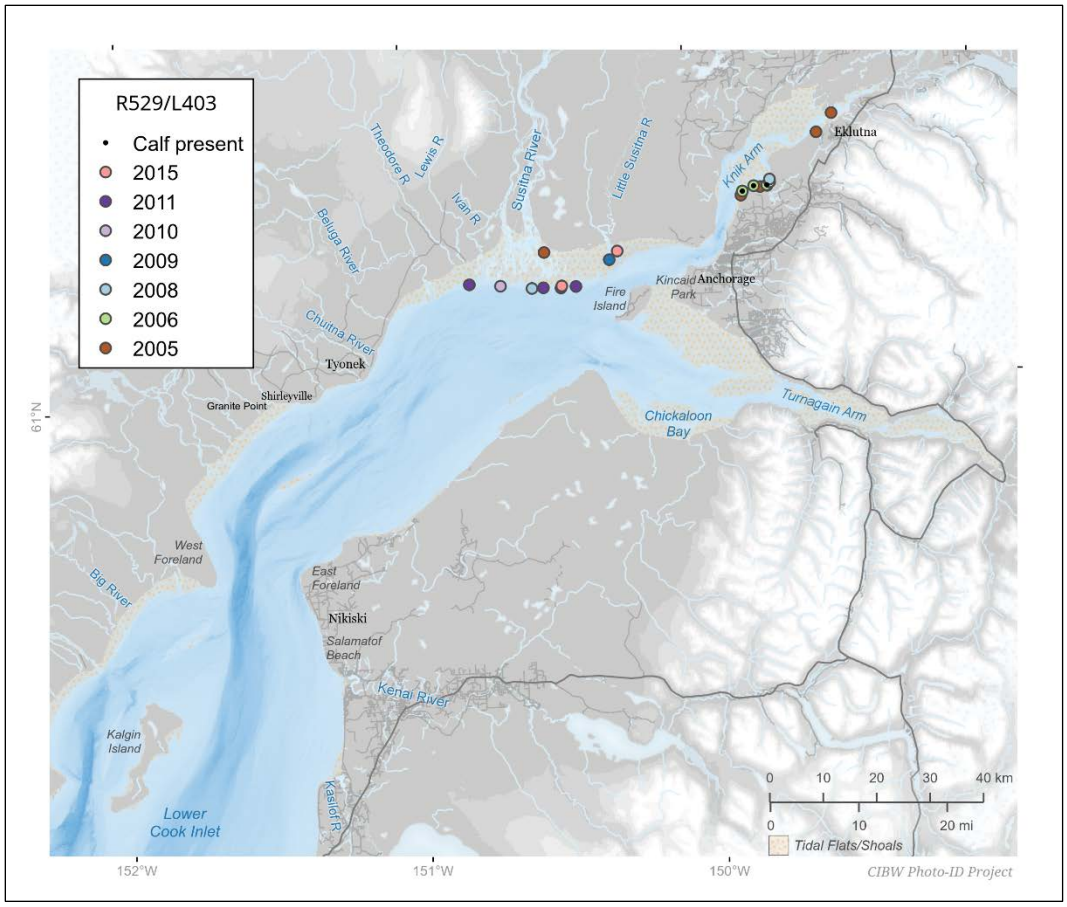


Figure B8. Sighting history and photograph of beluga L17368. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Photograph of the left side).



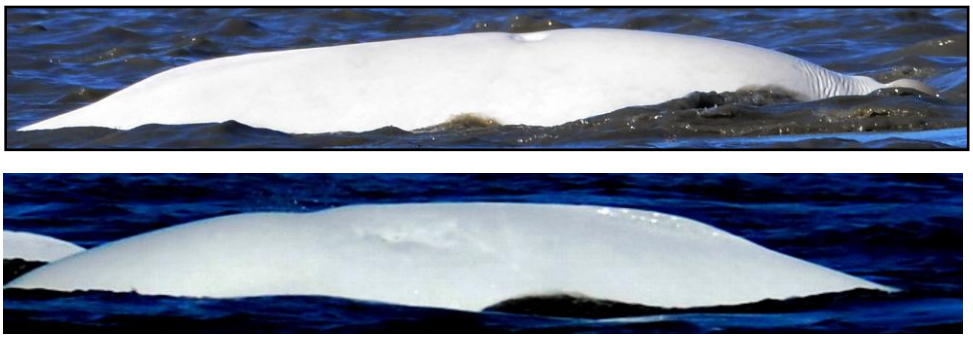
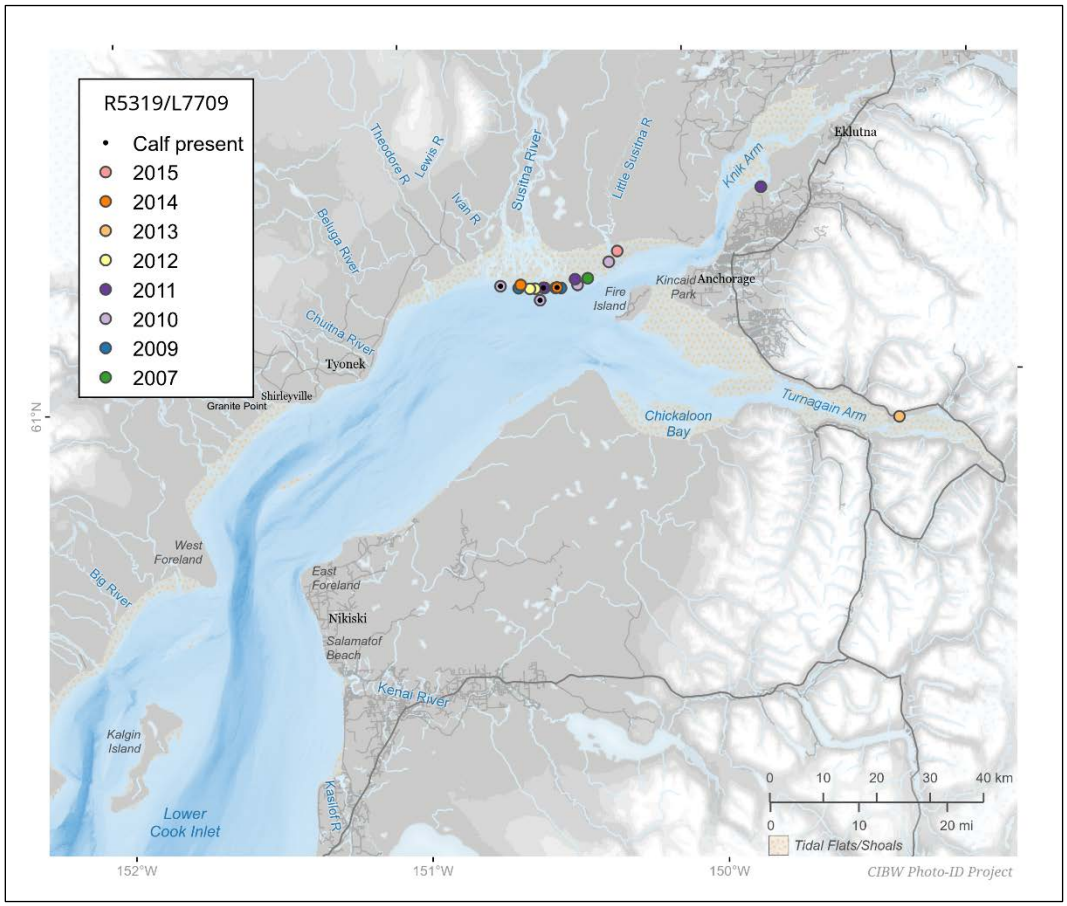


Figure B9. Sighting history and photographs of beluga R529/L403. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).



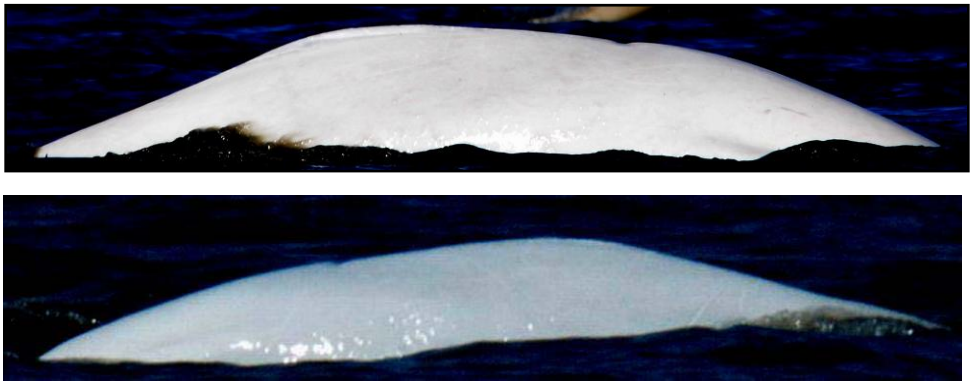


Figure B10. Sighting history and photographs of beluga R5319/L7709. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).

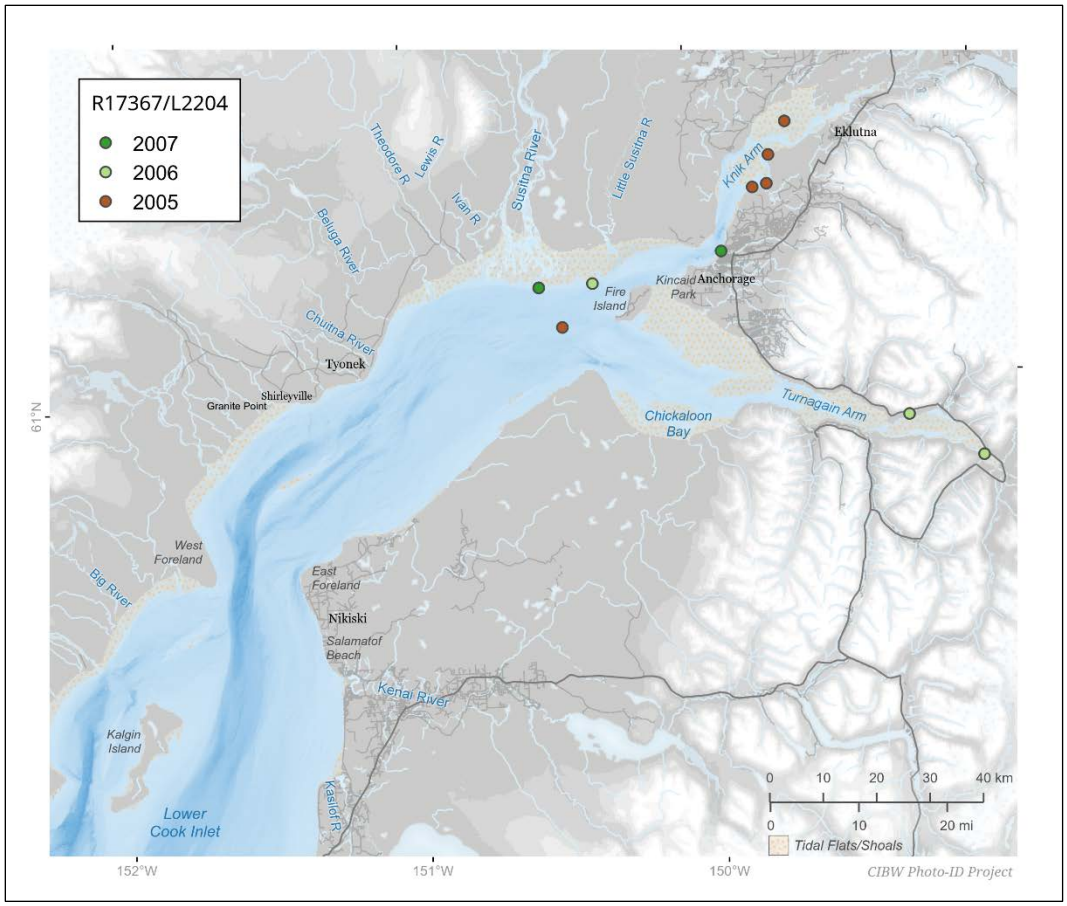
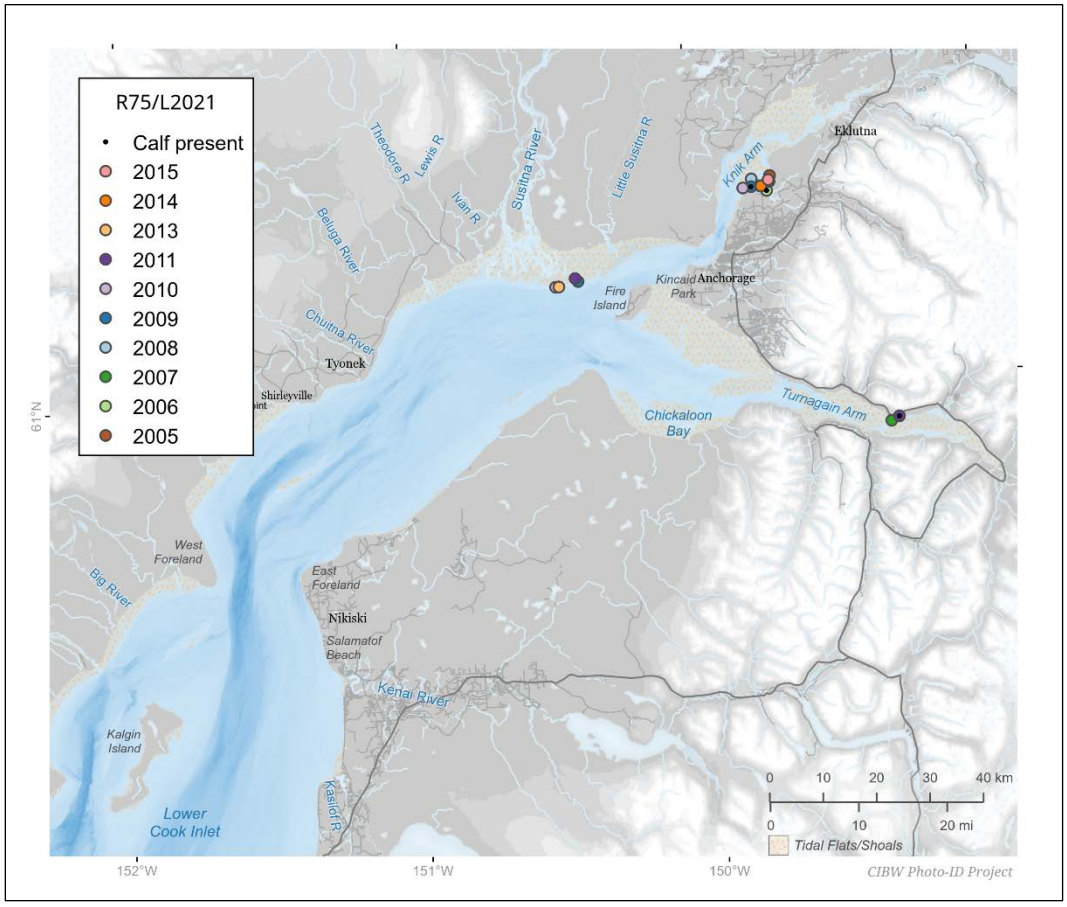


Figure B11. Sighting history and photographs of beluga R17367/L2204. This whale was tagged by NMFS on August 3, 2002 during their satellite tagging study. This whale is a male and photo-id evidence indicates this whale may have died after 2007. (Top photo is of the right side; bottom photo is of the left side).



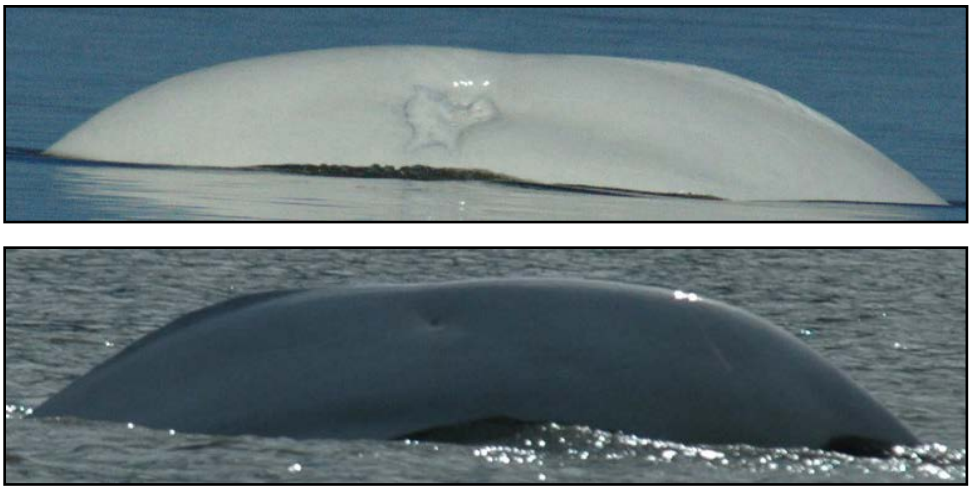
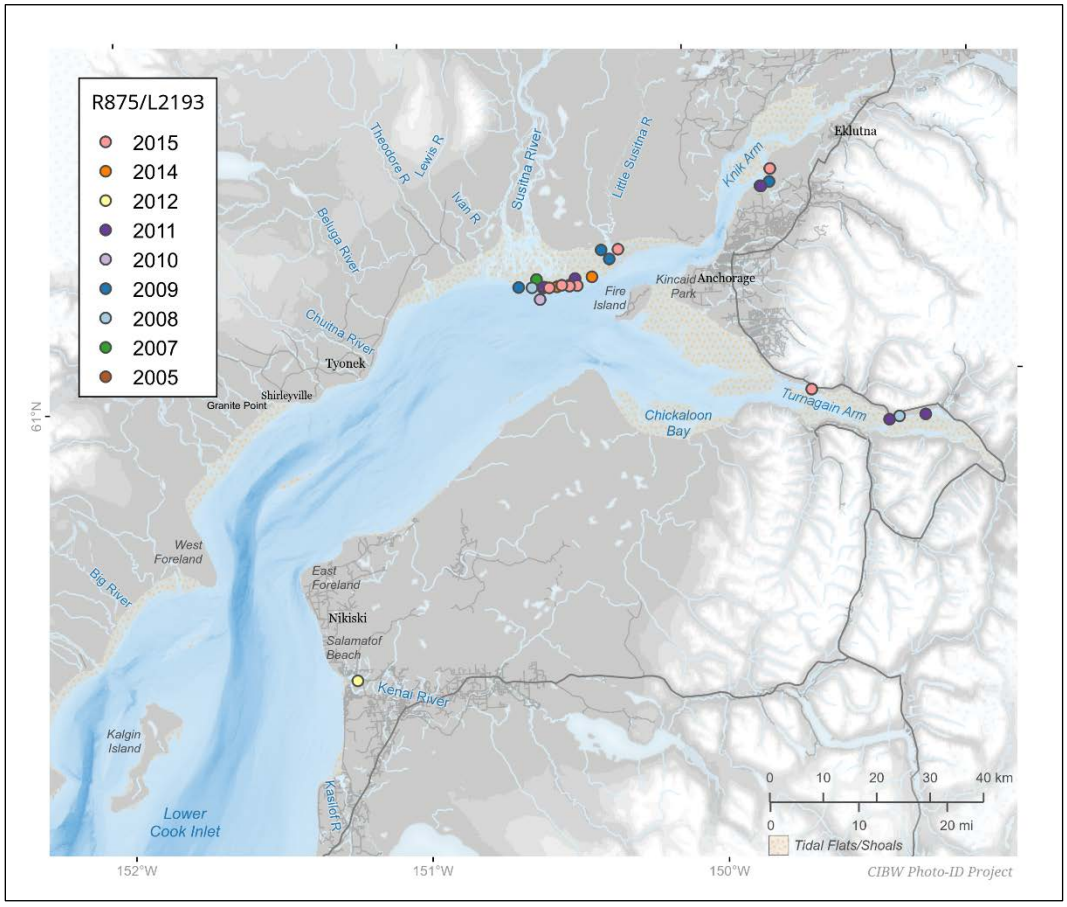


Figure B12. Sighting history and photographs of beluga R75/L2021. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf (Top photo is of the right side; bottom photo is of the left side).



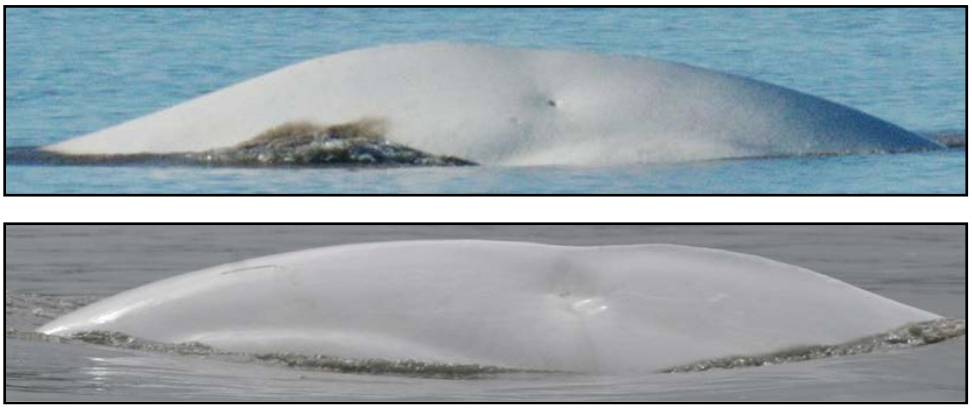


Figure B13. Sighting history and photographs of beluga R875/L2193. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. (Top photo is of the right side; bottom photo is of the left side).

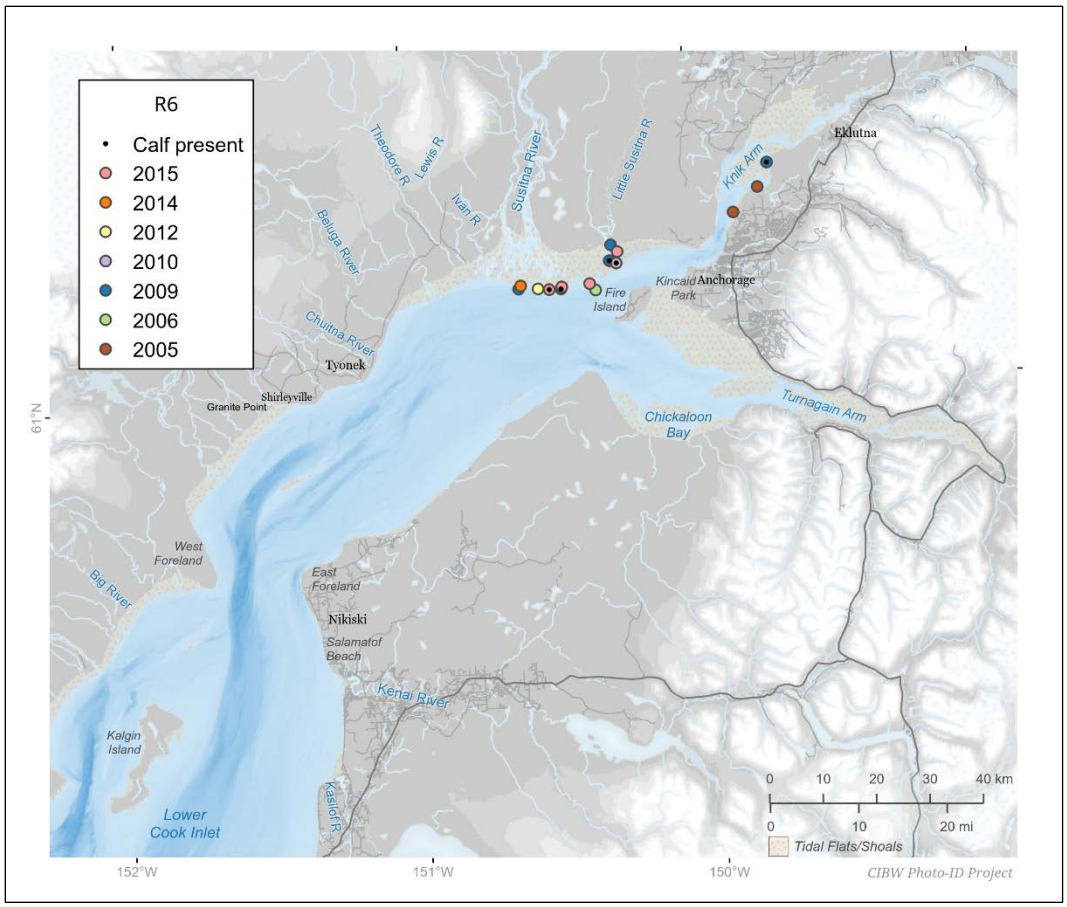


Figure B14. Sighting history and photograph of beluga R6. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a presumed mother based on photographs with an accompanying calf. (Photograph is of the right side).

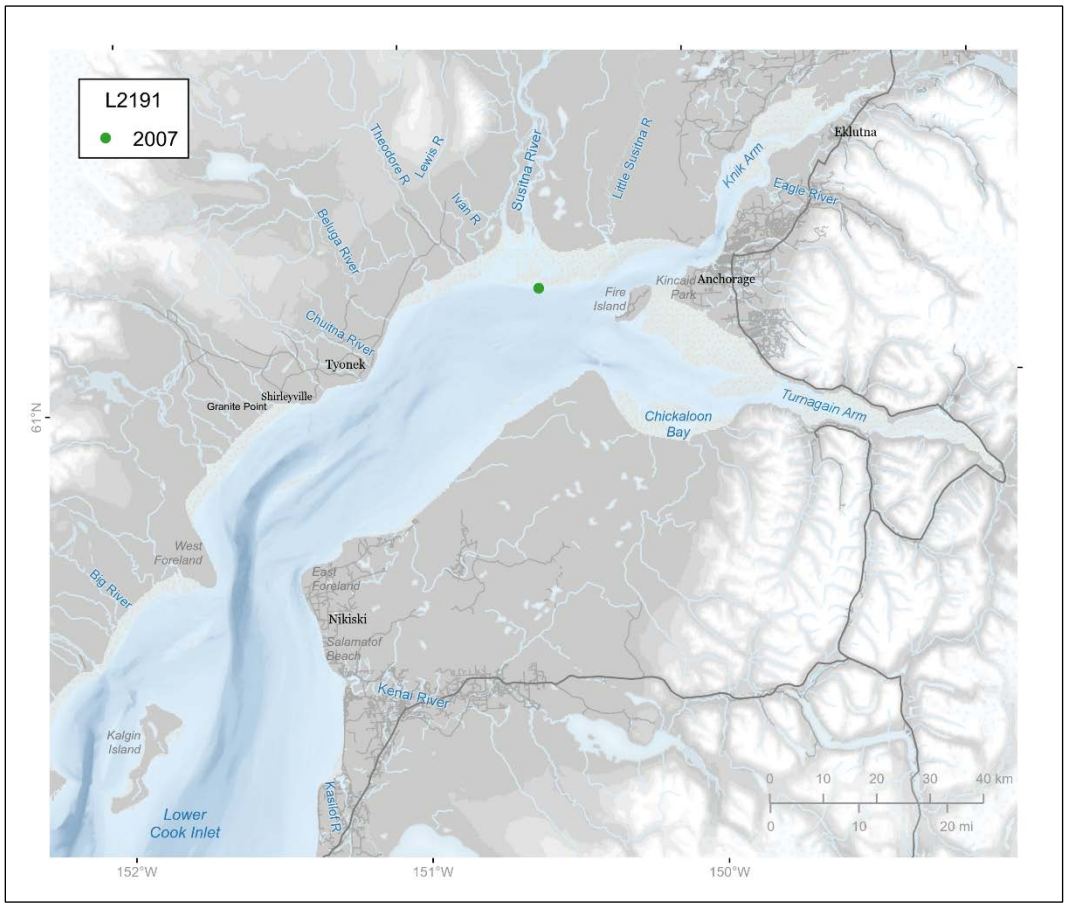


Figure B15. Sighting history and photograph of beluga L2191. This whale was captured but not tagged by NMFS on May 31, 1999 during their satellite tagging study. (Photograph is of the left side).

Appendix C. Sighting Histories of Stranded Individuals

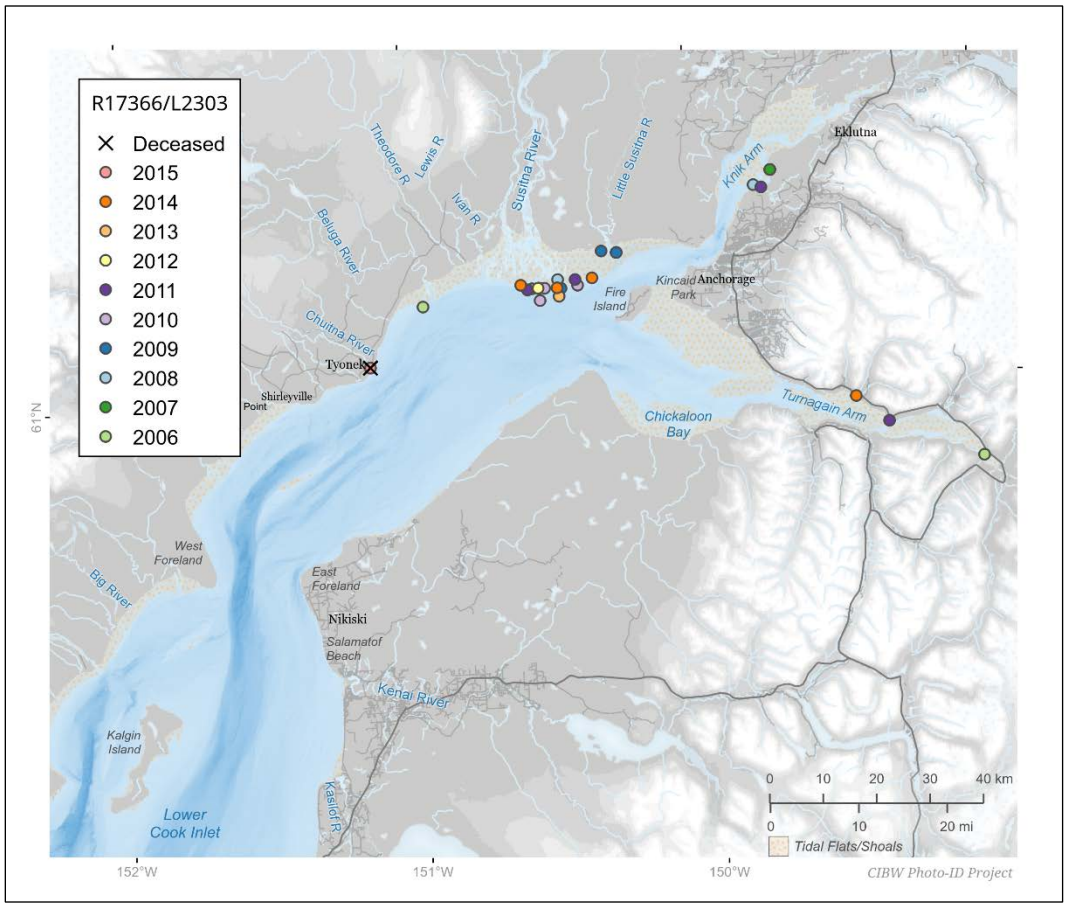


Figure C1. Sighting history and photographs of beluga R17366/L2303. This whale has scars indicating it was tagged by NMFS during their 1999-2002 satellite tagging study. This whale is a male and was found dead near Tyonek in 2015. (Top photo is of the left side; bottom photo of dead stranded whale left side is courtesy of Alaska Marine Mammal Stranding Network).

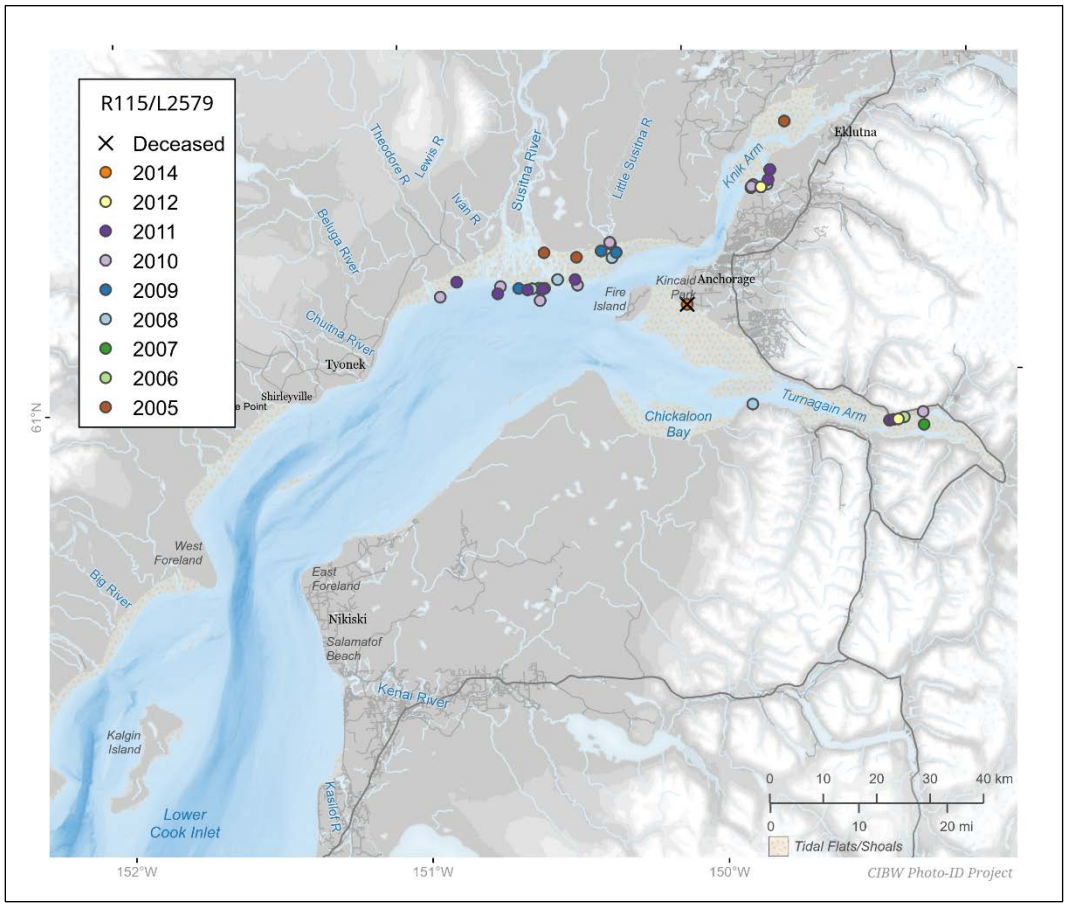


Figure C2. Sighting history and photographs of beluga R115/L2579. This whale was tagged by NMFS on August 4, 2002 during their 1999-2002 satellite tagging study. This whale is a male and was found dead in Kincaid Park, Anchorage in 2014. (Top photo is of the right side; bottom photo is of the left side).

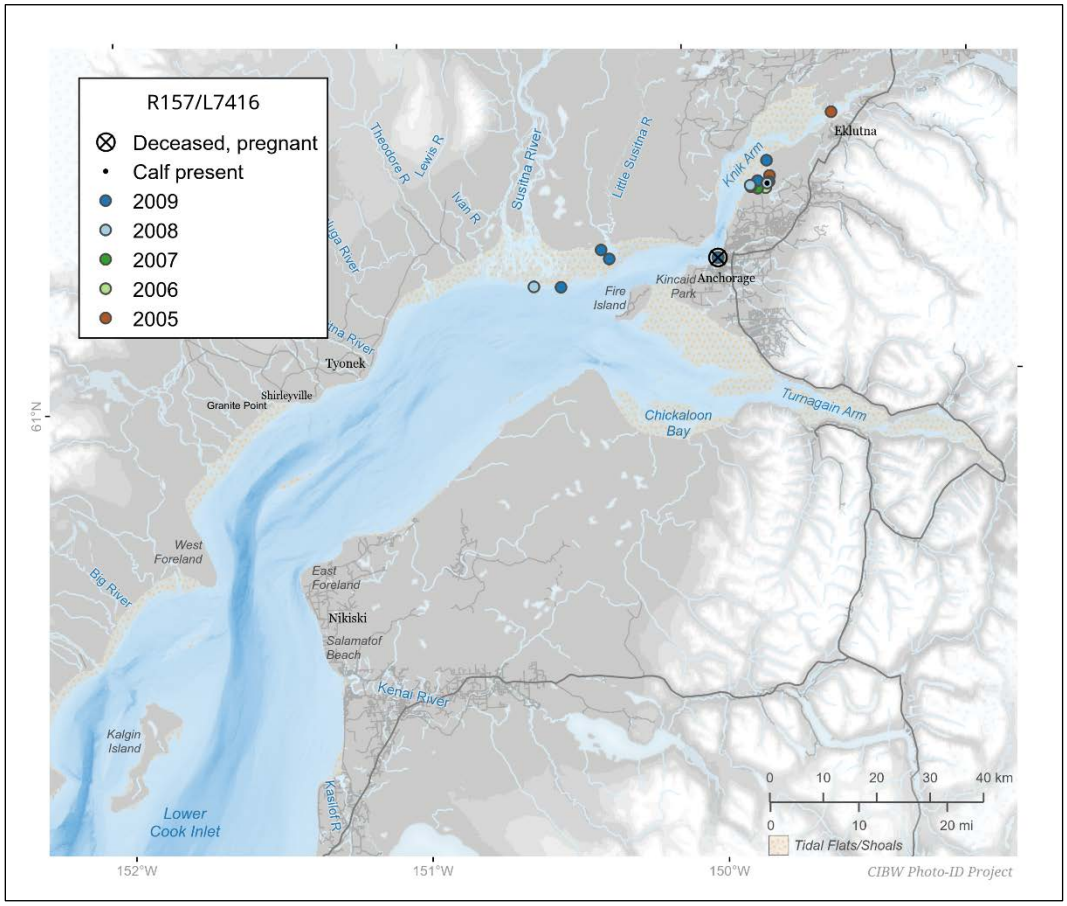


Figure C3. Sighting history and photographs of beluga R157/L7416. This pregnant female whale was found dead in Knik Arm. (Top photo is of the right side; bottom photo is a close up of right-side marks).

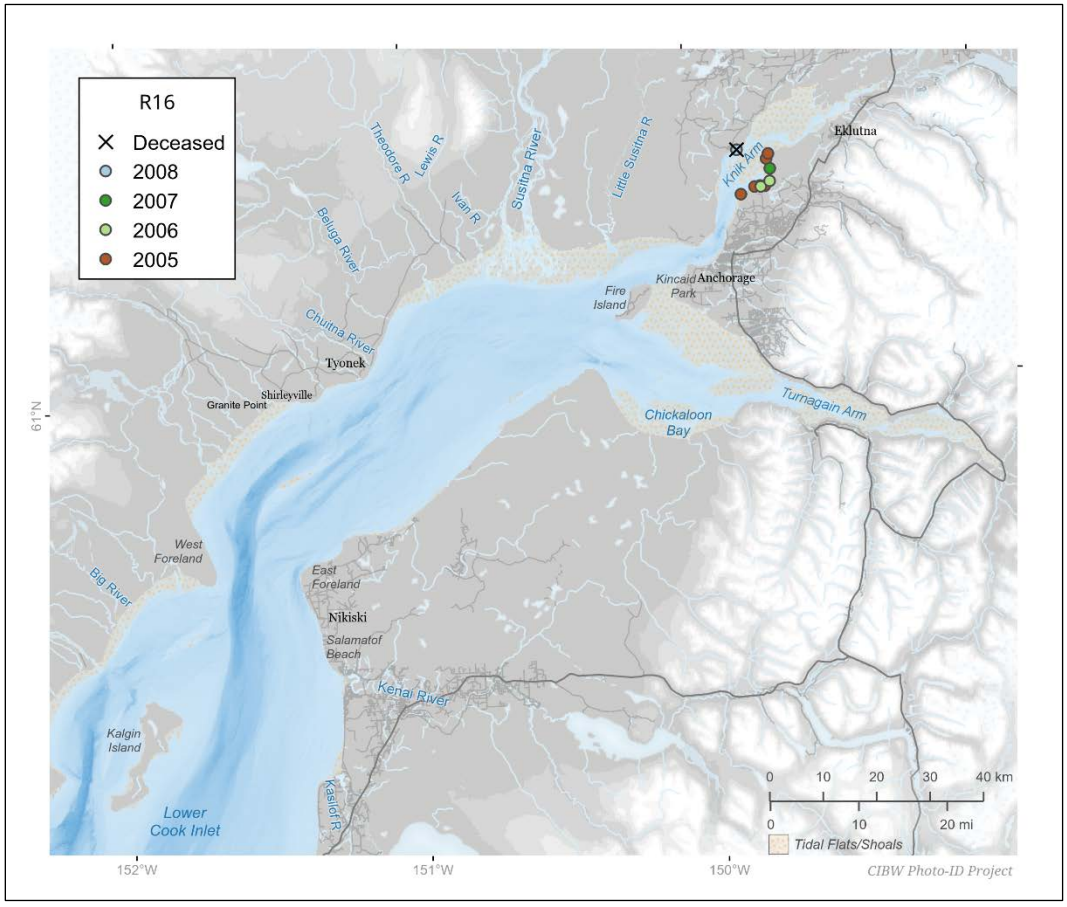
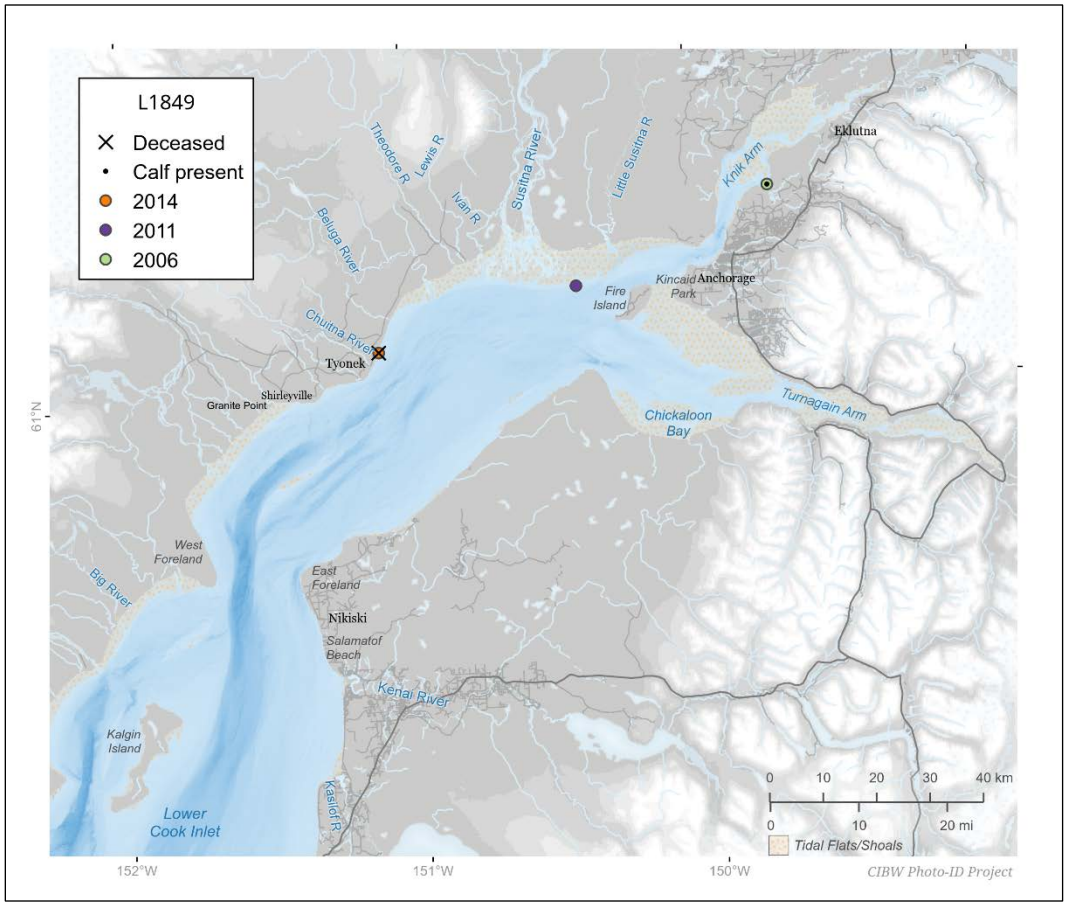


Figure C4. Sighting history and photograph of beluga R16. This female whale was found dead in Knik Arm. (Photograph is of the right side).



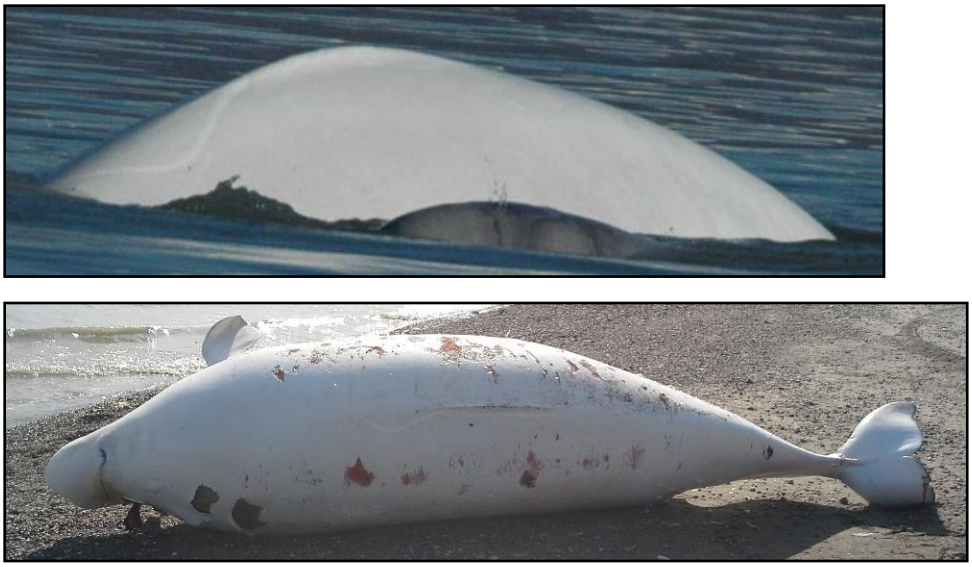


Figure C5. Sighting history and photographs of beluga L1849. This female whale was found dead near the Chuitna River mouth in 2014. This whale was a presumed mother based on photographs with an accompanying calf. (Top photo is of the left side with a calf; bottom photo is from necropsy, courtesy of the Alaska Marine Mammal Stranding Network).

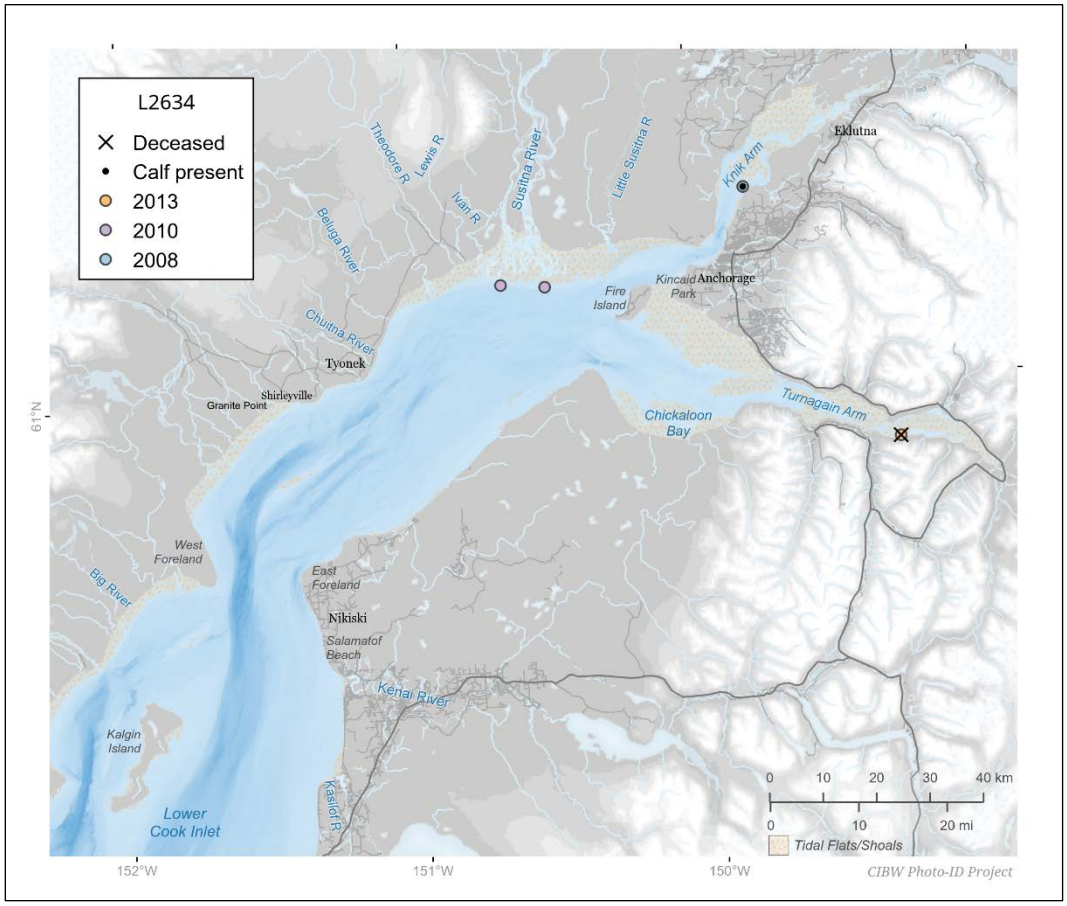


Figure C6. Sighting history and photographs of beluga L2634. This female whale was found dead onshore in Turnagain Arm in 2013. This whale was a presumed mother based on photographs with an accompanying calf. (Top photo is of the left side with a calf; bottom photo is of the left side of the dead whale courtesy of the Alaska Marine Mammal Stranding Network).

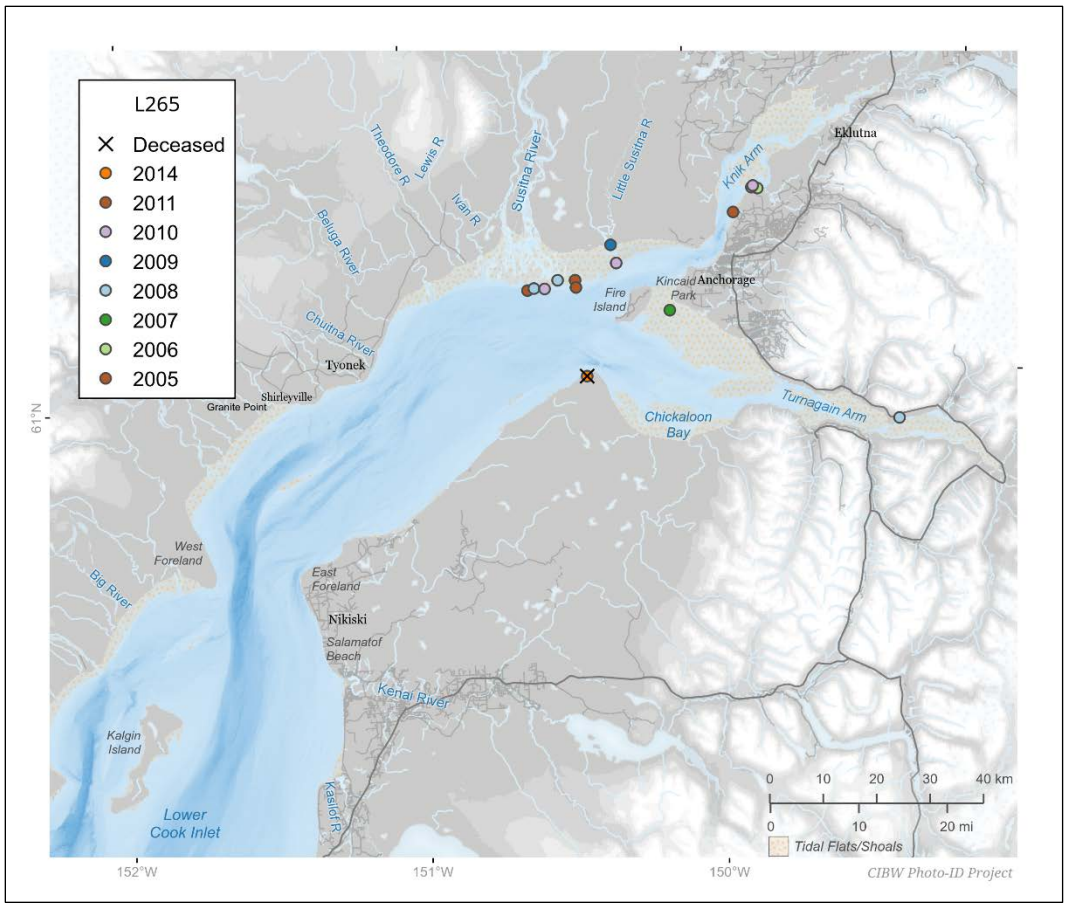
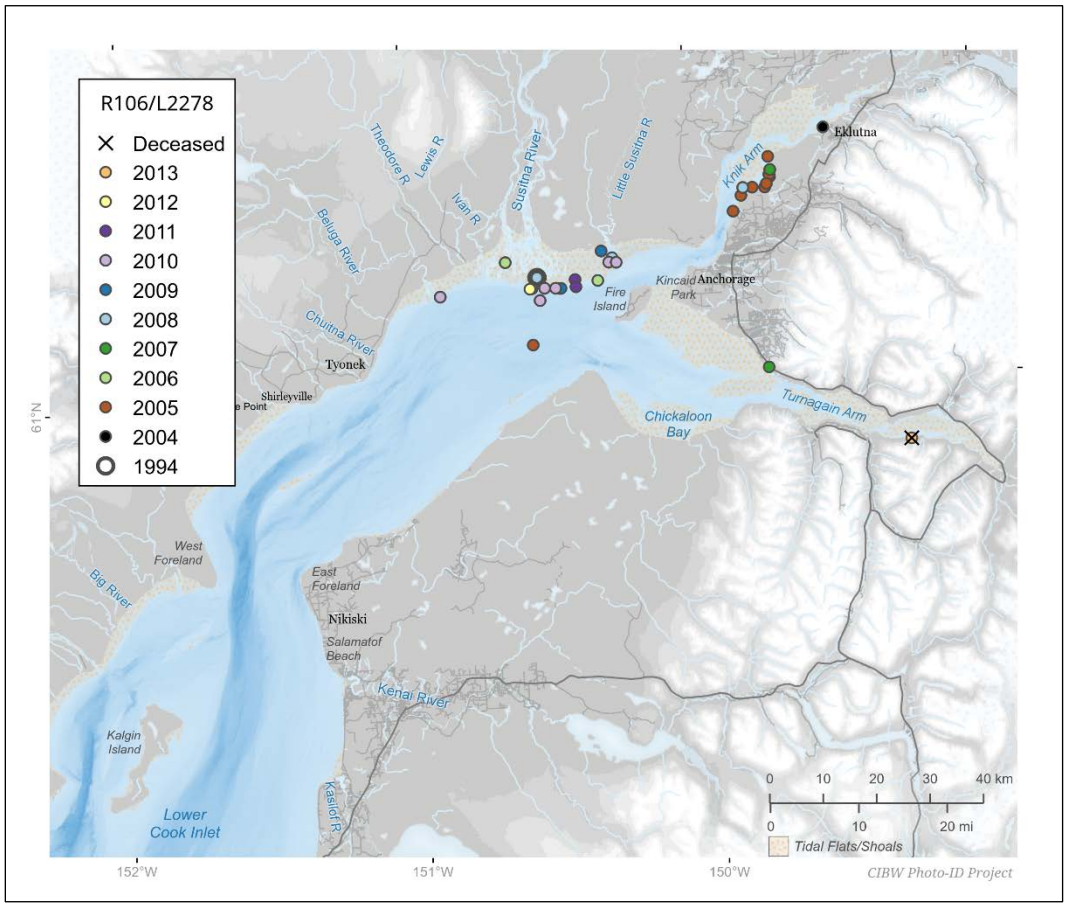


Figure C7. Sighting history and photographs of beluga L265. This female whale was found dead onshore near Pt. Possession in 2014. (Top photo is of the left side; bottom photo is of the left side of the dead whale courtesy of the Alaska Marine Mammal Stranding Network).



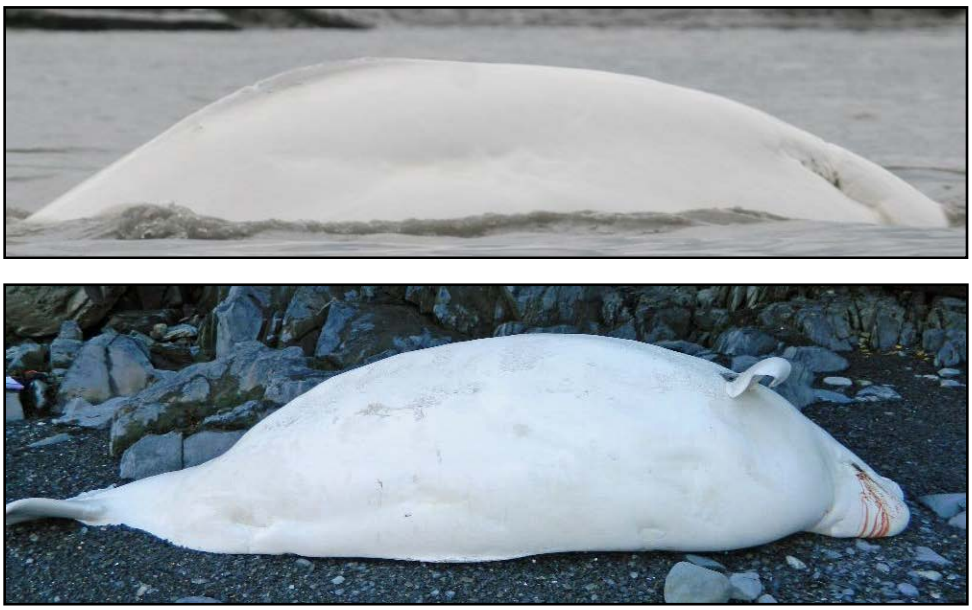


Figure C8. Sighting history and photographs of beluga R106/L2278. This male was first photographed in 1994 by NMFS. It was found dead in Turnagain Arm in 2013. (Top photo is of the left side; bottom photo is of the left side of the dead whale courtesy of the Alaska Marine Mammal Stranding Network).

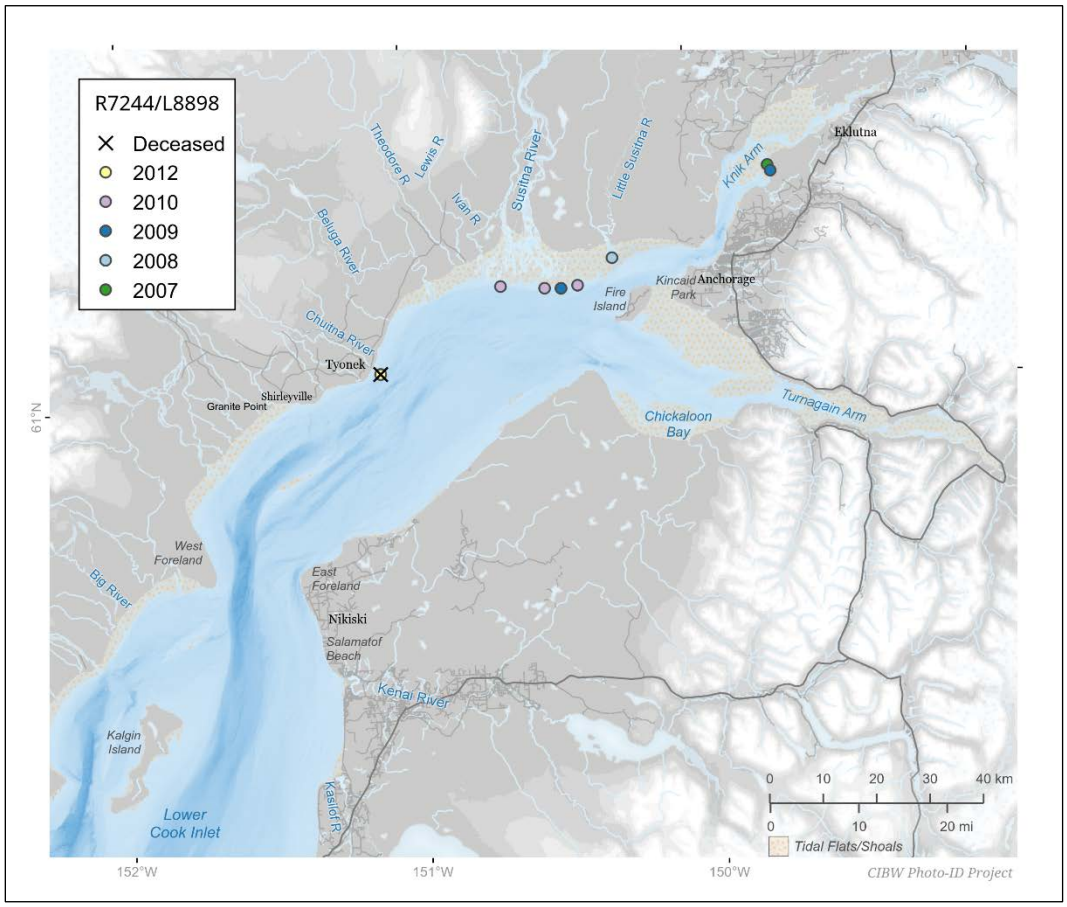


Figure C9. Sighting history and photographs of beluga R7244/L8898. This male was found dead floating near Tyonek in 2012. (Top photo is of the right side; bottom photo is the right side of the dead whale).

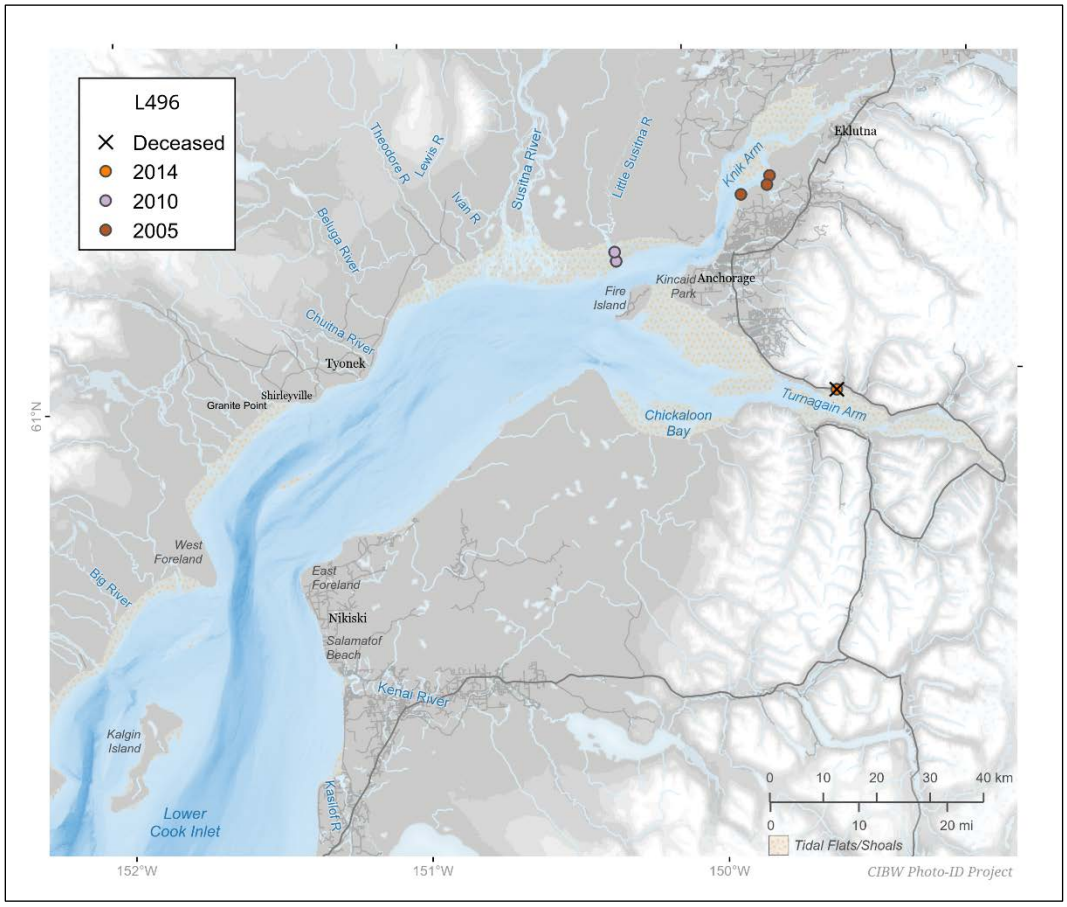


Figure C10. Sighting history and photographs of beluga L496. This male was found dead onshore in Turnagain Arm in 2014. (Top photo is of the left side; bottom photo is of the left side of the dead whale).

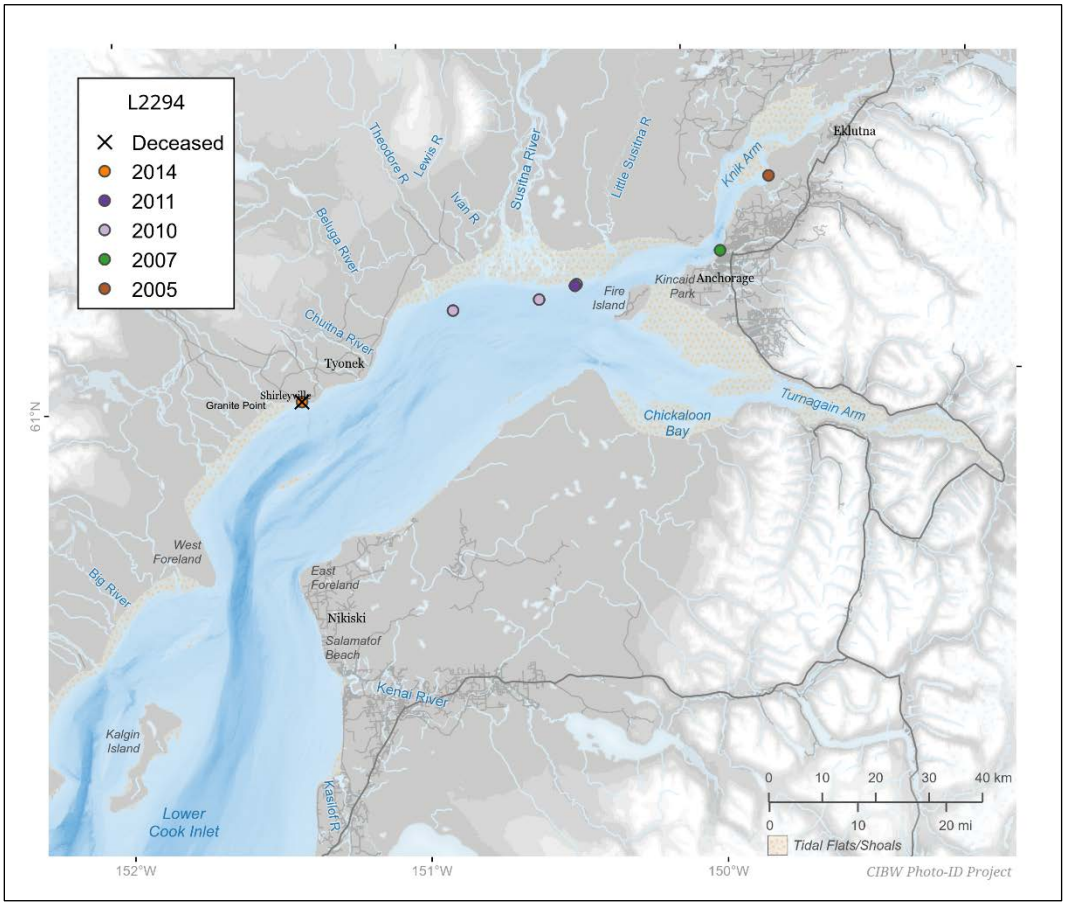


Figure C11. Sighting history and photographs of beluga L2294. This male was found dead onshore near Tyonek in 2014. (Top photo is of the left side; bottom photo is the left side of the dead whale, courtesy of Alaska Marine Mammal Stranding Network).

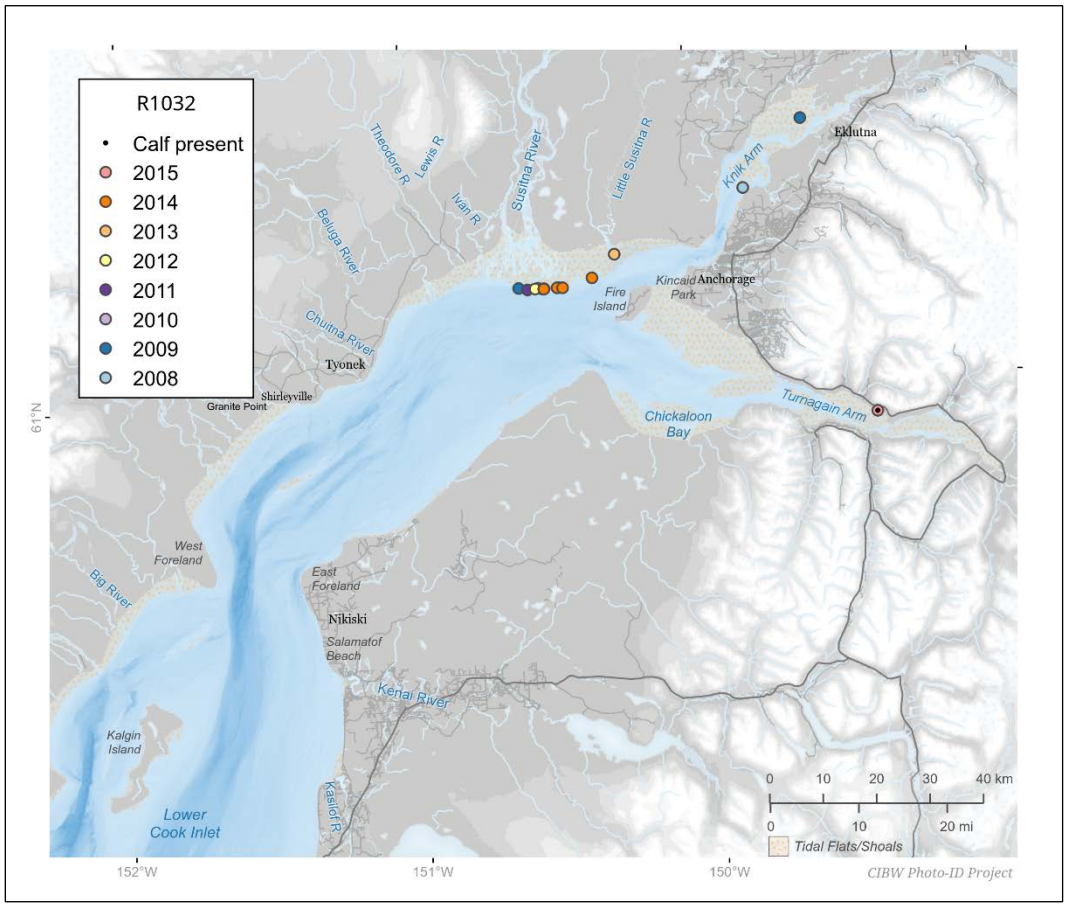


Figure C12. Sighting history and photographs of beluga R1032. This female was a live stranding on the mudflats with her presumed calf in Turnagain Arm in 2014. (Top photo is of the right side; bottom photo is of the right side and is courtesy of the Alaska Marine Mammal Stranding Network).

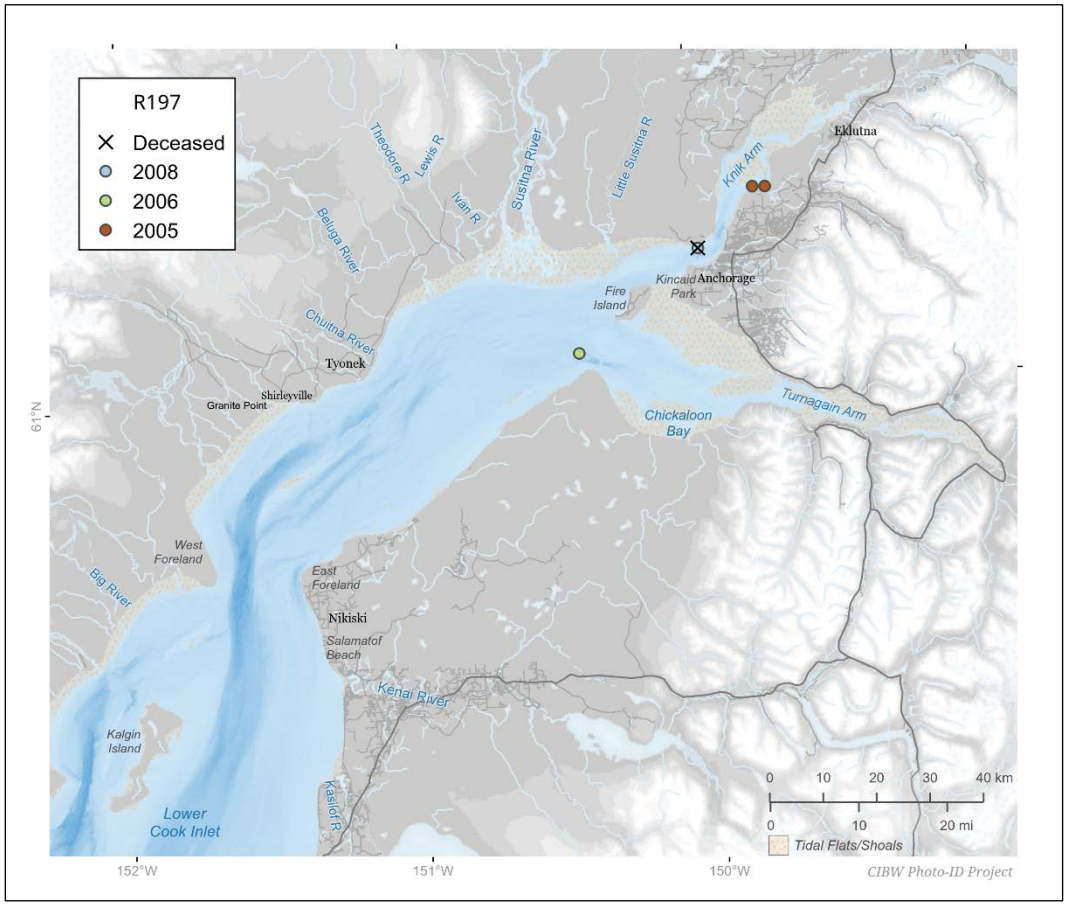


Figure C13. Sighting history and photograph of beluga R197. This female was found dead on shore in Knik Arm in 2008. (Photo is of the right side).

Appendix D. Sighting Histories of Biopsied Individuals

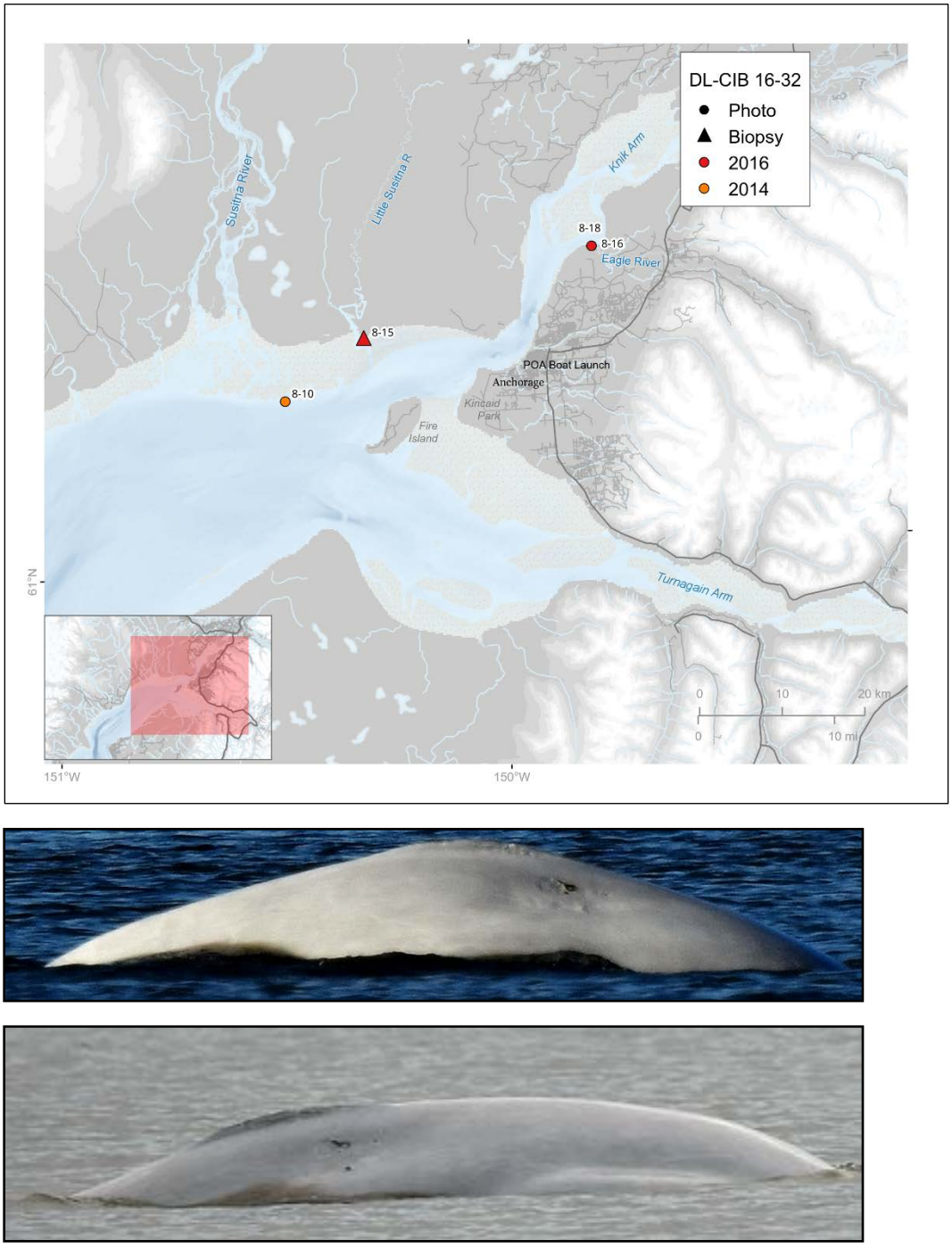


Figure D1. Whale DL-CIB 16-32 was biopsied on August 15, 2016. It was first identified in 2014. Biopsy determined it is a male. (Top photo is of the right side; bottom photo is of the left side).

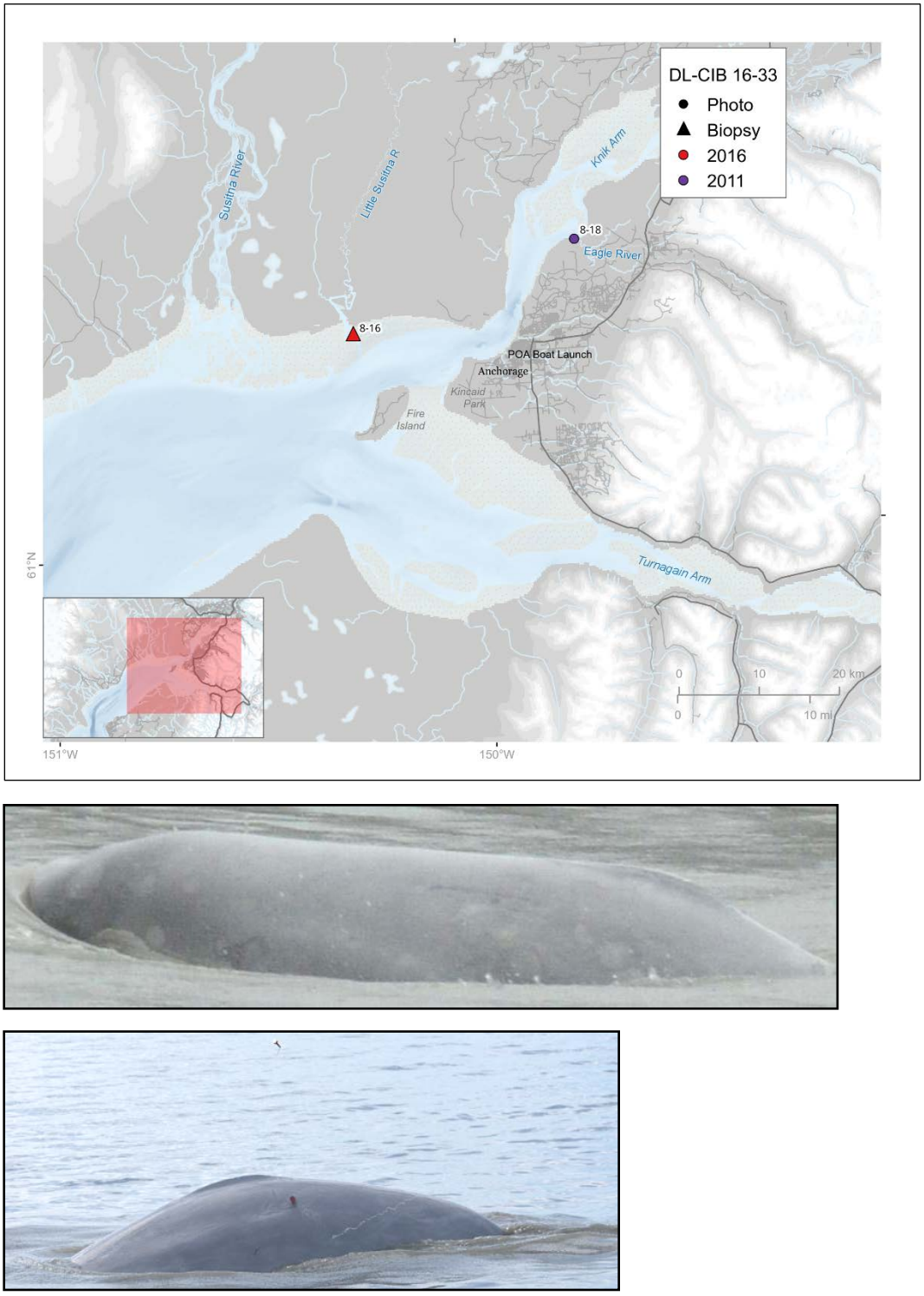


Figure D2. Whale DL-CIB 16-33 was biopsied on August 16, 2016 from a vessel. It was first identified in 2011 (top photo, left side). Although biopsy determined it is a female, it has not been photographed with a calf. (Bottom photo is of the left side during biopsy).

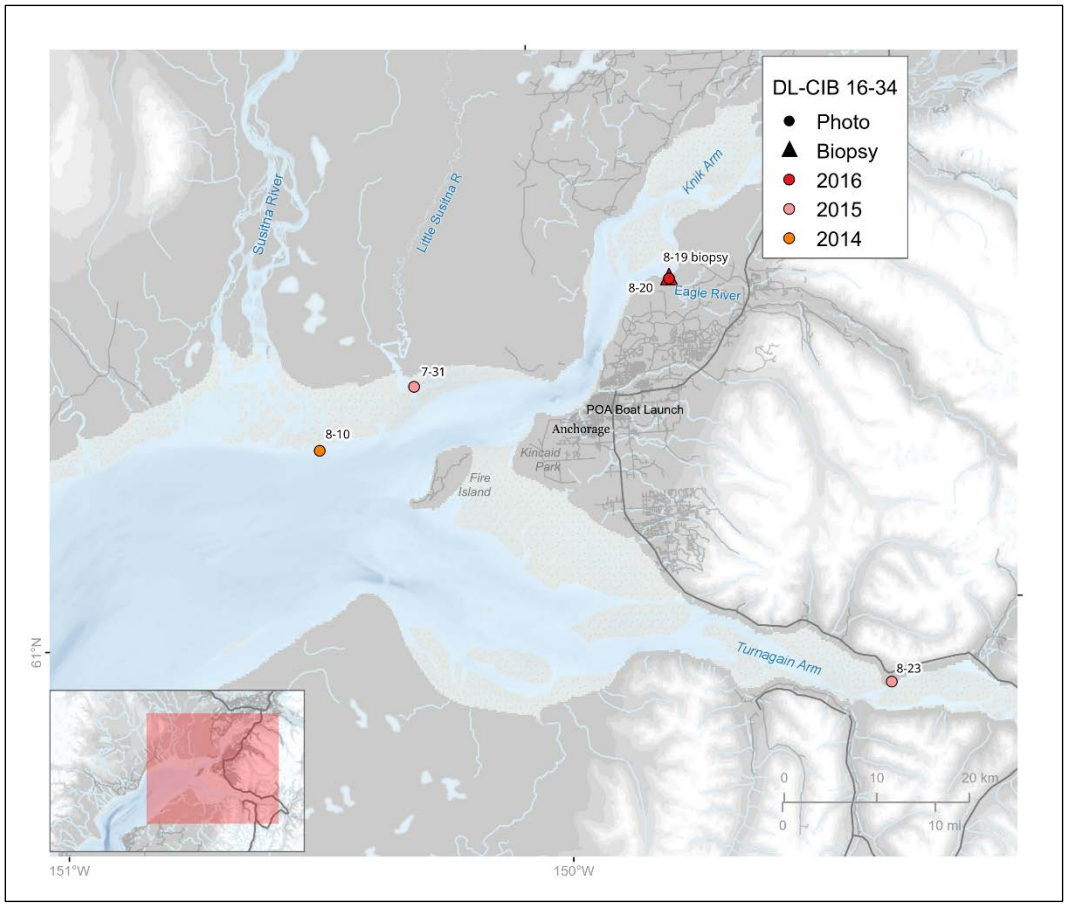
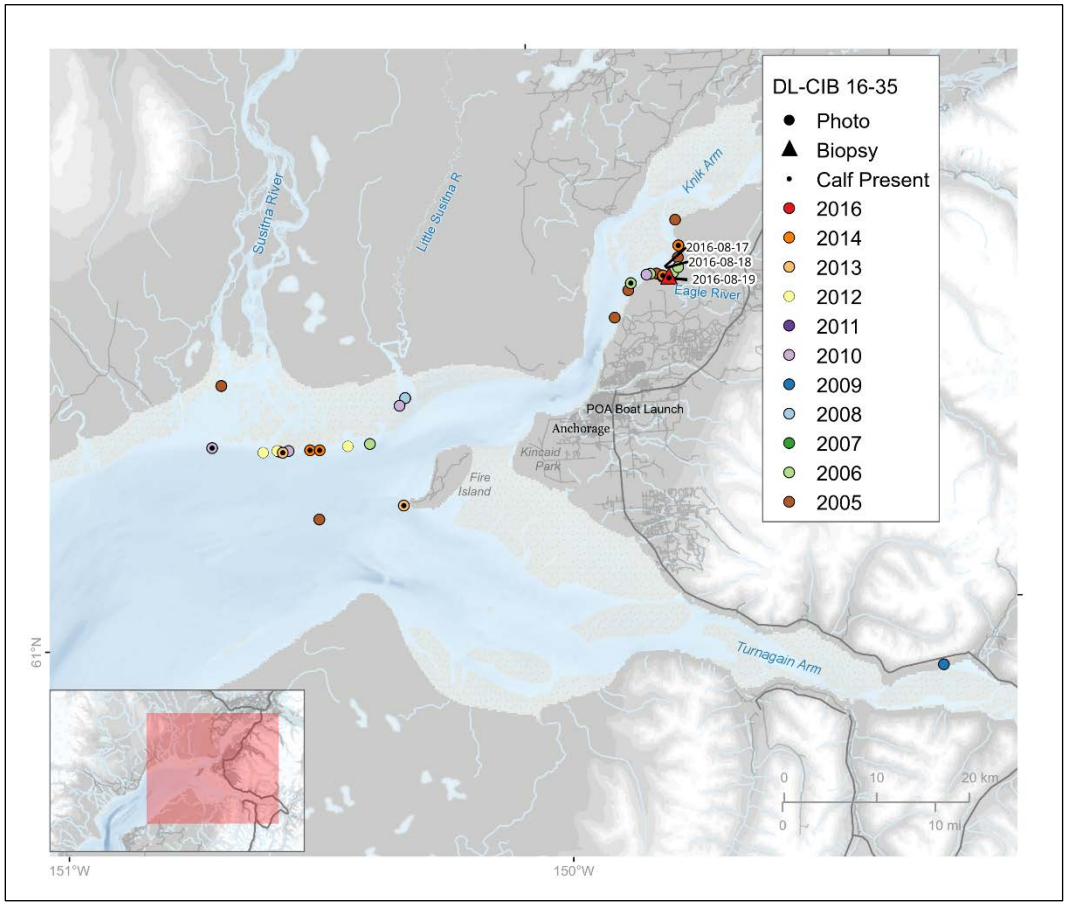


Figure D3. Whale DL-CIB 16-34 was biopsied from land on August 19, 2016. It was first identified in 2014. Although biopsy determined it is a female, it has not been photographed with a calf. (Photo is of the left side during biopsy.)



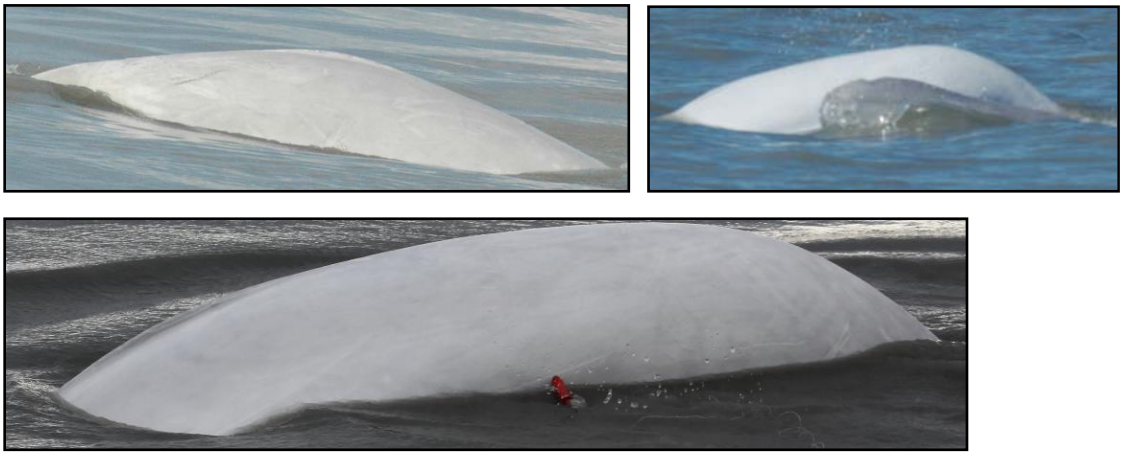


Figure D4. Whale DL-CIB 16-35 was biopsied from land August 19, 2016. It has a resighting history of being photographed with calves, and biopsy determined it is a female. (Top left photo is of the right side; top right photo is of the left side with a calf; bottom photo is of the left side with biopsy dart).

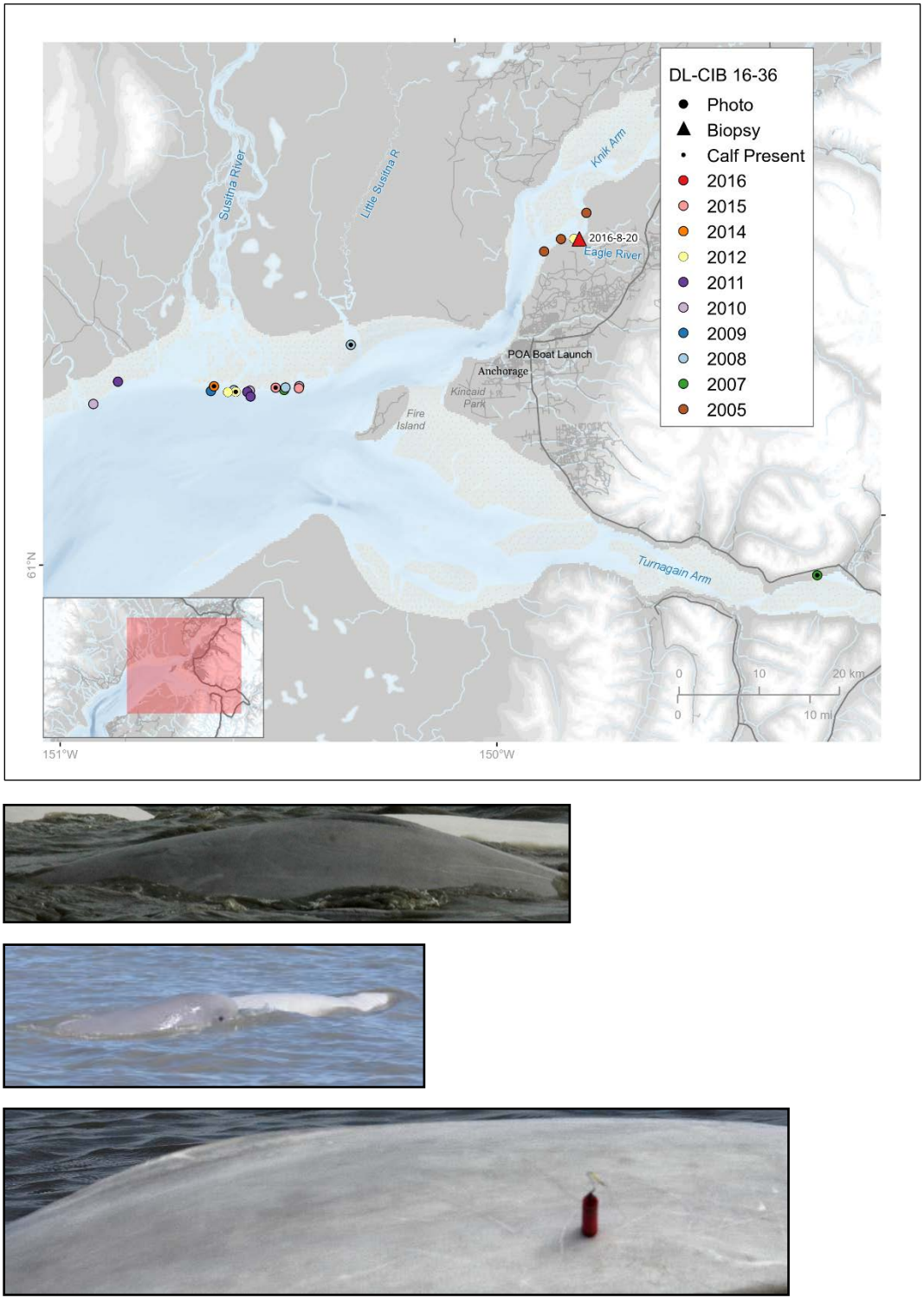


Figure D5. Whale DL-CIB 16-36 was biopsied from land August 20, 2016. It was first photographed in 2005 and has a resighting history of being photographed with calves, and biopsy determined it is a female. (Top photo is of the right side; middle photo is of the right side with a calf; bottom photo is of the left side during biopsy).

Appendix E. Sighting Histories of Known-Sex Individuals

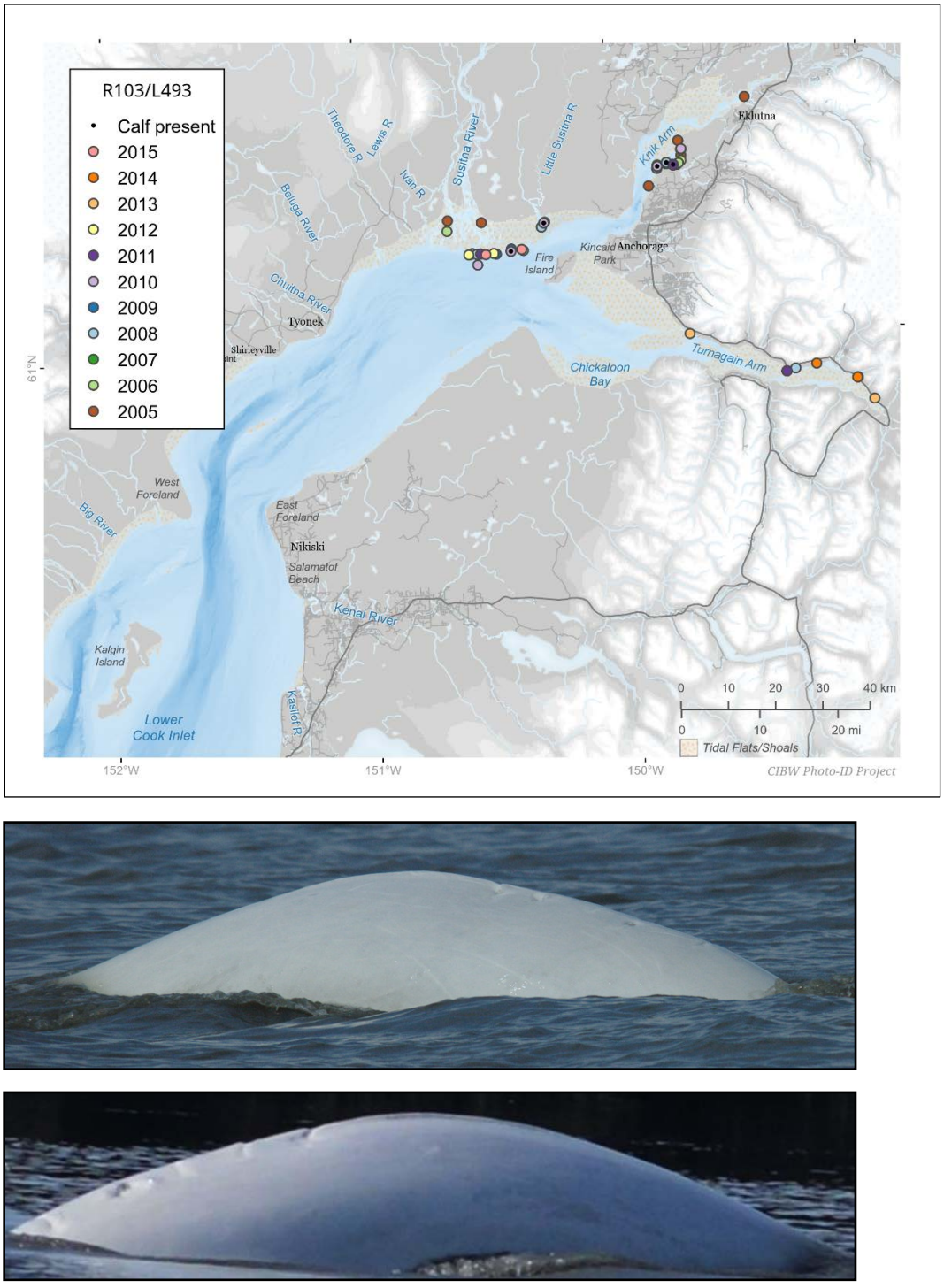


Figure E1. Sighting history and photographs of confirmed female beluga R103/L493. This whale was photographed in every year of the 2005-2015 study. This whale was tagged by NMFS on August 15, 2001 during their satellite tagging study. R103/L493 is a presumed mother based on photographs with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).

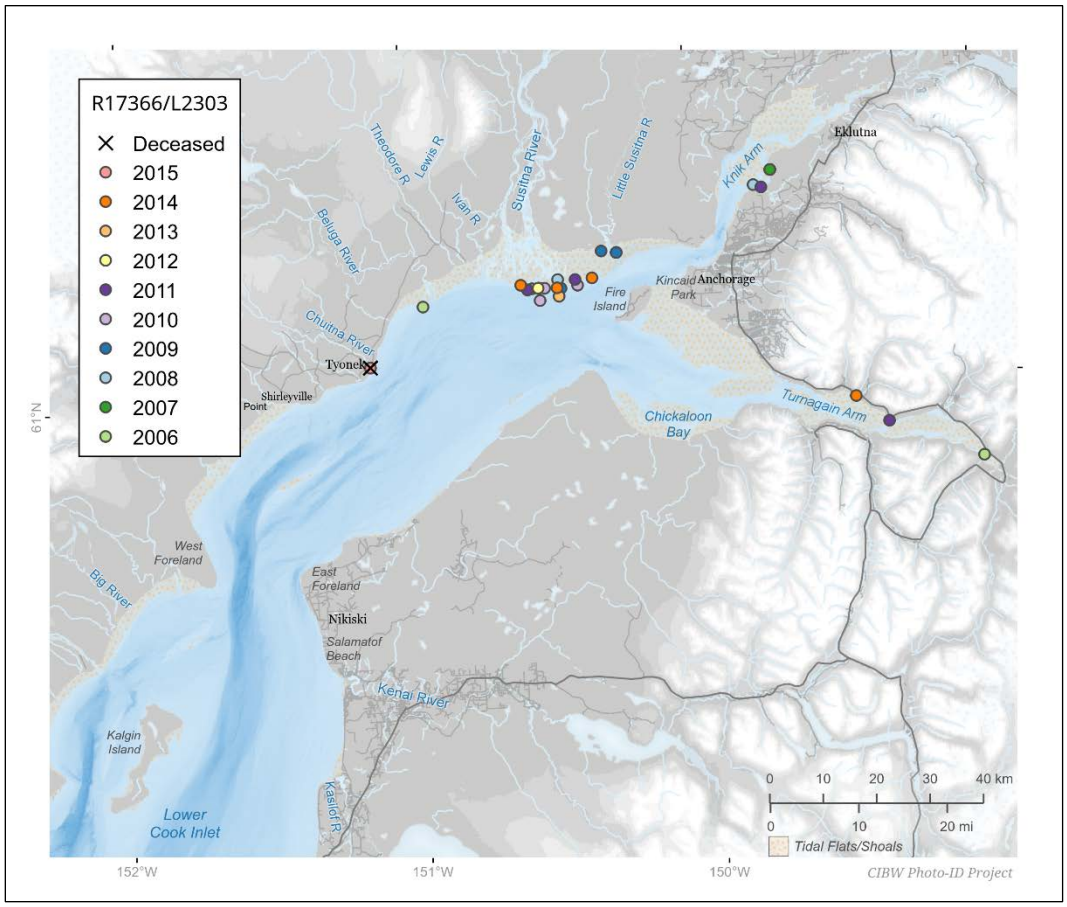


Figure E2. Sighting history and photographs of confirmed male beluga R17366/L2303. This whale was tagged by NMFS on August 2, 2002 during their satellite tagging study. This whale is a male and was found dead in 2015. (Top photo is of the right side; bottom photo is of the left side).

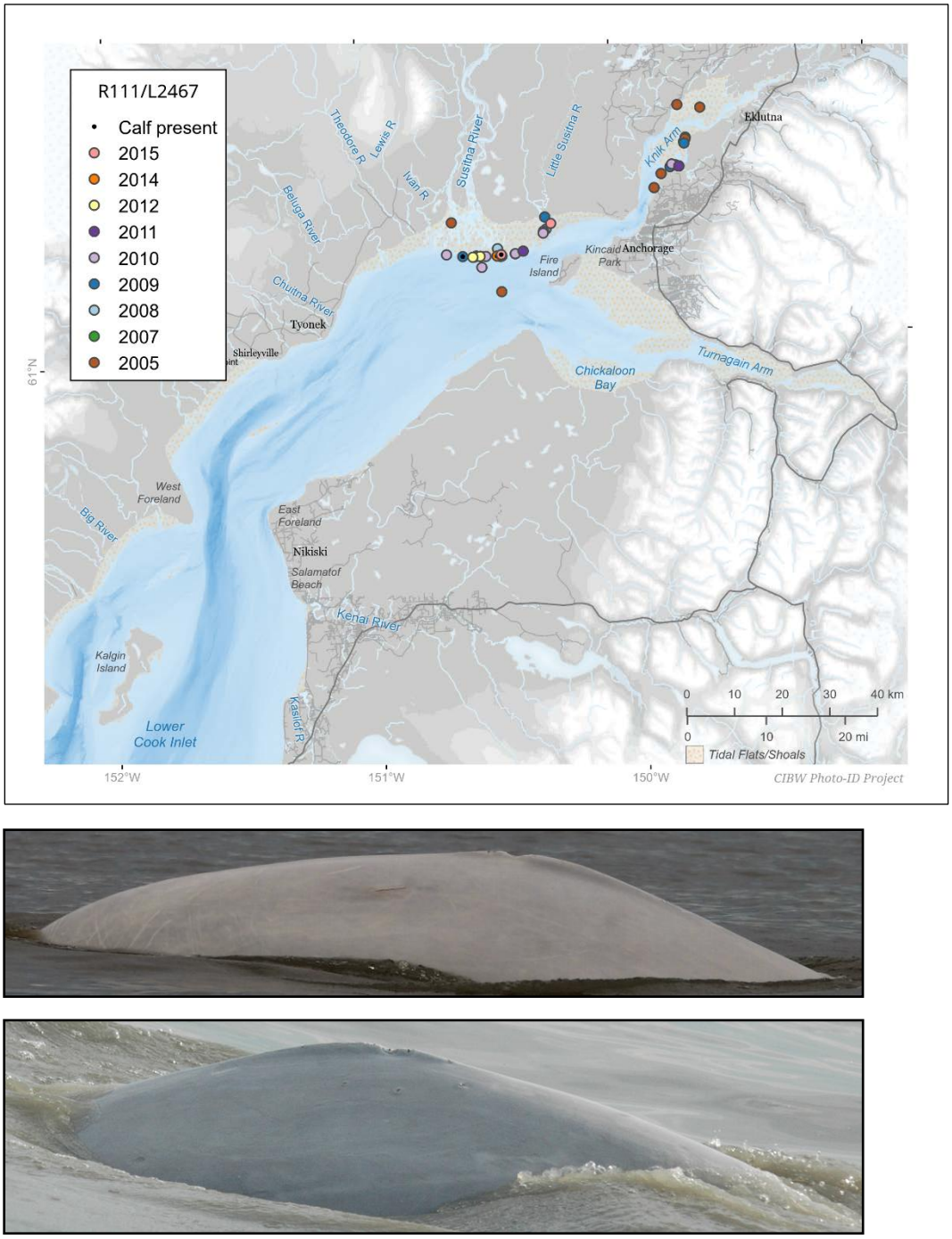
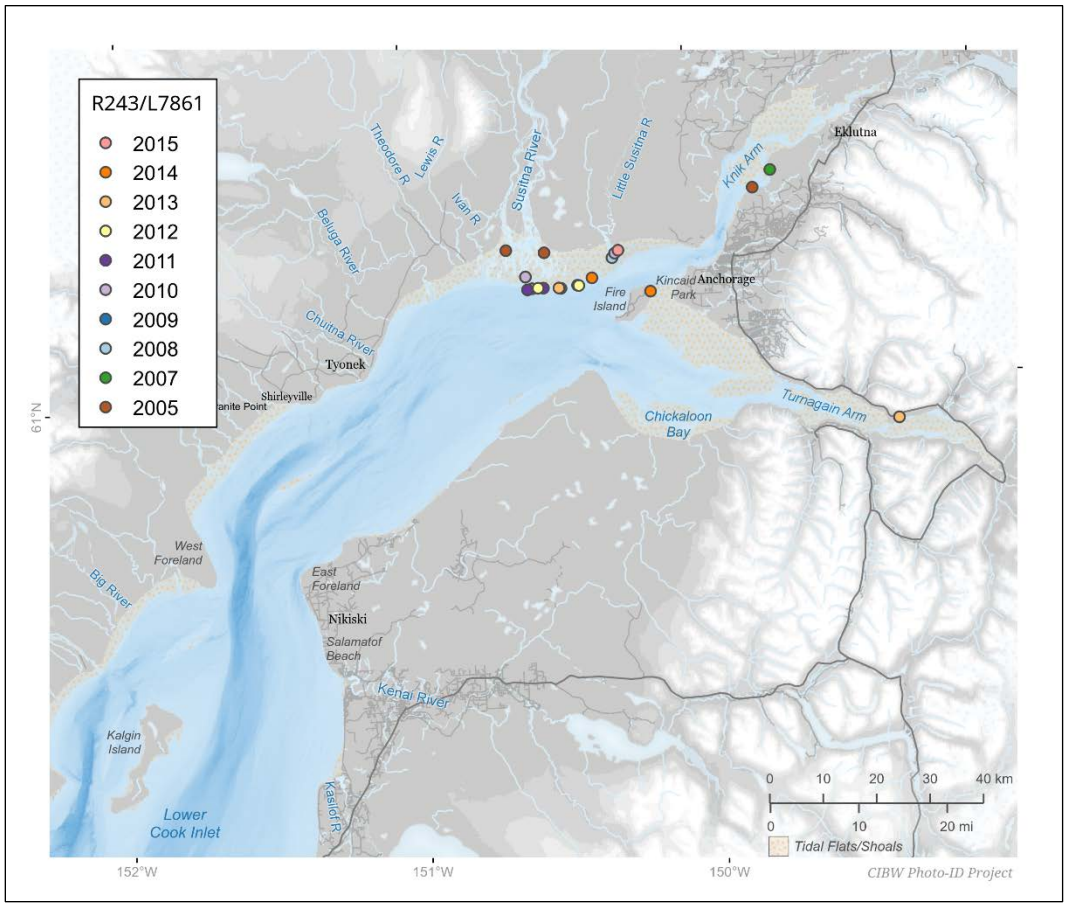


Figure E3. Sighting history and photographs of confirmed female beluga R111/L2467. This whale was tagged by NMFS on September 13, 2000 during their satellite tagging study. This whale is a female and a presumed mother based on photographs taken with an accompanying calf. (Top photo is of the right side; bottom photo is of the left side).



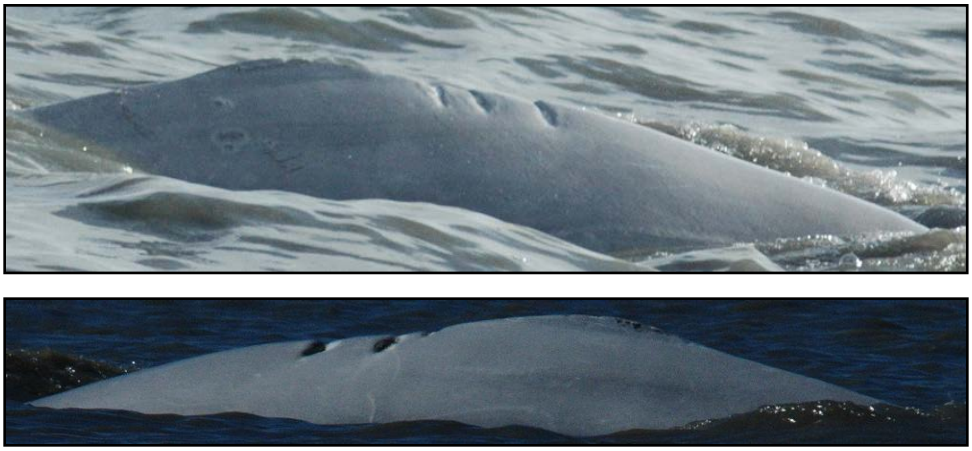


Figure E4. Sighting history and photographs of confirmed female beluga R243/L7861. This whale was tagged by NMFS on August 10, 2001 during their satellite tagging study. This whale is a female but has never been photographed with a calf. (Top photo is of the right side; bottom photo is of the left side).

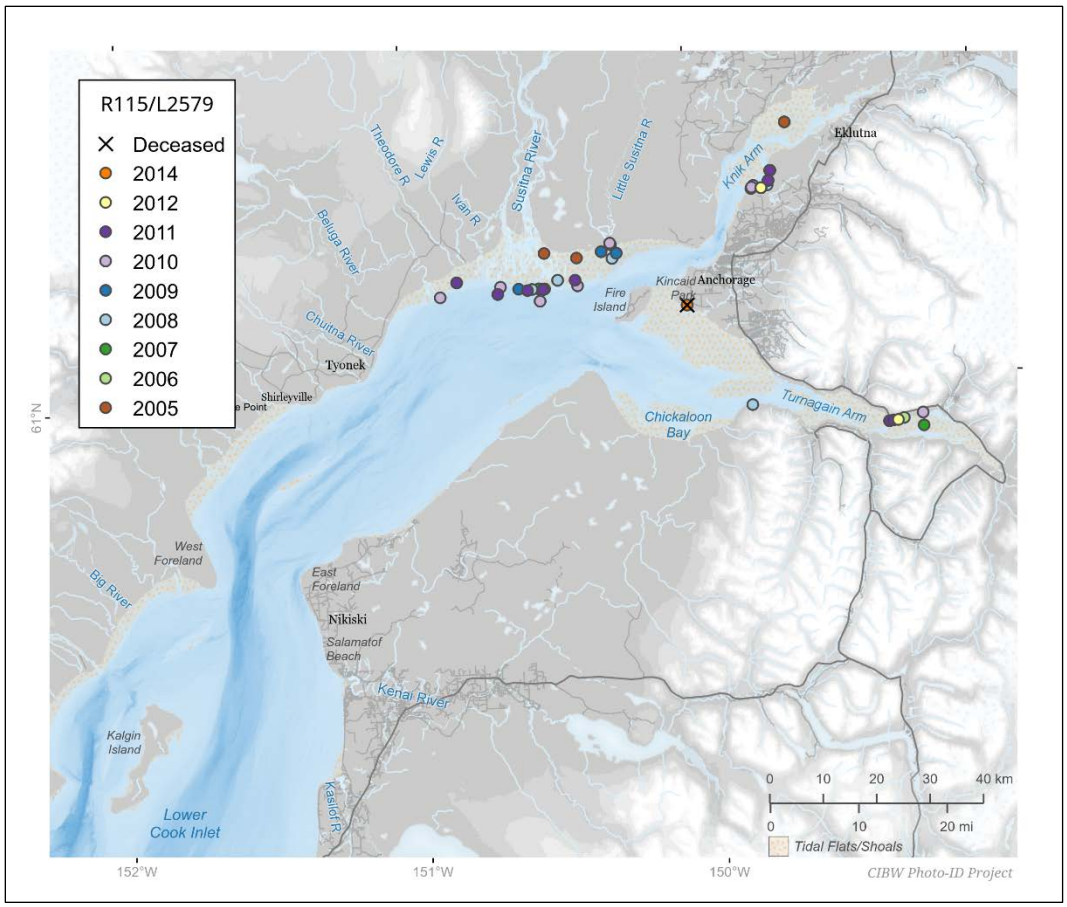


Figure E5. Sighting history and photographs of confirmed male beluga R115/L2579. This whale was tagged by NMFS on August 4, 2002 during their 1999-2002 satellite tagging study. This whale is a male and was found dead in 2014. (Top photo is of the right side; bottom photo is of the left side).

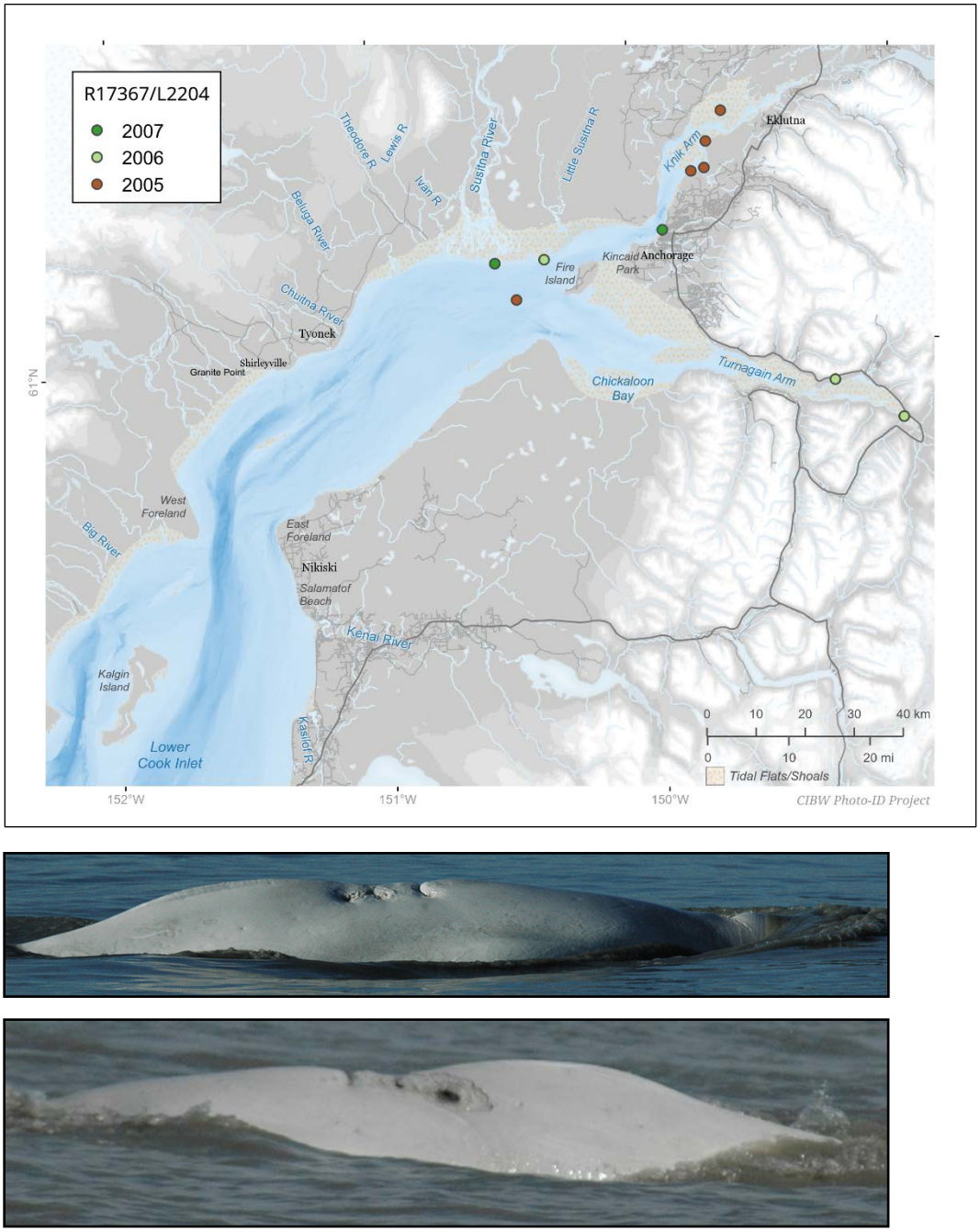


Figure E6. Sighting history and photographs of confirmed male beluga R17367/L2204. This whale was tagged by NMFS on August 3, 2002 during their satellite tagging study. This whale is a male and photo-id evidence indicates this whale may have died after 2007. (Top photo is of the right side; bottom photo is of the left side).

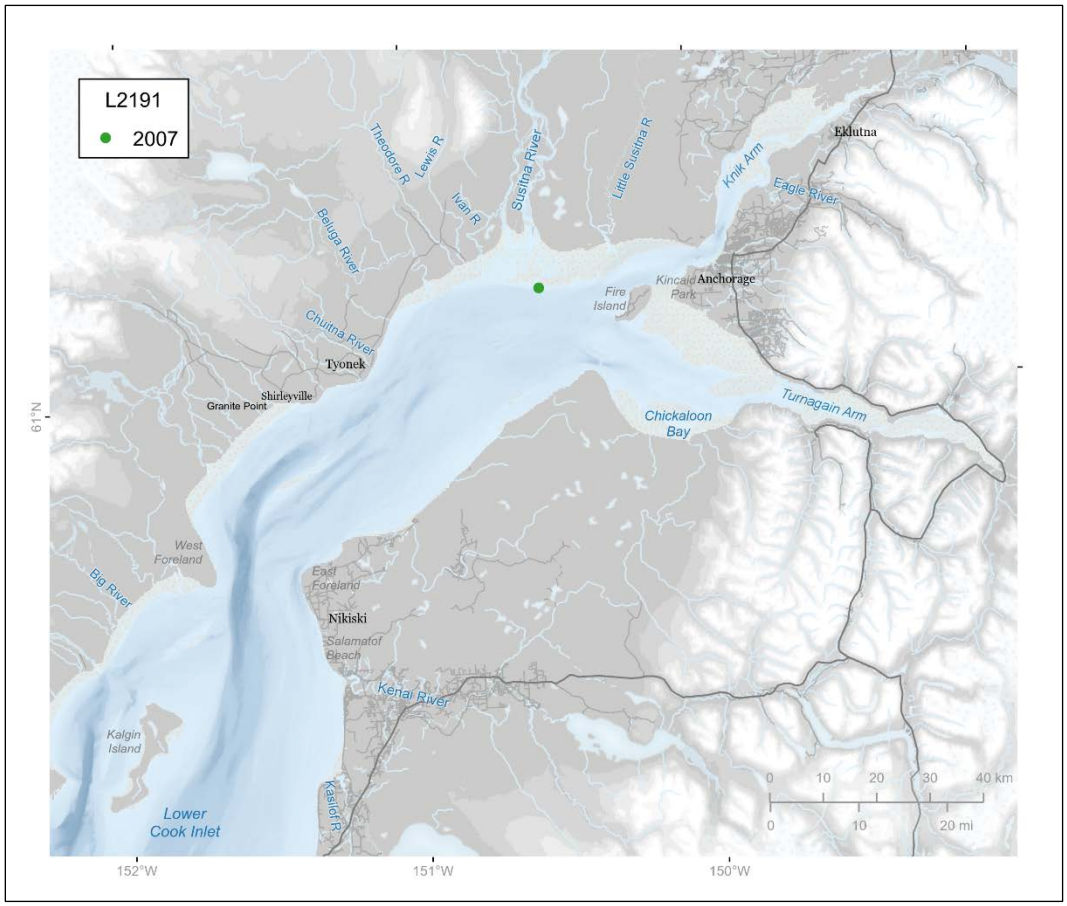


Figure E7. Sighting history and photograph of confirmed female beluga L2191. This whale was captured but not tagged by NMFS during their 1999-2002 satellite tagging study. (Photograph is of the left side).

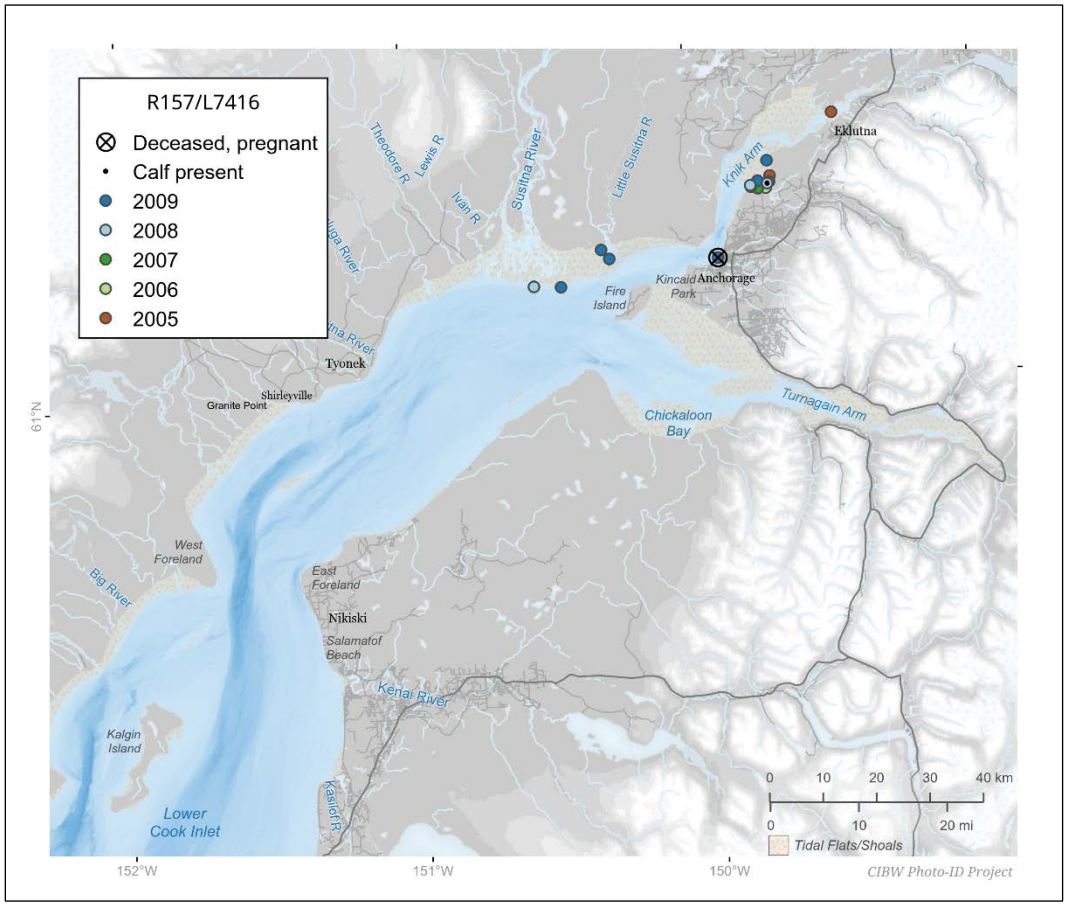


Figure E8. Sighting history and photographs of beluga R157/L7416. This pregnant female whale was found dead in Knik Arm in 2009. (Top photo is of the right side; bottom photo of the left side).

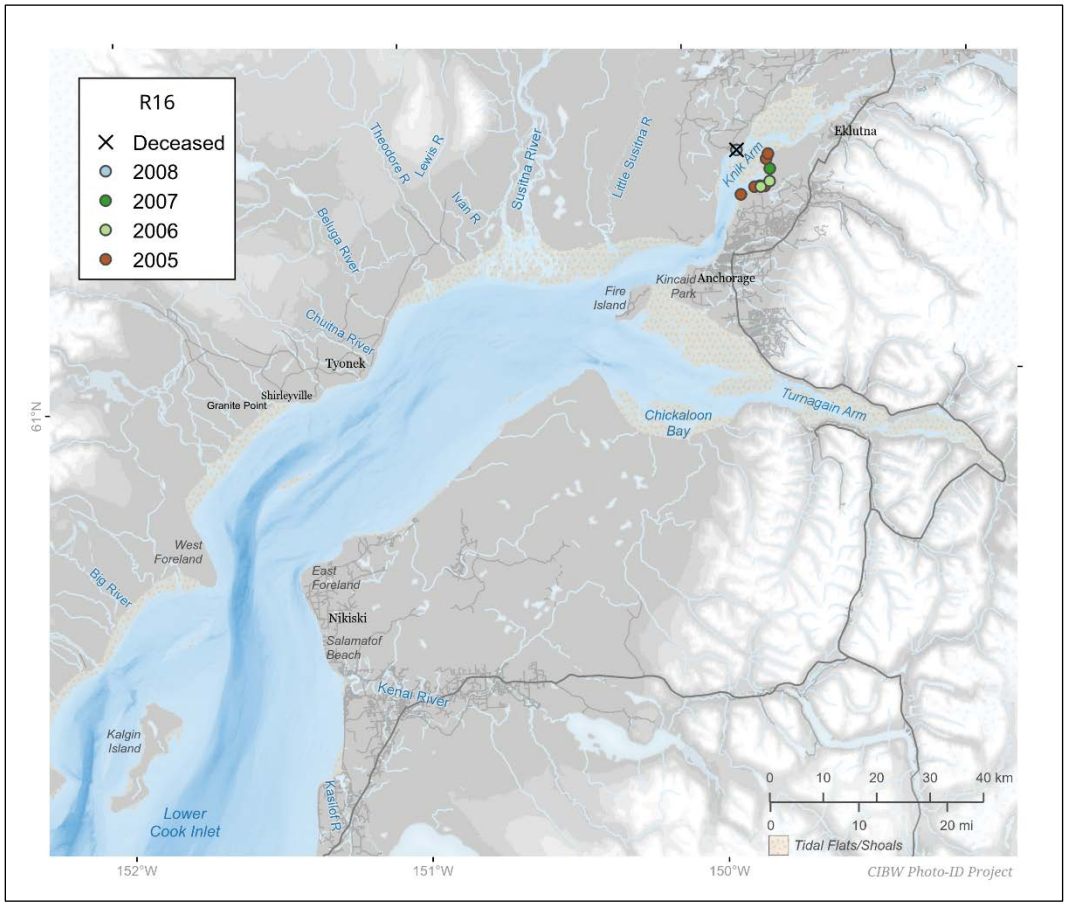


Figure E9. Sighting history and photograph of confirmed female beluga R16. This whale was found dead in Knik Arm in 2008. (Photograph is of the right side).

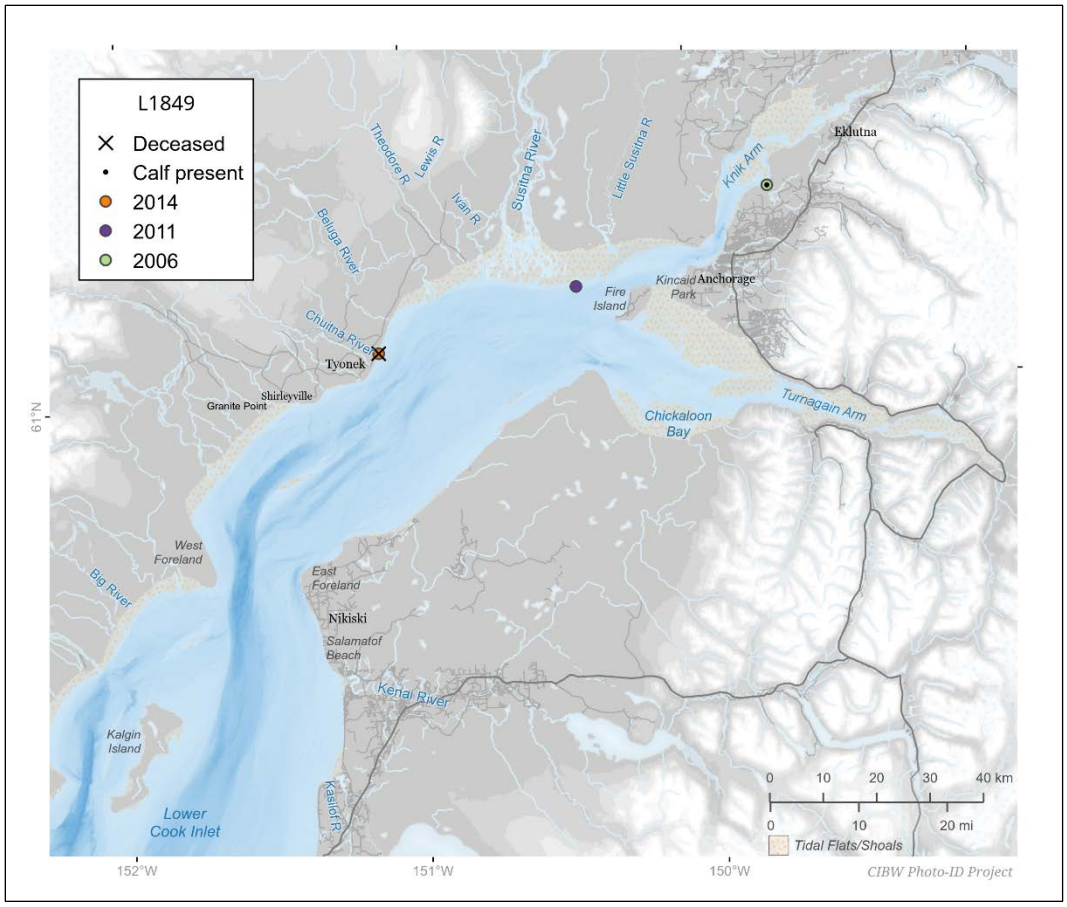


Figure E10. Sighting history and photograph of beluga L1849. This female whale was found dead near the Chuitna River mouth in 2014. This whale was a presumed mother based on photographs with an accompanying calf. (Photo is of the left side with a calf).

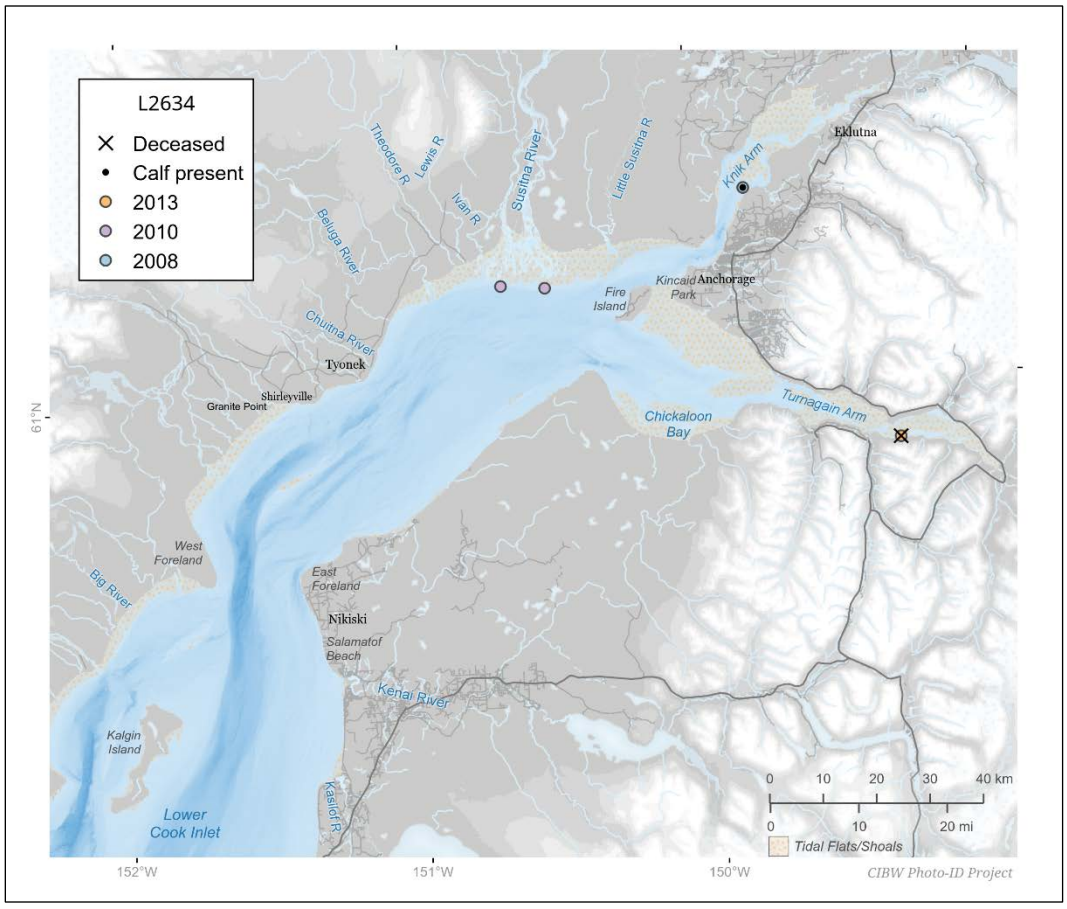


Figure E11. Sighting history and photograph of beluga L2634. This female whale was found dead onshore in Turnagain Arm in 2013. This whale was a presumed mother based on photographs with an accompanying calf. (Photo is of the left side with a calf).

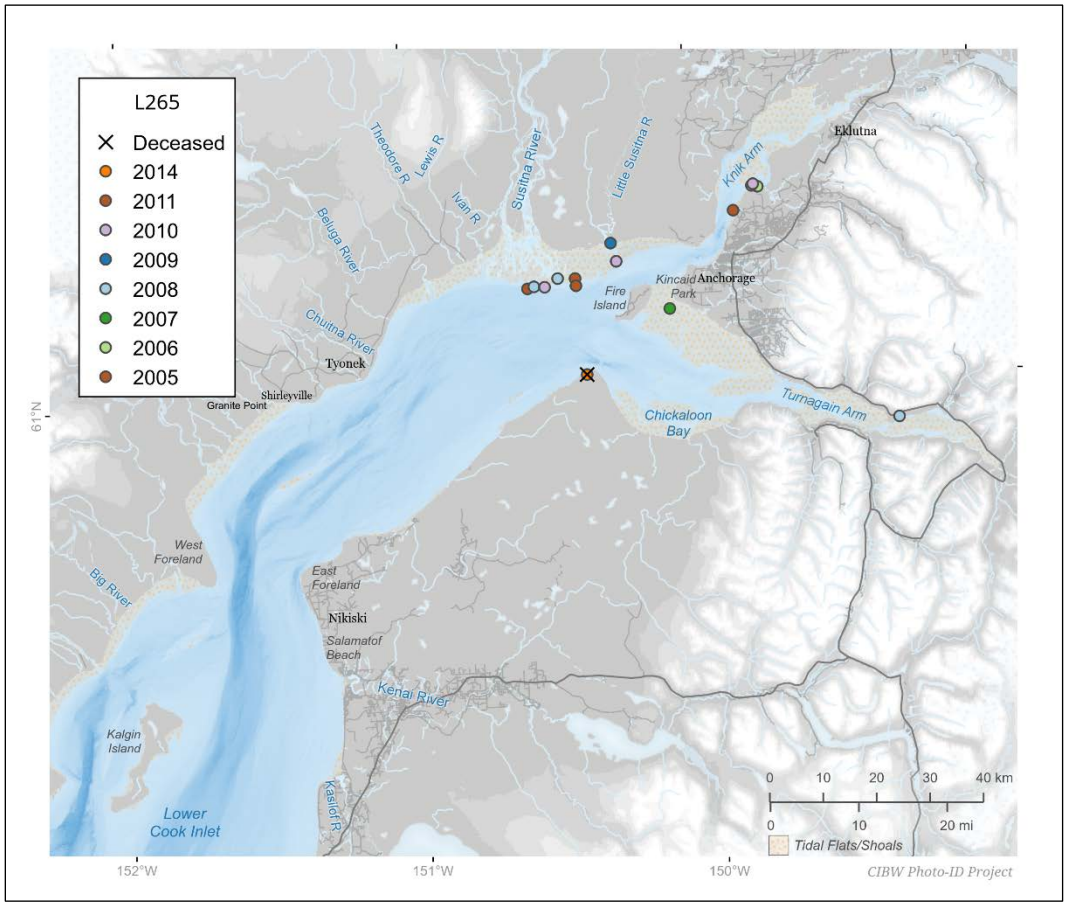


Figure E12. Sighting history and photograph of beluga L265. This female whale was found dead onshore near Pt. Possession in 2014. (Photo is of the left side).

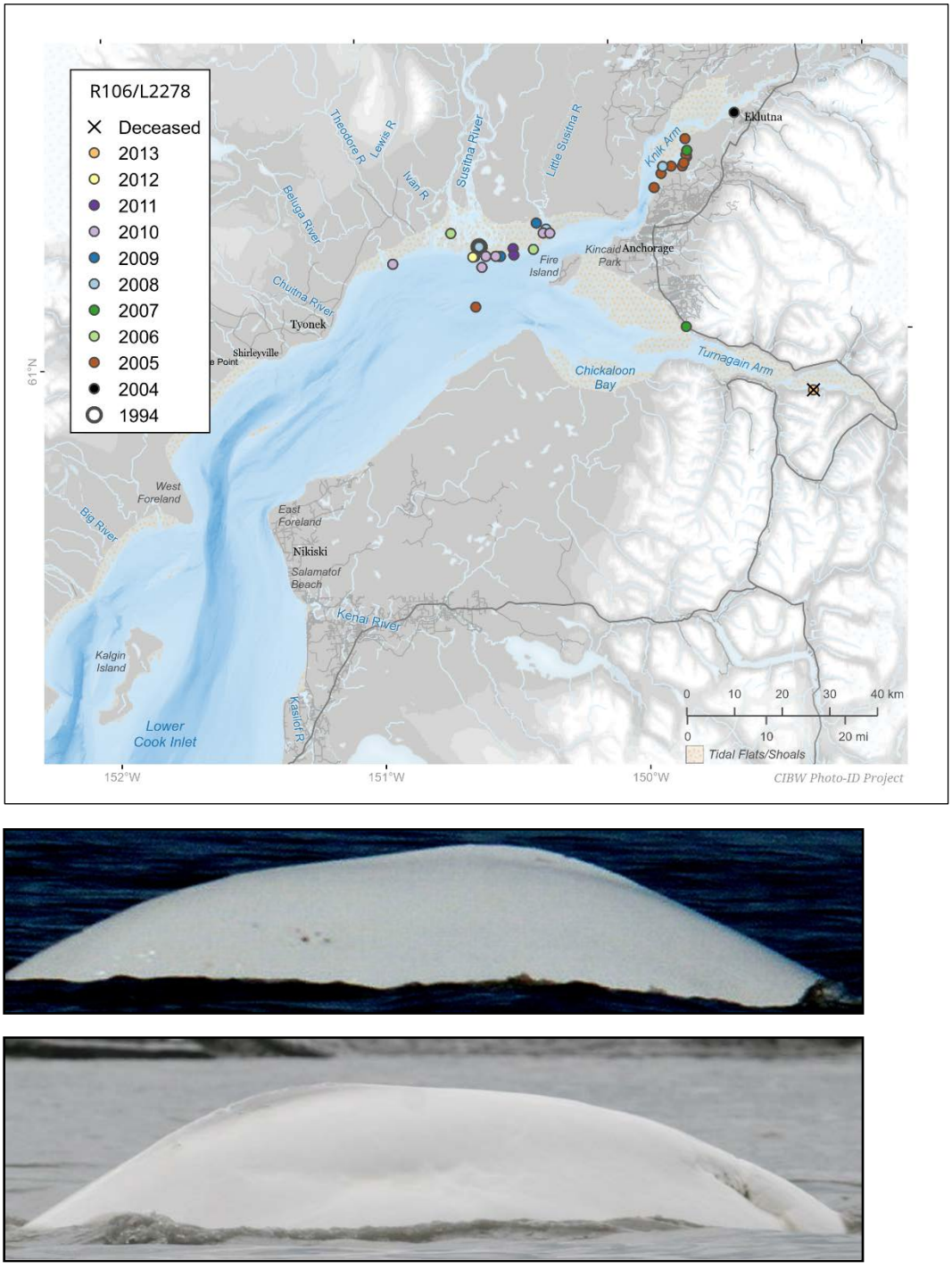
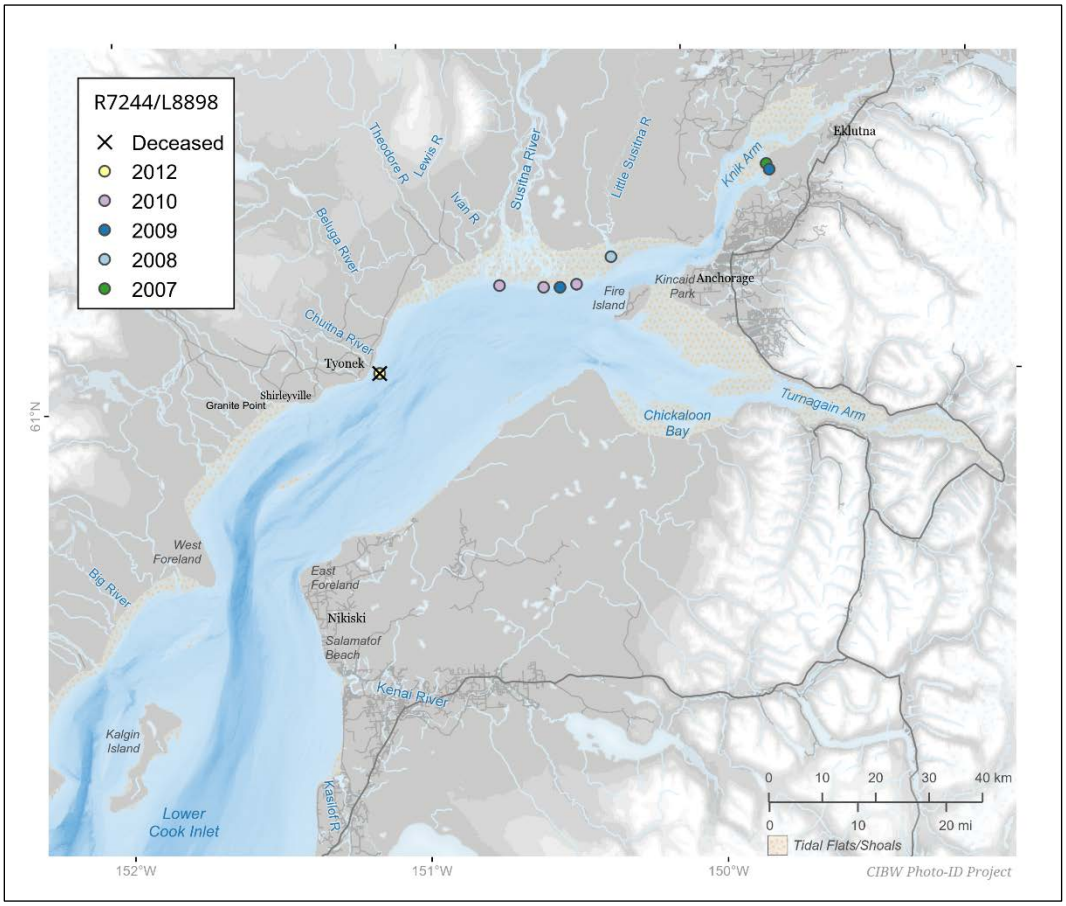


Figure E13. Sighting history and photographs of confirmed male beluga R106/L2278. This male was first photographed in 1994 by NMFS. It was found dead in Turnagain Arm in 2013. (Top photo is of the right side; bottom photo is of the left side).



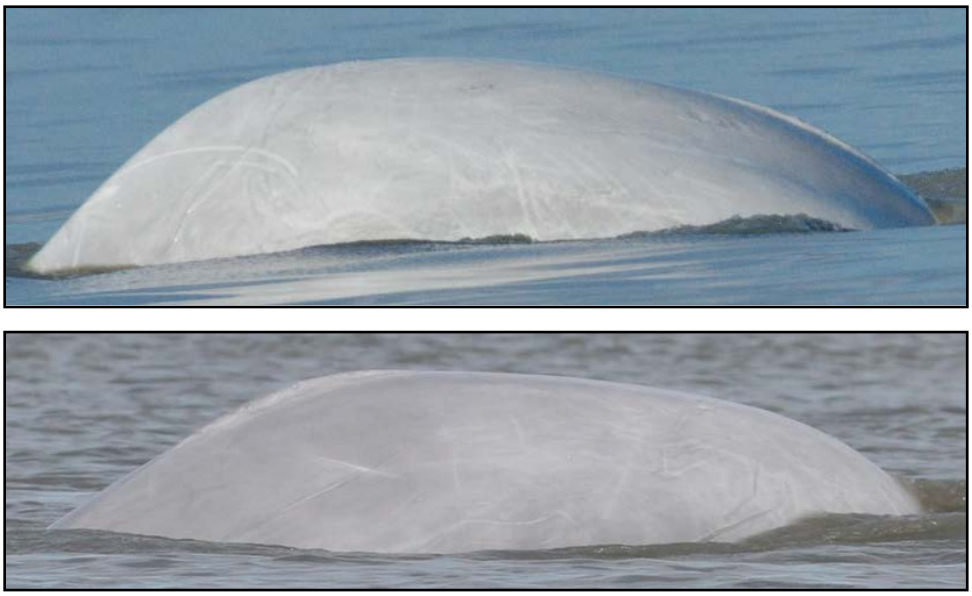


Figure E14. Sighting history and photographs of confirmed male beluga R7244/L8898. This male was found dead floating near Tyonek in 2012. (Top photo is of the right side; bottom photo is of the left side).

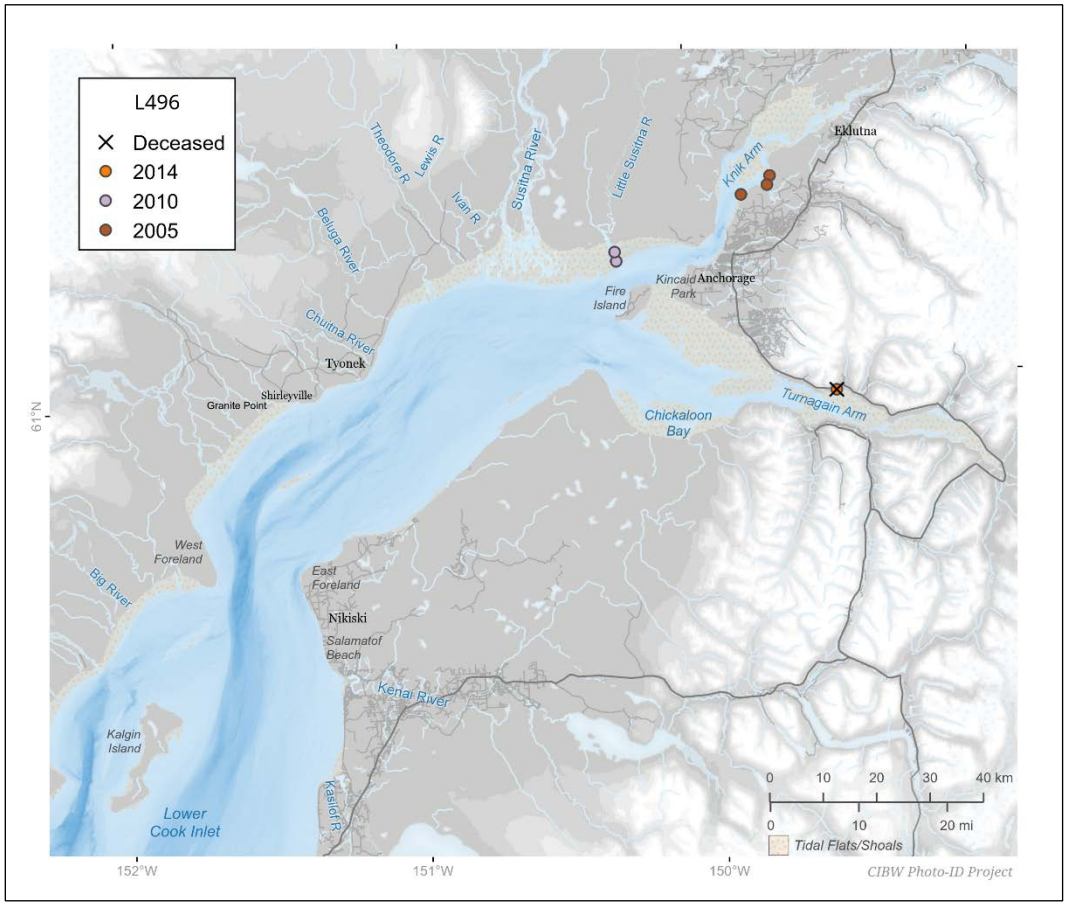


Figure E15. Sighting history and photograph of confirmed male beluga L496. This male was found dead onshore in Turnagain Arm in 2014. (Photo is of the left side).

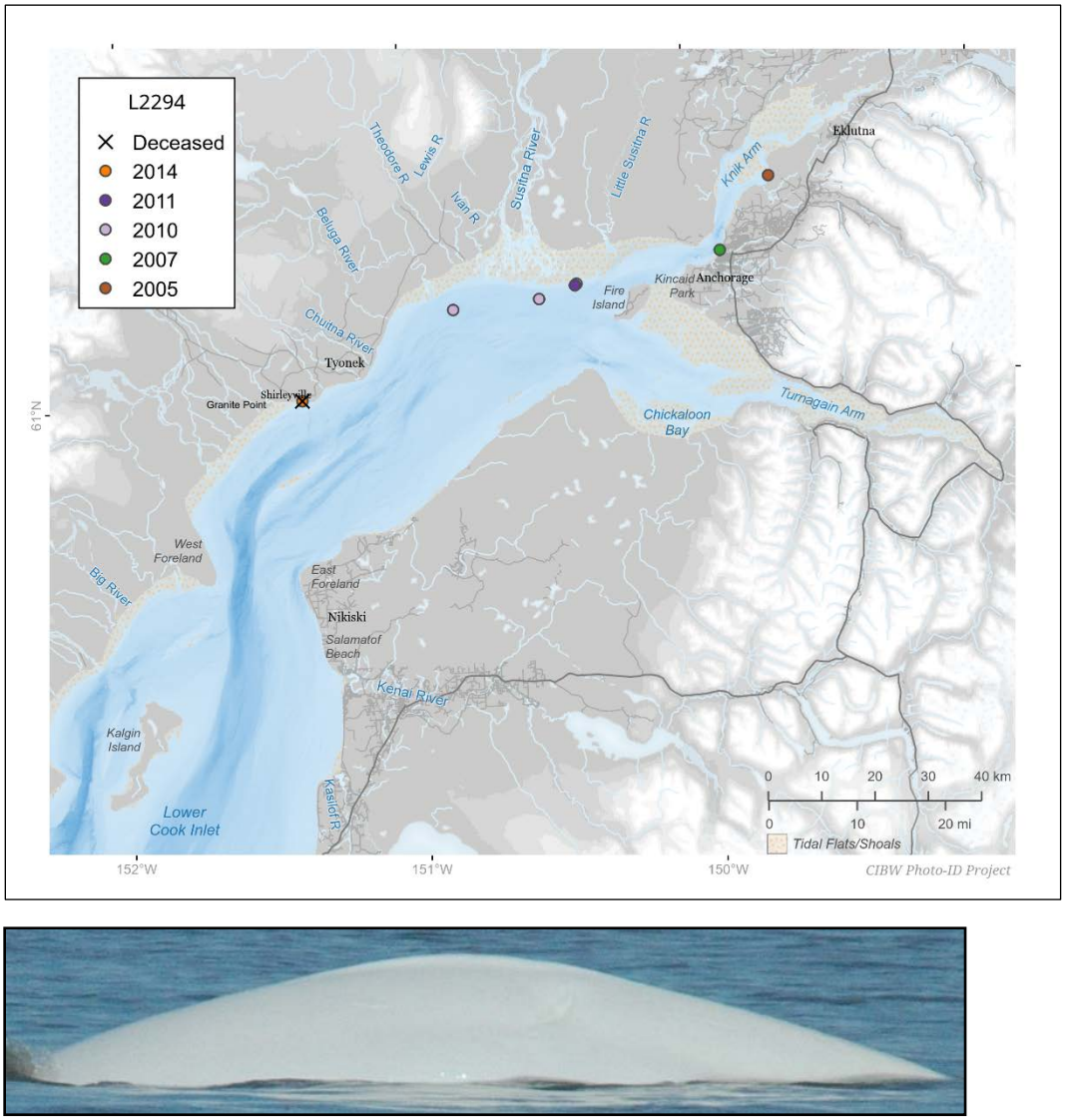


Figure E16. Sighting history and photograph of beluga L2294. This male was found dead onshore near Tyonek in 2014. (Photo is of the left side).

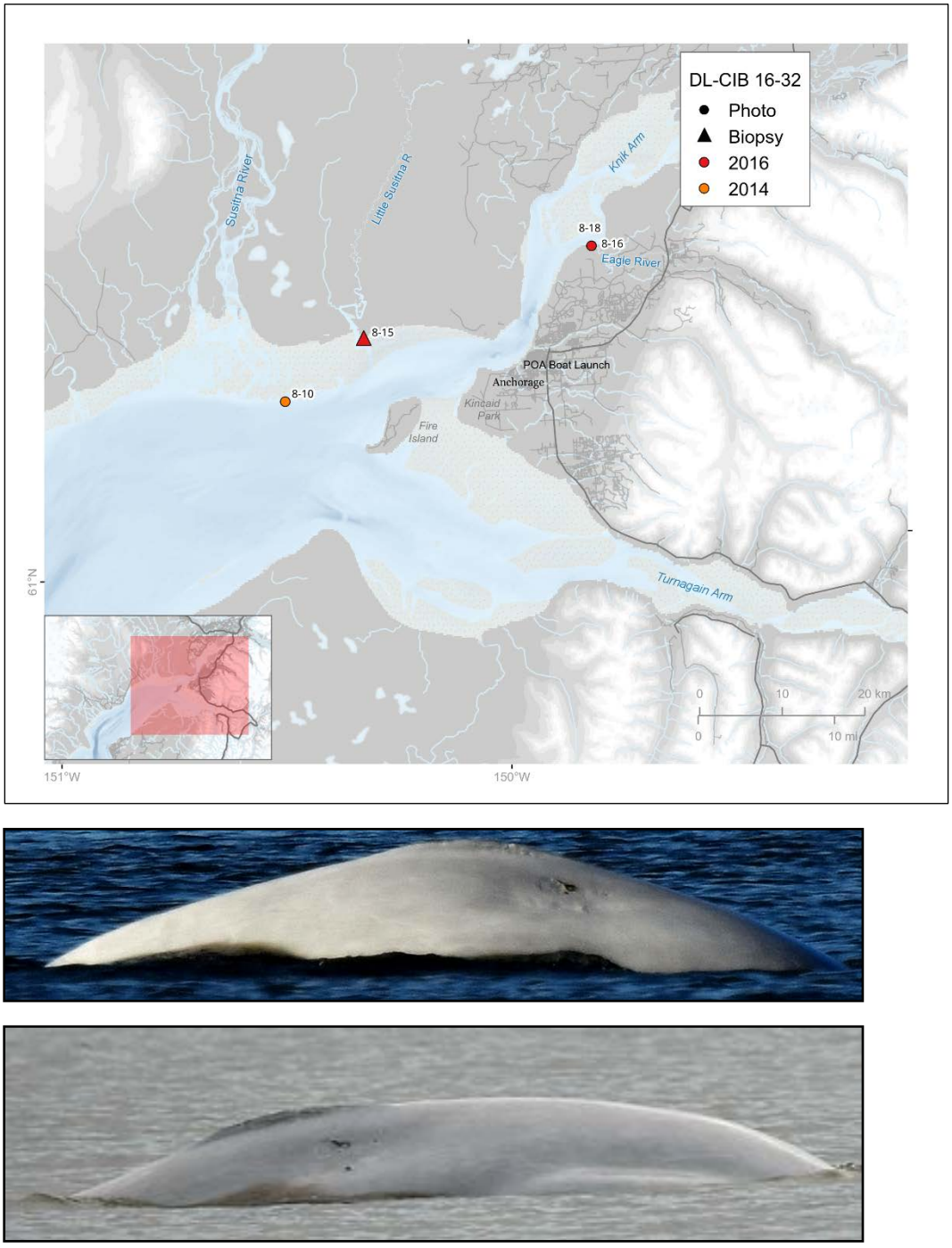


Figure E17. Whale DL-CIB 16-32 was biopsied on August 15, 2016. It was first identified in 2014. Biopsy determined it is a male. (Top photo is of the right side; bottom photo is of the left side).

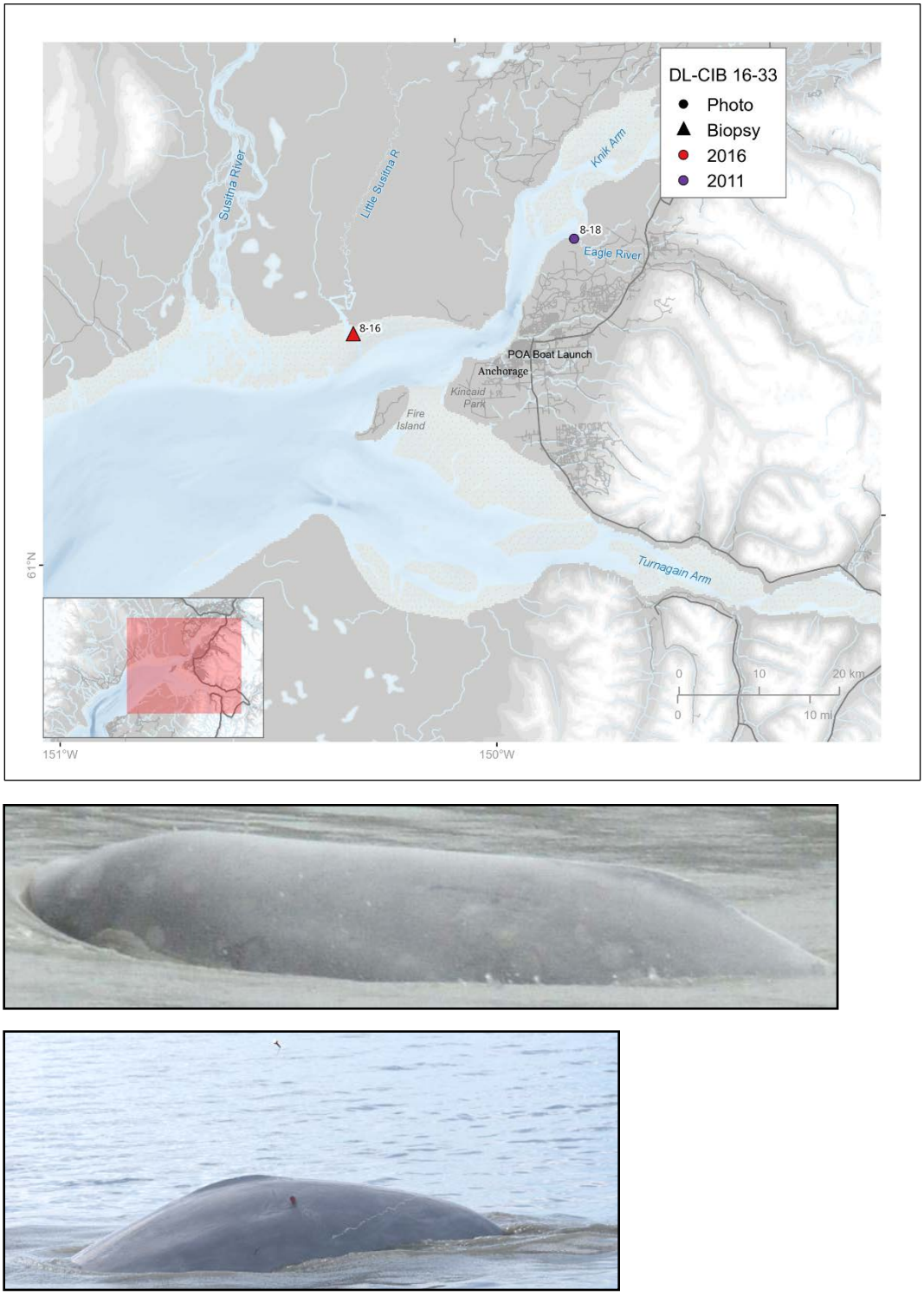


Figure E18. Whale DL-CIB 16-33 was biopsied on August 16, 2016 from a vessel. It was first identified in 2011 (top photo of the left side). Although biopsy determined it is a female, it has not been photographed with a calf. (Bottom photo is of the left side during biopsy.)

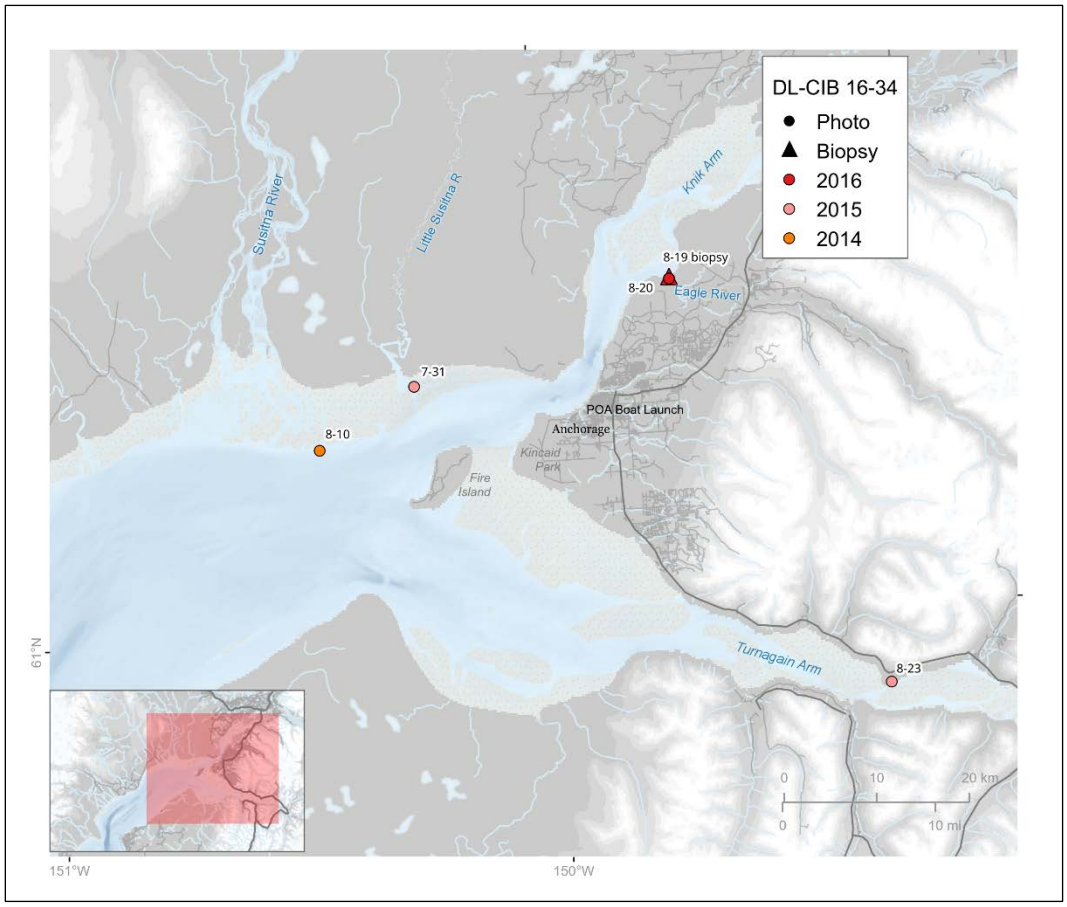


Figure E19. Whale DL-CIB 16-34 was biopsied from land on August 19, 2016. It was first identified in 2014. Although biopsy determined it is a female, it has not been photographed with a calf. (Photo is of the left side during biopsy).

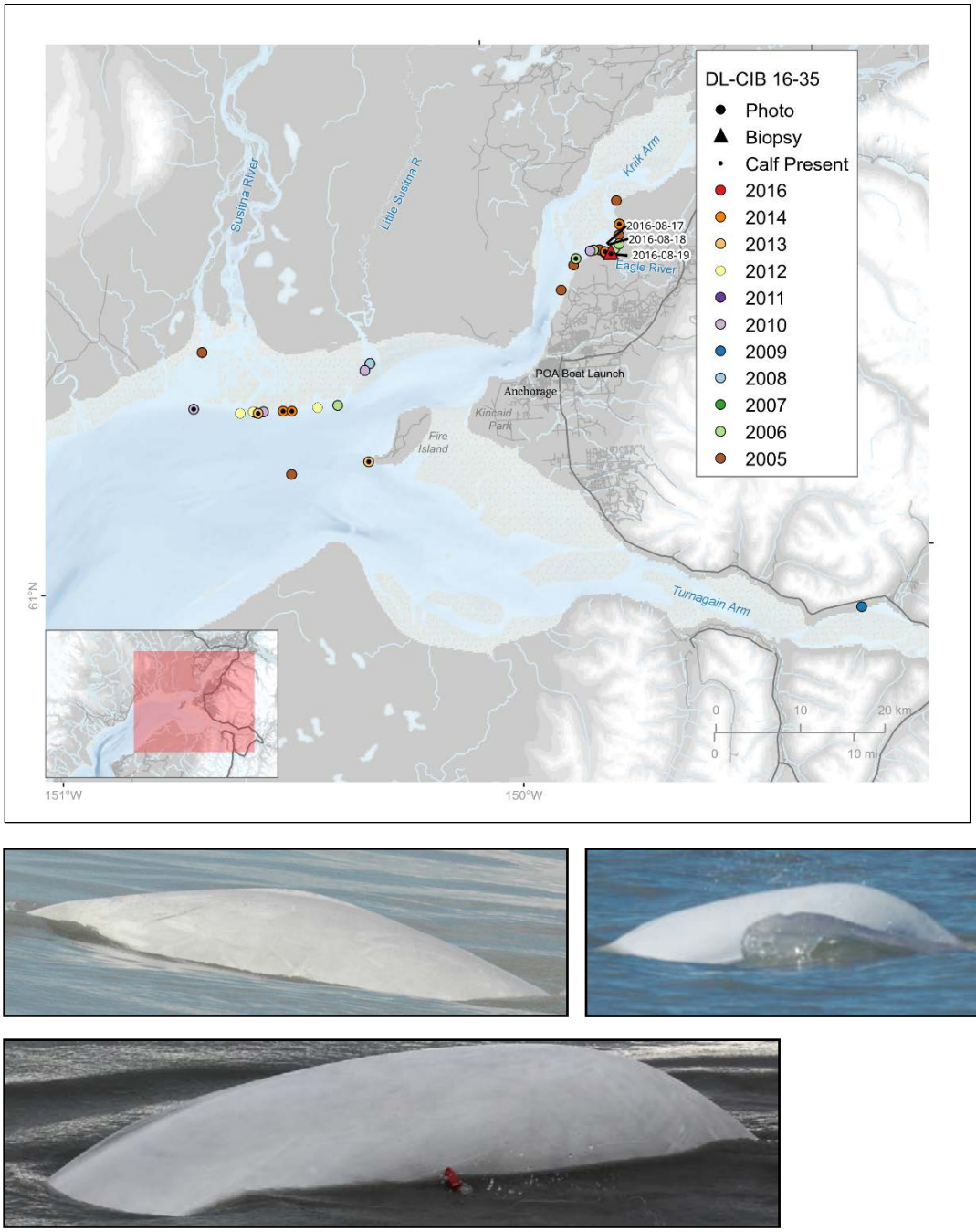


Figure E20. Whale DL-CIB 16-35 was biopsied from land on August 19, 2016. It has a resighting history of being photographed with calves, and biopsy determined it is a female. (Top left photo is of the right side; top right photo is of the left side with a calf; bottom photo is of the left side with biopsy dart).

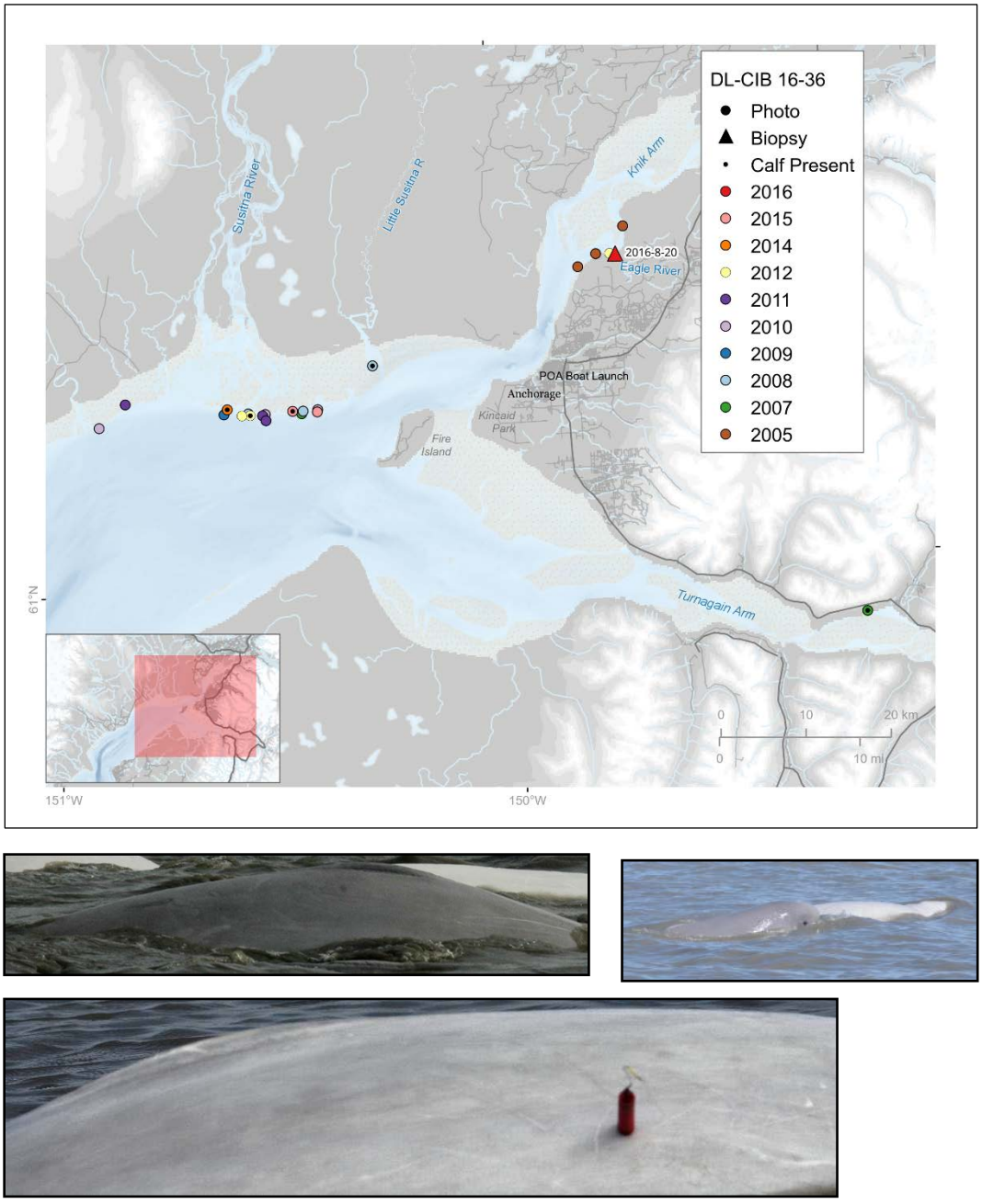


Figure E21. Whale DL-CIB 16-36 was biopsied from land August 20, 2016. It was first photographed in 2005 and has a resighting history of being photographed with calves, and biopsy determined it is a female. (Top left photo is of the right side; top right photo is of the right side with a calf; bottom photo was taken in 2016 and is of the left side during biopsy).

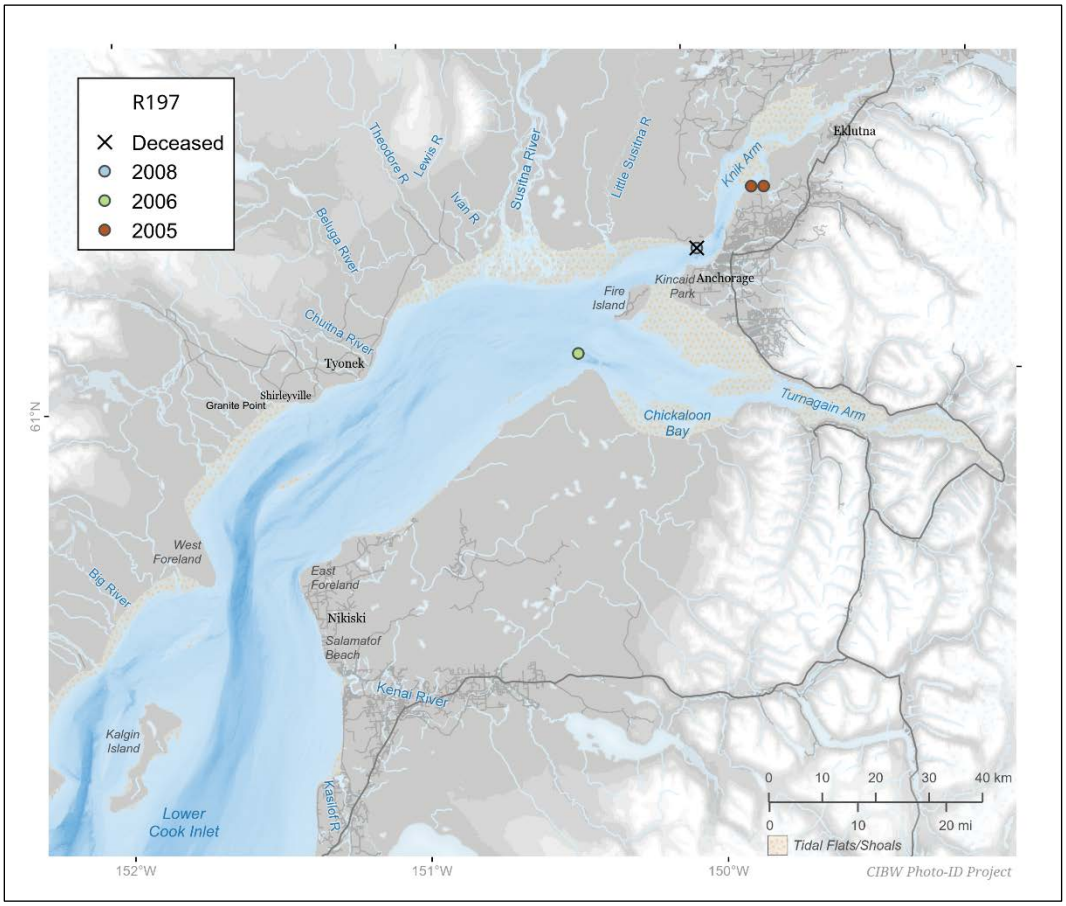


Figure E22. Sighting history and photographs of beluga R197. This female was found dead on shore in Knik Arm in 2008. (Photo is of the right side).

Appendix F: Outreach Activities for the 2005-2016 Cook Inlet Beluga Whale Photo-ID Project

Presentations about Cook Inlet Beluga Whales and the Photo-ID Project:

- the NMFS Beluga Whale Science Conference (2010, 2014)
- the NMFS Cook Inlet Beluga Whale Biopsy Workshop
- the Alaska Beluga Whale Committee
- the BP Cumulative Effects of Noise on Marine Mammals Working Group
- ConocoPhillips Alaska (Anchorage offices and Nikiski LNG plant)
- the Joint Base Elmendorf Richardson Conservation Division
- the Kenai Senior Center
- the Kenai Borough Cook Inlet Beluga Whale Conference
- the Northern District Set Netters Association of Cook Inlet
- United Cook Inlet Drift Association
- Cook Inlet Aquaculture Association
- the Alaska Marine Mammal Stranding Network Annual Meetings (2009, 2015)
- the Society for Marine Mammalogy Biennial Conference (2009, 2011, 2015)
- the Alaska Marine Science Symposium (2008-2017)
- the Alaska Chapter Meeting of the Wildlife Society
- the Defenders of Wildlife Cook Inlet Beluga Whale Symposium
- the Alaska Oil and Gas Association Environmental Studies Symposium
- the Cook Inlet Beluga Whale Recovery Team Stakeholder and Science Panels' First Meeting

Expertise Sharing

- Advised Friends of the Anchorage Refuge/Defenders of Wildlife on their citizen science Anchorage Coastal Beluga Survey (2009, 2010)
- Provided comments to NMFS about Beluga Critical Habitat, based on data from the Cook Inlet Beluga Whale Photo-id Project
- NMFS meeting for Knik Arm Crossing Project

Exhibits Developed

The CIBW Photo-ID Project worked with the Pratt Museum in Homer, the Alaska SeaLife Center, and the Alaska Teen Media Center Project with the Anchorage Museum to provide information and photographs about CIBWs and the CIBW Photo-ID Project for displays at these institutions.

Presentations at Festivals/Events

- Shared display booth with NOAA Office of Law Enforcement at "Great Alaska Gathering" Aviation Show, Ted Stevens International Airport, Anchorage. Made

and distributed pocket-sized cards for pilots, with contact numbers to call and report live and dead beluga whale sightings to NMFS and the CIBW Photo-ID Project.
- Shared display booth with NOAA Office of Law Enforcement at "Great Alaskan Sportsman Show" Anchorage. Staffed table with display on belugas and the CIBW Photo-ID Project.
- Sent project pamphlets with NOAA Office of Law Enforcement for their display booth at the Alaska State Fair, Palmer. August 2014.

Presentations in Schools (K-12, Undergraduate)

- A talk on the CIBW Photo-ID Project was given at the Four Valleys School in Girdwood, and students later participated in a land-based survey along Turnagain Arm. Students participated in interactive educational activities, such as "the blubber glove", the beluga matching game, and "name that beluga" (2014).
- A talk on belugas and the CIBW Photo-ID Project was given at the Kincaid Elementary to the entire 5th Grade. Students participated in interactive educational activities, such as "the blubber glove", the beluga matching game, and "name that beluga" (2014).
- Students and professors from the UAA Homer/Kenai Peninsula College Marine Mammal class accompanied project biologists during fieldwork along Turnagain Arm and the Kenai River and assisted with observations (2013 and 2014).
- Presentation on CIBWs and the Photo-ID Project to UAA Homer Marine Mammal class (2015-2016).
- Mentored Alaska Native Science and Engineering Program (ANSEP) Intern (2014, 2016).
- Presentation on CIBW and the Photo-ID Project to Anchorage Central Middle School for Science (2015).
- Symposium on Cook Inlet Beluga Whale Photo-id Project to faculty, staff, students (graduate and undergrad) and public at Hatfield Marine Science Center, Oregon State University, Newport Oregon (2011).
- Invited presentation on math and beluga whale studies for the Anchorage School District's "Middle School Girls Math Conference" (2010).

Press Articles

- Article about the CIBW Photo-ID Project in the Redoubt Reporter (2014).
- Article about the CIBW Photo-ID Project in the Peninsula Clarion (2014).
- Channel 2 News Interview (2008).

Factsheets Produced and Distributed

- Informational pamphlet
- Guide for how to photograph stranded CIBWs
- Business card-sized handout with information on how and where to report live and dead CIBWs.

Pamphlets and cards were distributed during fieldwork and at all public outreach events. Distribution during fieldwork included to fisherpeople, recreational boat users, and hunters at the Anchorage Small Boat Launch and Kenai City Dock; and to tourists and residents as they beluga-watched along the Seward Highway along Turnagain Arm.

Website

The CIBW Photo-ID project website (www.cookinletbelugas.org or www.cookinletbelugas.com) describes the project, gives background information about CIBWs and the project, and contains a page for members of the public to report beluga sightings and share photos with the project. The website address is distributed via the project bumper sticker (below), project pamphlets, and wallet-cards. All sighting reports are shared with NMFS.

Project Results

All CIBW Photo-ID Project reports are publicly available on the project website (www.cookinletbelulgas.org) as well as https://alaskafisheries.noaa.gov/pr/beluga-research-cook-inlet. In addition, the CIBW Photo-ID Project has provided their survey dataset to the publicly available "NMFS Cook Inlet Beluga Whale Scientific Sightings Mapper" at https://alaskafisheries.noaa.gov/pr/beluga-research-cook-inlet. These data are also a layer in the publicly available and free-of-charge Alaska Ocean Observing System's (AOOS) Cook Inlet Beluga Whale Ecosystem Portal http://portal.aoos.org/cibw.php.