Photo-identification of beluga whales in Knik Arm and Turnagain Arm, Upper Cook Inlet, Alaska

Summary of field activities and whales identified in 2014

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Cover Photo: Beluga whale mother and calf seen September 21, 2014, during low tide at Windy Corner, Turnagain Arm. Photo credit: A. Stephens, LGL Alaska Research Assoc.

EXECUTIVE SUMMARY

More information about Alaska's endangered Cook Inlet beluga whale (CIBW) population (*Delphinapterus leucas*) is needed to promote its recovery and conservation. The CIBW photo-identification catalog and associated surveys from ten field seasons (2005–2014) provide information about the distribution, movement patterns, and life-history characteristics of individually identified CIBWs, including mothers with calves. This report summarizes field effort and whales identified in Knik and Turnagain Arms in 2014. The fieldwork completed in 2014 brings the project total to 381 photo-identification surveys conducted in Cook Inlet.

Surveys of Knik and Turnagain Arms were conducted from land in 2014, August through October. In addition, two surveys of Knik Arm were conducted from a small vessel in August. CIBW sightings and environmental conditions were recorded during the surveys, and whales were photographed with a digital camera and zoom lens. Locations of CIBW groups and survey routes were mapped and figures were prepared showing survey routes, group location, group size, and group color composition.

There were 11 groups encountered and photographed in Knik Arm and 15 groups encountered and photographed in Turnagain Arm. Group size in Knik Arm ranged between one and 120 whales per group and group size in Turnagain Arm ranged between one and 70 whales per group. Mean group size in Knik Arm was more than twice as large as in Turnagain Arm. Color and age-class composition of all groups varied by survey date. Calves and/or neonates were seen in nine of the 11 groups encountered in Knik Arm and in eight of the 15 groups seen in Turnagain Arm. Milling and traveling were the most frequently observed group activities in Knik and Turnagain Arms. Feeding behavior was confirmed on August 18 in Knik Arm in Eagle River, and suspected feeding behavior was noted September 21 at Windy Corner during low tide. There were two instances in which belugas were seen to dive in apparent response to approach by humans (once in a skiff and once on paddle boards) and to remain submerged until the watercraft had moved away.

The 15,814 photos taken in Knik Arm and Turnagain Arm in 2014 were cropped and sorted into 6,642 useable images of the right sides of whales, and 6,327 left-side images. There were 47 individual whales identified from right-side photos taken in Knik Arm in 2014; two of these were new to the catalog in 2014 and 45 were individuals that had been identified in previous years of the study. Twenty individual whales were identified from right-side photos taken in Turnagain Arm in 2014; one of these was new to the catalog in 2014 and 19 were individuals that had been identified in previous years of the study. Photographs of ten dead belugas were either taken by or supplied to the CIBW Photo-Identification Project in 2014, and five of these were identified as known individuals in the photo-identification catalog.

A summary and synthesis of results of all photo-identification surveys of Cook Inlet conducted from 2005 to 2015 and of all sighting information from identified whales will be presented in a comprehensive report, scheduled to be issued December 2016. Previous project results are presented in reports that are available at https://alaskafisheries.noaa.gov/pr/beluga-research-cook-inlet.

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INTRODUCTION

Alaska's Cook Inlet beluga whale (CIBW) population (*Delphinapterus leucas*) is considered a distinct population segment by the National Marine Fisheries Service (NMFS) because of geographic and genetic isolation. A steep decline in the CIBW population occurred in the late 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; NMFS 2008a). Because 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.

Many information gaps and uncertainties are associated with the current understanding of the CIBW population's lack of recovery following the cessation of an unsustainable level of hunting that was thought to have contributed to the population decline (NMFS 2008b). More information on annual abundance estimates of age-specific cohorts, habitat preferences, 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. Data describing CIBW residency and movement patterns, habitat use by mothers and calves, and behavior will aid in the identification of movement corridors and locations of habitats for feeding, calving, and rearing of young.

Available sources of information used to understand distribution, movement, and habitat use include beluga whale sightings from aerial surveys (Hobbs et al. 2015; Rugh et al. 2000, 2004, 2005, 2006, 2010; Shelden et al. 2013, 2015a&b), tidal flow models (Ashford et al. 2013, Goetz et al. 2007, 2012a), and movement data from 14 satellite-tagged individuals (Goetz et al. 2012b, Hobbs et al. 2005, Shelden et al. 2015a). This information is key in characterizing and understanding habitat needs, as is information on beluga whale movement and residency patterns obtained from land-based observational studies of CIBWs in Upper Cook Inlet (Funk et al. 2005, Markowitz and McGuire 2007, Markowitz et al. 2007, Nemeth et al. 2007, Prevel-Ramos et al. 2006). Land- and vessel-based photo-identification surveys (McGuire and Bourdon 2012; McGuire and Kaplan 2009; McGuire et al. 2008, 2009, 2011a&b, 2013a&b, 2014) are also used to characterize distribution and movement patterns of individual beluga whales, and results of these surveys complement information from aerial surveys and tagging-tracking studies conducted by NMFS.

The CIBW Photo-Identification (photo-id) Project has been ongoing since 2005, and has demonstrated that beluga whales in Upper Cook Inlet possess distinct natural marks that persist across years, and that these marks can be effectively identified and re-sighted with digital photography. The photo-id catalog and associated surveys from ten field seasons (2005–2014) provide information about the distribution, movement patterns, and life-history characteristics of individually identified beluga whales,

including mothers with calves (McGuire and Bourdon 2012; McGuire and Kaplan 2009; McGuire et al. 2008, 2009, 2011a&b, 2013a&b, 2014).

This report presents results of land- and vessel-based surveys in Knik Arm (including Fire Island and the Port of Anchorage) and land-based surveys of Turnagain Arm in 2014. Additional beluga photo-id surveys in 2014 were conducted in the Susitna River Delta, and those results are presented in a separate report (McGuire and Stephens 2016). A summary and synthesis of results of all photo-id surveys of Cook Inlet conducted from 2005 to 2015, including all belugas identified in the 2005-2015 right-side and 2005-2011 left-side catalogs, will be presented in a comprehensive report scheduled to be issued December 2016.

METHODS

Field Surveys

Survey effort

Dedicated surveys and opportunistic sampling (Figure 1 and Figure 2) were conducted from land and from a small vessel in 2014. Survey schedules varied according to those combinations of season, location, and tide that provided the greatest likelihood of detecting the largest groups of beluga whales. These combinations were derived from results from NMFS aerial surveys (Hobbs et al. 2015; Rugh et al. 2000, 2004, 2005, 2010; Shelden et al. 2013, 2015a&b) other studies of CIBWs (Funk et al. 2005, Markowitz et al. 2007, Markowitz and McGuire 2007, Nemeth et al. 2007, Prevel-Ramos et al. 2006), and previous years of photo-id surveys in this area (McGuire and Kaplan 2009; McGuire et al. 2008, 2009, 2011a&b, 2013a&b, 2014). General routes were followed (Figure 2), although deviations were made depending on where beluga groups were encountered. Surveys generally lasted 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. Surveys were not conducted on days for which rain or high winds (>15 mph/24 km/hr) were predicted. Surveys of Knik Arm were centered around low tide and surveys of Turnagain Arm were centered around high tide. Tidal information was obtained from the program *JTides* (*www.arachnoid.com/JTides/*) for the Anchorage Small Boat Launch and Knik Arm, and from a combination of *JTides* and *www.Tides.info* (Sunrise Station) for Turnagain Arm.

Vessel-based surveys

Vessel-based surveys of lower Knik Arm were conducted from the *R/V Leucas*, a 4.9 m (16 ft) inflatable Proman 9 Zodiac® powered by a 4-stroke 50 hp Yamaha motor. The *Leucas* usually carried one skipper and one observer/photographer. Vessel position was recorded with a Garmin™ GPS (Global Positioning System) Map 76C. Survey routes were determined by tidal stage, water depth, and navigational hazards, and were designed to maximize the probability of encountering large 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. We did not approach within 50 meters of the belugas, as specified by our research permit. 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 were used to estimate approximate whale group positions. All vessel surveys were conducted under NMFS MMPA/ESA Scientific Research Permit # 18016. 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 the Department of Defense and the

Alaska Department of Fish and Game. One exception was made on August 23, 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. In addition, while en route to a survey of the Susitna River Delta on August 30, belugas were observed in lower Knik Arm and near Fire Island, and those data are included in this report.

Land-based surveys

Surveys along Turnagain Arm generally began three hours before high tide, based on results from previous research conducted by LGL (Markowitz and McGuire 2007). A single observer (or occasionally two together) drove south and east from Anchorage along Turnagain Arm's Seward Highway and stopped at turnouts along the highway. The observer alternated 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.

Dedicated surveys of the Eagle River Flats of Knik Arm (Figure 1 and Figure 2) were conducted from shore by a team of observers (2-4) lead by Joint Base Elmendorf Richardson, with invited participation by an LGL observer. Surveys were scheduled around the low tide, as this provided the greatest likelihood of detecting whales at this location (Funk et al. 2005, JBER 2010, McGuire et al. 2008). Observers were stationed at the mouth of Eagle River and had views of Eagle Bay and Eagle River.

Field 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 observer, 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, average distance among individuals, and any 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 the observer(s) to be the most accurate. Group size was usually difficult to determine and counts provided best estimates rather than the actual number of whales in the 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 would be an example of a discrete event by an individual.

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 – only recorded if a 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.

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. 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.

Environmental data were collected hourly or when conditions changed. Environmental variables recorded included Beaufort sea state, swell height, cloud cover, visibility, wind speed and direction, air temperature, 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 with auto-focus. Typical settings included shutter speed priority, dynamic auto-focus, 800 ISO, and shutter speed of 1,000 or greater. Photographs were taken in JPEG format and stored on compact flash memory cards.

Archiving and Analysis of Field Survey Data

All photographs were downloaded from the camera's compact flash 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 and photographs (2005–2014) were consolidated into a single, comprehensive, and integrated custom database. Data from surveys included the survey route, environmental conditions, 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 dates and locations when photos were taken. Locations of beluga whale sightings and survey routes were mapped in ArcGIS™ 10.2 (http://www.esri.com) and figures were prepared showing survey routes, group location, group size, and group color composition for each survey conducted.

Processing of Photographs

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 features of marks were obvious even in poor quality photographs, the photo was considered for inclusion in the catalog.

When an original field photograph contained two or more whales, 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, and was comprised of 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. 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.

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 1999-2002. Our research 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 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 were 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; 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. "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. Whales with complete profile sets were considered to be 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. All matches in the existing catalog were reviewed and verified by at least two experienced photo-analysts.

Identification of Dead Belugas

When informed of dead belugas by the Alaska Marine Mammal Stranding Network and authorized by NMFS, CIBW Photo-ID Project biologists photographed dead belugas, or relied on other stranding responders to obtain and share photographs of dead belugas. The project developed a protocol for photographing dead belugas for identification marks that was distributed to members of the Alaska Marine Mammal Stranding Network and posted on the NMFS Alaska Region website https://alaskafisheries.noaa.gov/pr/beluga-research-cook-inlet. Photographs of dead belugas were examined for marks that could be used to compare to photographic records from the 2005-2014 catalog. Sex and relative age (i.e., neonate, calf, adult) of dead whales were determined and entered into the records of cataloged individuals.

Incidental Beluga Sighting Reports

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 CIBW Photo-ID Project website (www.cookinletbelugas.org) contains a page for members of the public to report Cook Inlet beluga whale 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 Alaska Region Office and NMFS's National Marine Mammal Lab.

RESULTS

Surveys

Survey effort, number of whales, and whale groups encountered in 2014

In 2014, there were seven surveys conducted of Knik Arm (six in August and one in September) and eight surveys conducted in Turnagain Arm (two in August, five in September, and one in October; Table 1). The fieldwork completed in 2014 brings the project total to 381 photo-id surveys conducted in Cook Inlet over ten consecutive field seasons (Table 2). In 2014, there were 11 groups encountered and photographed in Knik Arm, and 15 groups encountered and photographed in Turnagain Arm (Table 1). Maps of whale group sighting locations and survey routes in 2014 are presented in Figures 3 through 6.

Group size in Knik Arm in 2014 ranged between 1 and 120 whales per group (Table 3). The largest of these groups was seen on August 18 (Table 3). Group size in Turnagain Arm in 2014 ranged between 1 and 70 whales per group, with the largest group seen on August 31 (Table 4). Slightly more groups per survey day were encountered in Turnagain Arm than in Knik Arm, but mean group size in Knik Arm was more than twice as large as in Turnagain Arm (Table 5).

Color composition and age class of groups encountered during surveys in 2014

Color and age-class composition of all groups varied by survey date (Table 3 and Table 4). For all 2014 Knik Arm groups combined, the average group contained 14% calves and 2% neonates, and was split roughly evenly between white and gray whales (Table 6). Groups in Turnagain Arm had a high percentage of animals of unknown age-class/color.

Calves and/or neonates were seen in nine of the 11 groups encountered in Knik Arm and in eight of the 15 groups seen in Turnagain Arm (Table 3, Table 4, Figure 7, and Figure 8). Neonates were first seen on August 23 in Knik Arm and on August 31 in Turnagain Arm. Neonates could have been present in groups in Turnagain Arm on August 21, but poor sighting conditions may have prevented their detection. Groups with neonates occurred in the same general locations as group without neonates (Figure 7 and Figure 8). Neonates were noted in groups seen on August 15, 18, 19, and 20, but were not counted separately from calves because the observer used the datasheet provided by the JBER team, who do not count neonates separately from calves.

Behavior of whale groups in Knik Arm and Turnagain Arm in 2014

Milling and traveling were the most frequently observed primary and secondary group activities in Knik Arm and in Turnagain Arm (Table 7 and Table 8). 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 Eagle Bay and Eagle River during low

tide, and traveled back up Knik Arm during rising tide. Whales in lower Knik Arm traveled down the Arm along the shore of the Port of Anchorage during the falling tide, traveled south and west along exposed mudflats between Point Woronzoff and north Fire Island, and appeared to head to the Susitna River Delta on the rising tide. Feeding behavior was confirmed and noted on August 18 in Knik Arm (Table 7 and Figure 9).

Whales along Turnagain Arm traveled up the Arm with the rising tide, occasionally stopping to mill in small coves and back eddies created by natural (i.e., Beluga Point, Bird Point) and man-made rocky outcroppings, traveling rapidly back down the Arm with the falling tide. They tended to follow the deeper channels along the north and south shores of Turnagain Arm and usually avoided the shallow areas found in the middle of the Arm, although during the rising tide they sometimes appeared to be looking for and pursuing prey along the edges of these shallow areas. On both the incoming and outgoing tides, whales often used the relatively quiet pools and eddies created by natural and artificial outcroppings to mill, presumably search for food, and possibly reduce their exposure to strong currents. The outcropping at Bird Point appeared to be a common area 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. Suspected feeding behavior was noted September 21 at Windy Corner during low tide (Table 8 and Figure 9). Possible nursing behavior was noted October 3 at Bird Point along Turnagain Arm (Table 8).

There were two instances in which belugas were seen to dive in apparent response to approach by humans and to remain submerged until after the humans had moved away. The first instance was August 23 at the Port of Anchorage small boat launch when a duck-hunting skiff approached a group of whales, and the second instance was on September 1 along Turnagain Arm when two paddle boarders approached a group of belugas (Table 7 and Table 8). The NMFS Office of Law Enforcement was contacted in both instances.

Photo-identification of beluga whales in Knik Arm and Turnagain Arm in 2014

The 15,814 photos taken in Knik Arm and Turnagain Arm in 2014 were cropped and sorted into 6,642 useable images of the right sides of whales, and 6,327 left-side images. Left-side images were archived. There were 47 individual whales identified from right-side photos taken in Knik Arm in 2014; two of these were new to the catalog in 2014 and 45 were individuals that had been identified in previous years of the study. Twenty individual whales were identified from right-side photos taken in Turnagain Arm in 2014; one of these was new to the catalog in 2014 and 19 were individuals that had been identified in previous years of the study. The individual sighting histories, movement patterns, and information on association with calves of these identified whales will be included in the 2005-2015 comprehensive report, scheduled to be issued December 2016.

Stranded belugas photographed in 2014

Photographs of ten dead belugas were either taken by or supplied to the CIBW Photo-ID Project in 2014 (Table 9 and Figure 10). Nine of these whales were classified

as adults and one as a calf. Photographs were provided by NMFS, members of the Alaska Marine Mammal Stranding Network, and the public. Of these ten dead belugas, five were identified as known individuals in the photo-id catalog, and five could not be identified from photographs. Detailed histories of the five identified dead whales will be presented in the 2005-2015 comprehensive report.

On August 23, NMFS relayed a report of a mass live-stranding of approximately 50 belugas during low tide in Knik Arm, near Eagle Bay, with possibly five belugas floating dead near Birchwood. Our survey boat had just returned to the Port of Anchorage after a survey of Fire Island, so we re-launched and traveled up Knik Arm to search for stranded belugas. Our boat had to turn back abruptly at Birchwood, due to live firing over the water from the Birchwood Firing Range. We did not encounter any dead or live-stranded belugas. NMFS later reviewed drone video provided by the Alaska Army National Guard and reported that all five belugas previously reported as dead were seen to re-float with the rising water and swim away (Mandy Migura pers comm, August 25, 2014).

Incidental sighting reports of belugas in 2014

Approximately 100 incidental reports of sightings of Cook Inlet belugas were received by the CIBW Photo-ID Project in 2014 (Table 10 and Figure 11). Sightings were reported by fishermen/women, pilots, the media, law enforcement officers, vessel operators, tourists, biologists, educators, regulators, environmentalists, and oil company employees. Belugas were reported in Knik Arm in August, and in Turnagain Arm in March, April, August, September, and December.

Observations of other marine mammals in 2014

Other than belugas and harbor seals, no other marine mammal species were seen during photo-id surveys. A humpback whale was photographed by LGL biologists in April in Turnagain Arm and was reported to NMFS. A stranded harbor porpoise was reported by NMFS in September in Kincaid Park in Anchorage.

DISCUSSION

Whales Encountered During Surveys

The seasonal pattern of CIBWs in Knik Arm and Turnagain Arm during the 2014 field season was consistent with patterns found in previous years of this study (McGuire and Bourdon 2012; McGuire and Kaplan 2009; McGuire et al. 2008, 2009, 2011a&b, 2014) and in other studies (Hobbs et al. 2005; Moore et al. 2000; Nemeth et al. 2007; Shelden et al. 2015a); belugas abruptly appear in the Arms in early-mid August, just as the large groups in the Susitna River Delta are breaking up, peak mid-late August through mid-September, then taper off for the rest of the ice-free season. 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–early August; NMFS 2008b).

Patterns of localized aggregations and rapid and directed travel among distinct areas have been reported for satellite-tagged CIBWs (Hobbs et al. 2005) and beluga whales in Norway (Lydersen et al. 2001). Because sightings of Cook Inlet belugas transiting between known aggregation areas (i.e., the Susitna River Delta, Knik Arm, Turnagain Arm, the Kenai River Delta) are low, it remains unknown if there are distinct movement corridors among areas or if movement patterns are more diffuse and variable. For example, do whales always use the channel between Fire Island and Anchorage to travel between Knik Arm and Turnagain Arm, or do they sometimes 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 would seem to be as important as the identification and protection of aggregation areas.

Color and Age Composition of Groups

Whale groups did not appear to be segregated by color, and most of the groups encountered in 2014 in Knik Arm and Turnagain Arm contained both white and gray whales. As in previous years of the study, groups that were composed exclusively of mother-calf pairs, or only small gray animals were not encountered (McGuire et al. 2011b, 2013a). In 2014, there were three instances of groups that consisted of a lone white whale, but photographs of sufficient quality for identification could not be obtained and it is unknown if this was the same individual in all three instances.

Although not quantified, observers had the impression that white beluga whales were more likely to be detected than gray beluga whales, as gray belugas tended to blend with the turbid gray waters of Cook Inlet. 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 animals 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 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. 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 resulting from the usually strong Turnagain winds.

The timing and location of beluga whale calving in Cook Inlet is not well documented in the literature (Hobbs et al. 2008). Groups of belugas in the Canadian Arctic were found to have seasonal differences in proportions of calves, juveniles, and adults (Smith et al. 1994), which were used to determine seasonality of calving. 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 continue to indicate that calving for CIBWs begins in mid-late July/early August in the Susitna River Delta, with an inter-annual variation of up to two weeks (McGuire and Stephens 2016). The first year we sub-classified calves as neonates was 2007. The "calf" category used during field surveys in 2005 and 2006 did not differentiate newborn calves from those now known to be calves between one and four years old (ages determined photographically by sighting histories of calves of identified mothers); thus, any peak in newborn calf numbers would not have been captured in the data recorded during these earlier field surveys. Annual timing of the first appearance of neonates generally coincides with the timing of annual maximum group size (McGuire and Stephens 2016). During 2007–2014, the first neonates of the season were always seen at the Susitna River Delta, and neonates were later seen in groups occurring in Knik Arm and Turnagain Arm (McGuire and Stephens 2016; McGuire et al. 2014).

Behavior

The distinction among behavioral categories was somewhat artificial as the terms only described behaviors seen when the whales were briefly at the surface. In reality, it is likely that whales were simultaneously feeding, diving, and traveling as they pursued and captured prey. Whales were much easier to count and photograph when feeding or traveling than when diving. Feeding and traveling animals remained at the surface longer, had higher surfacing profiles, and exhibited less response (attraction or avoidance) to the survey vessel, whereas diving animals often remained submerged for long periods of time and were unpredictable in their surfacing locations and patterns.

Progress Made in 2014 and Dissemination of Project Results

Progress made in 2014 was measured in terms of the number of field surveys conducted, the number of groups of whales photographed, the number of whales identified, and improvements in survey and data processing techniques. Ongoing project results are presented in reports that are available at: https://alaskafisheries.noaa.gov/pr/beluga-research-cook-inlet

Communication of project results and collaboration with colleagues remain project priorities. Examples of existing partnerships include: the exchange of information

with NMFS about beluga locations during aerial (NMFS) and vessel (LGL) surveys during the field season; informing NMFS-AK of dead belugas (in some cases securing the carcass until NMFS is able to respond) and assisting with necropsies; informing the NMFS Office of Law Enforcement of suspected cases of beluga poaching or harassment; circulating photographs of injured or visibly diseased belugas to the Alaska Marine Mammal Stranding Network for expert opinion; exchange of whale sighting reports, photographs, and sighting history with wildlife biologists at the Joint Base Elmendorf Richardson and other researchers in Cook Inlet; and making project data available to the NMFS Alaska Region Protected Resources Division for use in management decisions, including ESA consultations.

Project Status and Future Work

Fieldwork in Knik Arm and Turnagain Arm from 2014 was completed September 9 and October 3, respectively. Additional project fieldwork was conducted May through October 2015, and right-side photographs are currently being cataloged during winter 2015/2016. A summary and synthesis of results of all photo-id surveys of Cook Inlet conducted 2005–2015 will be presented in a comprehensive report, scheduled to be issued December 2016. Plans for 2016 include May through October photo-id surveys of Upper Cook Inlet and cataloging of the photographs taken during these surveys.

ACKNOWLEDGMENTS

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NMFS Alaska Region (Mandy Migura, Barb Mahoney, Brad Smith, Greg Balogh, Jon Kurland, Gilbert Mendoza)
NMFS Office of Law Enforcement (Les Cockreham, Noah Meisenheimer)
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Research Permit

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Database Development

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TABLES

Table 1. Total photo-id survey effort and beluga whale group encounters in Turnagain and Knik Arms in 2014, Upper Cook Inlet, Alaska.

	Knik Arm	**Turnagain Arm**
Number of Photo-id Survey Days	7	8
Number of Groups Encountered	11	15
Range of Surveys	Aug 15-Sept 9	Aug 21-Oct 3
Season Survey Span (Months)	1	2.5

Table 2. The number of photo-id surveys conducted in Cook Inlet, Alaska between 2005 and 2014, according to area and year.

	Year										
Area	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	***Total***
Survey Days	51	40	23	34	40	39	48	54	30	22	**381**
Susitna River Delta	17	18	4	8	15	14	11	9	7	7	**110**
Knik Arm	33	15	10	12	12	10	14	12	2	7	**127**
Turnagain Arm	1	6	8	12	12	15	17	15	12	8	**106**
Chickaloon Bay/Fire Island	0	1	1	2	1	0	2	5	3	0	**15**
Kenai River Delta	0	0	0	0	0	0	4	13	6	0	**23**

Table 3. Number, composition, and size of groups sighted during vessel- and land-based surveys in Knik Arm in 2014. Group numbers were assigned by day. (Neonates are separate from calf total. Unknown = beluga of unknown color and size.)

Date	Survey Type	Beluga Group #	# White	# Gray	# Calves	# Neonates	# Unknown	Group Size
Aug 15	land	1	26	34	10	*	0	70
Aug 18	land	1	47	59	14	*	0	120
Aug 19	land	1	49	43	14	*	0	106
Aug 19	land	2	1	0	1	0	0	2
Aug 20	land	1	39	36	16	*	0	91
Aug 23	vessel	1	15	10	5	3	0	33
Aug 23	vessel	2	4	1	1	1	0	7
Aug 23	vessel	3	3	1	0	0	0	4
Aug 30	vessel	1	1	0	0	0	0	1
Aug 30	vessel	2	8	12	3	1	0	24
Sept 9	land	1	20	31	8	5	0	64
Annual Total		**11**	**213**	**227**	**72**	**10**	**0**	**522**

*neonates present but not counted separately from calves

Table 4. Number, composition, and size of groups sighted during land-based surveys in Turnagain Arm in 2014. Group numbers were assigned by day. (Neonates are separate from calf total. Unknown = beluga of unknown color and size. x = could not be determined).

Date	Beluga Group #	# White	# Gray	# Calves	# Neonates	# Unknown	Group Size
Aug 21	1	x	x	x	x	35	35
Aug 31	1	47	20	3	0	0	70
Aug 31	2	5	0	0	0	0	5
Aug 31	3	4	0	0	1	0	5
Sept 1	1	10	5	1	0	0	16
Sept 1	2	x	x	x	x	20	20
Sept 8	1	10	1	1	0	0	12
Sept 8	2	1	0	0	0	0	1
Sept 8	3	6	3	2	1	0	12
Sept 12	1	6	3	2	0	10	21
Sept 12	2	x	x	x	x	1	1
Sept 21	1	0	3	1	0	0	4
Sept 28	1	1	0	0	0	0	1
Sept 28	2	x	x	x	x	60	60
Oct 3	1	4	4	5	3	0	16
Annual Total	**15**	**94**	**39**	**15**	**5**	**126**	**279**

Table 5. Photo-id survey effort and beluga whale groups encountered in 2014 in Knik and Turnagain Arms, Upper Cook Inlet, Alaska.

2014	Knik Arm	Turnagain Arm
Number of Surveys	7	8
Total Number of Beluga Whale Groups	11	15
Annual Group Size Total	522	279
Mean Number of Groups per Survey	1.6	1.9
Mean Number of Whales per Survey	74.6	34.9
Mean Number of Whales per Group	47.5	18.6
Maximum Number of Whales per Group	120	70

Table 6. Percent color composition of beluga whale groups sighted during surveys conducted in 2014 in Knik and Turnagain Arms, Upper Cook Inlet, Alaska.

Area	Group Size Total	% White	% Gray	% Calves	% Neonates	% Unknown
Knik Arm	522	41	43	14	2	0
Turnagain Arm	279	34	14	5	2	45

Table 7. Summary of primary and secondary activities of beluga groups encountered in 2014 during photo-id surveys in Knik Arm, Upper Cook Inlet, Alaska.

Date	Group Size	Primary Group Activities Noted	Secondary Group Activities Noted	Events and Additional Comments
Aug 15	70	milling	traveling	shallow diving
Aug 18	120	milling	traveling/diving/ feeding suspected	feeding confirmed - one instance of fish in mouth of beluga
Aug 19	106	milling	traveling	shallow diving
Aug 19	2	traveling	none	
Aug 20	91	milling	traveling	socializing along sandbar middle of Eagle Bay
Aug 23	33	traveling	milling	travel along shore within a few meters of inter-tidal bulldozing along Port of Anchorge; at small boat ramp whales dive to avoid small duck-hunting motorized skiff that approaced them, whales submerge 2 minutes then reappear in same location after skiff leaves
Aug 23	7	milling	none	
Aug 23	4	milling	traveling	
Aug 30	1	traveling	none	
Aug 30	24	traveling	none	
Sept 9	64	traveling	milling	diving

Table 8. Summary of primary and secondary activities of beluga groups encountered in 2014 during photo-id surveys in Turnagain Arm, Upper Cook Inlet, Alaska.

Date	Group Size	Primary Group Activities Noted	Secondary Group Activities Noted	Events and Additional Comments
Aug 21	35	traveling	unknown	whales backlit and in shadows, hard to see behavior
Aug 31	70	traveling	milling	some traveling up Arm with rising tide, others milling around Bird Point and south across Arm
Aug 31	5	milling	none	milling in cove in front of culvert leading to Kern Creek- culvert blocked on Alaska Rail Road side and may back salmon up into cove
Aug 31	5	traveling	none	traveling rapidly with falling tide
Sept 1	16	traveling	none	traveling rapidly with rising tide, up middle of the Arm despite this looking like the shallowest area of the main Arm, then veer to north towards turnout just to the west of Girdwood and approach within 50 m of the pullout riprap
Sept 1	20	traveling	dive	dive to avoid paddle boarders who cross the Arm to approach the belugas, belugas stay submerged 8 minutes until boarders gone, then belugas resurfaced in same place, then slowly resume traveling west on falling tide
Sept 8	12	traveling	none	
Sept 8	1	traveling	none	
Sept 8	12	milling	traveling	milling in western cove at Beluga Point, heading west overall
Sept 12	21	milling	traveling	
Sept 12	1	unknown	unknown	poor sighting conditions (high wind, rough water)
Sept 21	4	feeding suspected	none	working area back and forth near shore at Windy Corner during low tide
Sept 28	1	traveling	none	
Sept 28	60	traveling	milling	
Oct 3	16	traveling, milling	none	milling around rocks at Bird Point and slowly traveling east with rising tide; mom and calf may be nursing- the adult whale is stretched out flat and still at the surface, the calf is alongside near the adult's tail, floating just below the surface of the water and surfacing very slowly

Table 9. Summary of stranded Cook Inlet beluga whales with photographs provided to or taken by the CIBW Photo-ID Project in 2014.

2014 Date	Location of Dead Beluga	Necropsy performed by Alaska Marine Mammal Stranding Network?	Age Class and Sex	Whale Matched to Known Catalog Whale?
May 26	Kincaid Park, Anchorage	yes	adult male	yes
May 26	Kincaid Park, Anchorage	yes	pregnant female	no (no identifying marks on exposed side)
July 10	Carr-Gottstein Park, Anchorage	no	calf, unknown sex	no (advanced decomposition)
Aug 1	Tyonek	yes	adult male	yes
Aug 26	Fire Island	no	adult, unknown sex	no (poor photo quality)
Sept 2	Chuitna River mouth	yes	adult female	yes
Sept 8	Indian, Turnagain Arm	yes	adult male	yes
Sept 27	Pt. Possession	no	adult female	yes
Oct 6	Potter Marsh, Turnagain Arm	no	adult, unknown sex	no (poor photo quality)
Nov 1	Moose Point, south of Pt. Possession	no	adult, unknown sex	no (advanced decomposition)

Table 10. Summary of incidental sighting reports of Cook Inlet belugas made to the CIBW Photo-ID Project in 2014. Shaded cells indicate belugas sightings were reported.

	Location						
Month	**Susitna Delta**	**Knik Arm**	**Turnagain Arm**	**Chickaloon Bay**	**Kenai River Delta**	**Port of Anchorage**	**Other**
January							
February							
March							Ninilchik; Kasilof
April							Nikiski; southwest of Fire Island by Beluga River
May							Nikiski; Granite Point; Tyonek Platform
June							Fire Island
July							
August							Anchorage; Homer (unconfirmed)
September							
October							Anchorage
November							mouth of Big River Lake (south of West Forelands)
December							

FIGURES

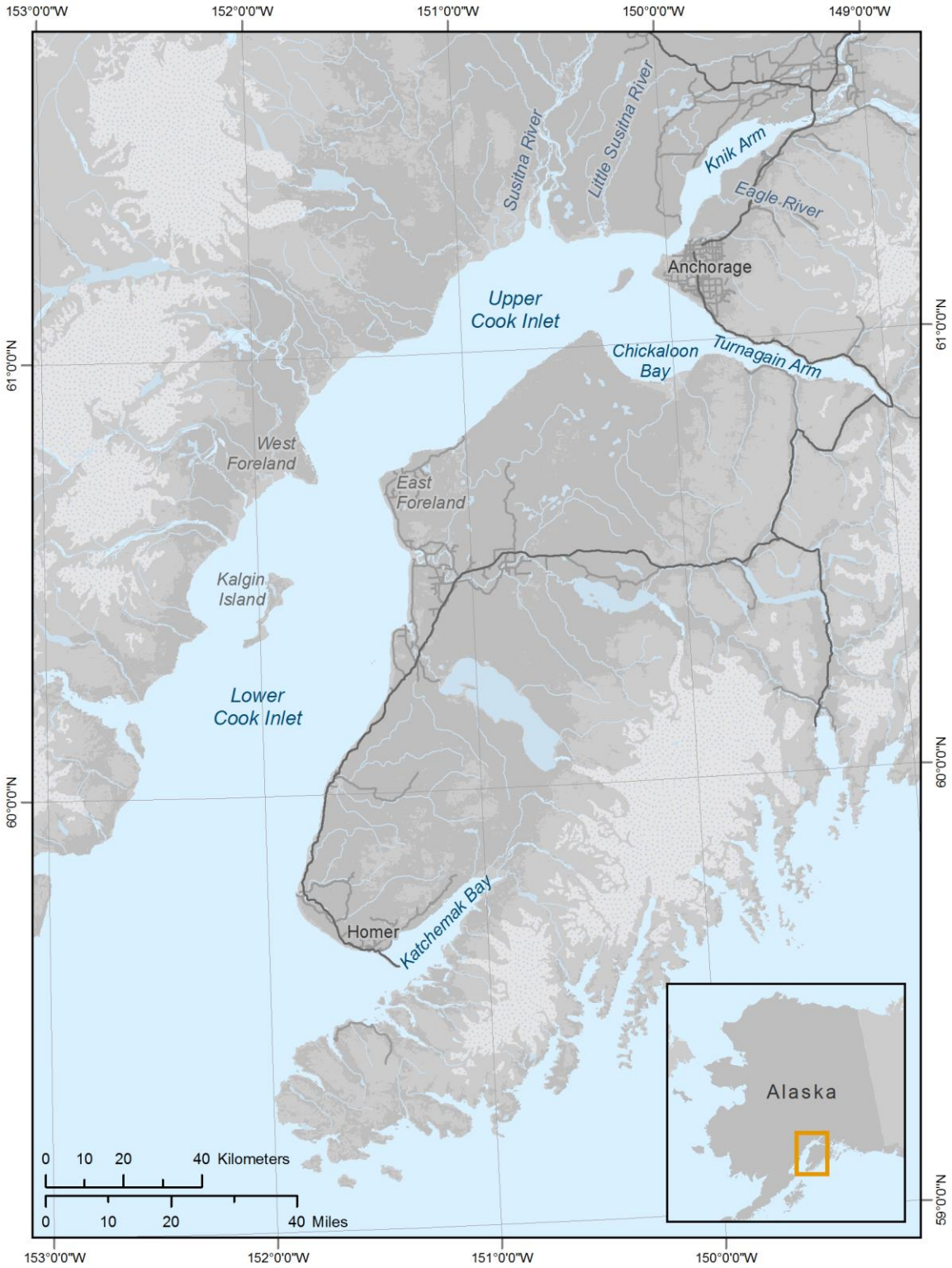

Figure 1. Map of Cook Inlet, Alaska, showing major features discussed in text.

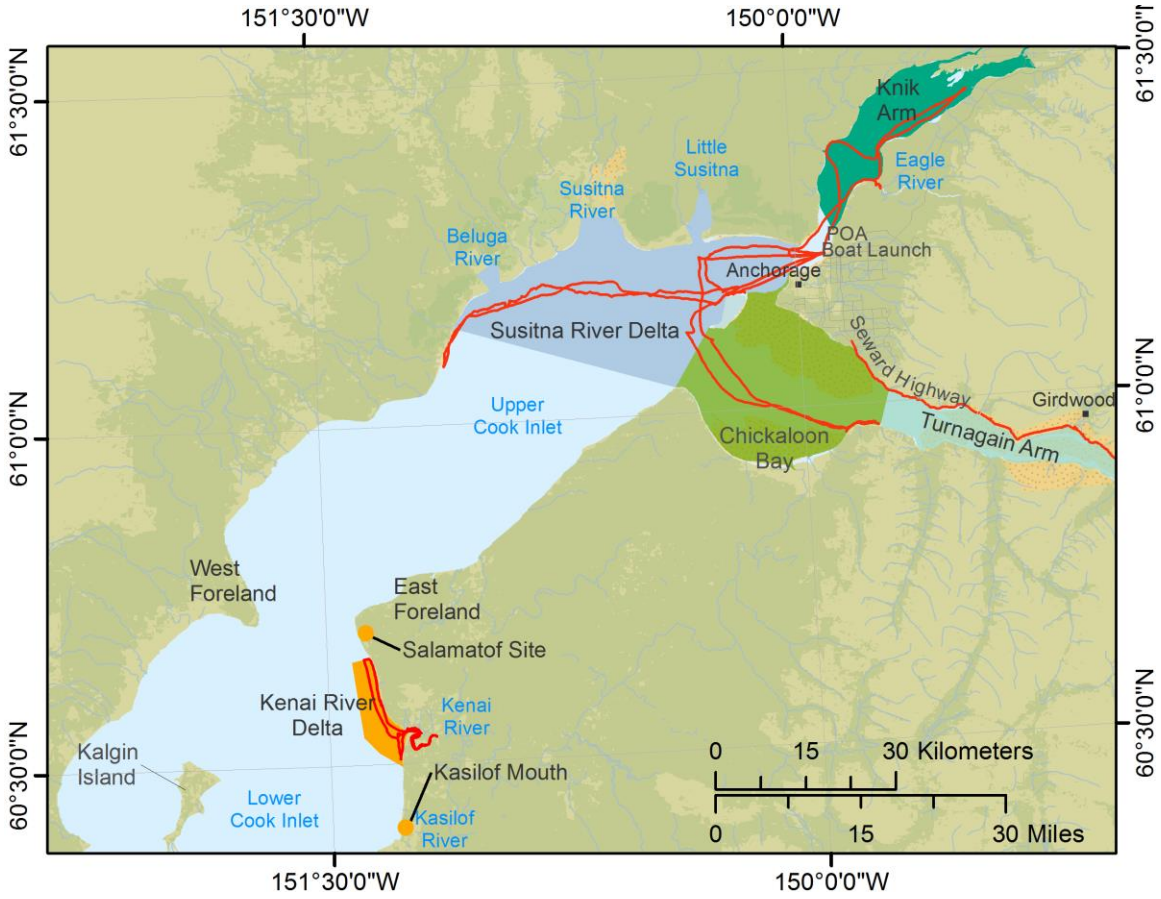

Figure 2. Map of Middle and Upper Cook Inlet, Alaska, showing shaded boundaries of sub-areas within the study area and the general survey routes used 2005–2014. The Kenai River Delta study area was surveyed 2011-2013. This report is limited to surveys conducted in Knik and Turnagain Arms in 2014.

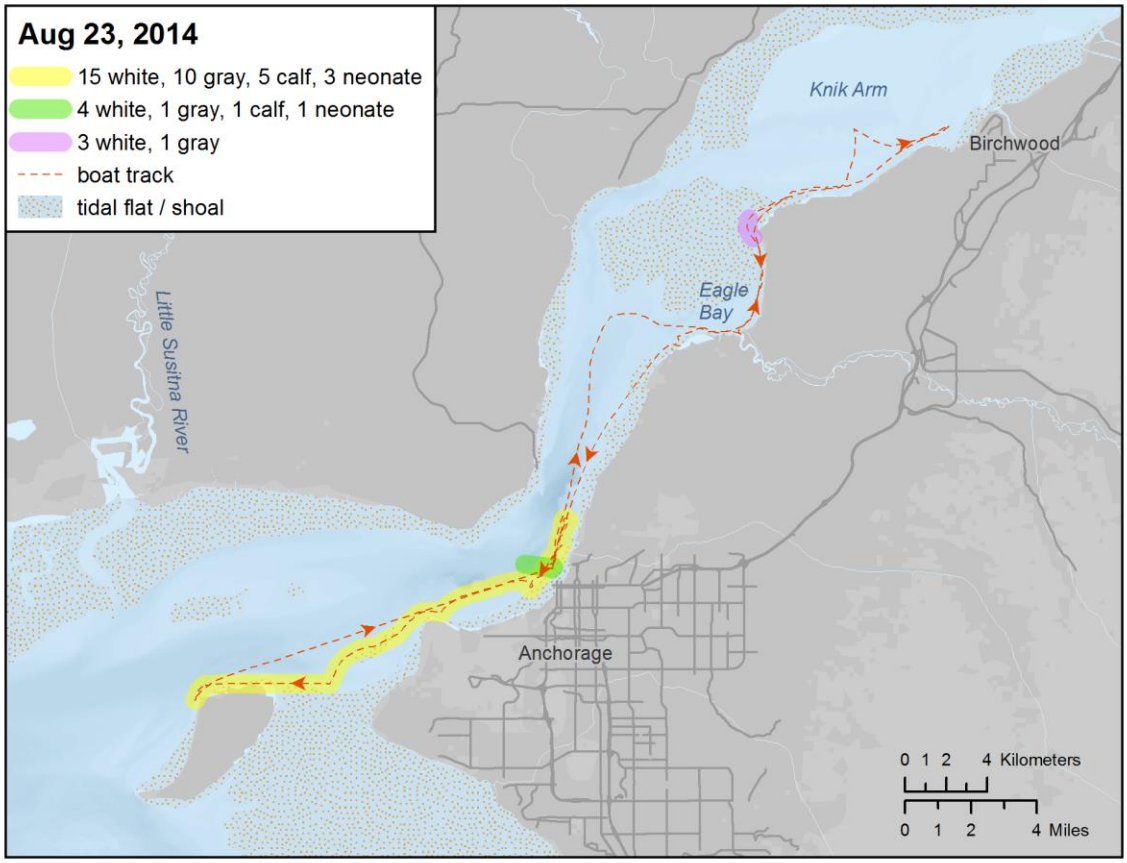

Figure 3. Route and beluga whale group(s) encountered during the vessel-based survey of August 23, 2014, in Upper Cook Inlet, Alaska.

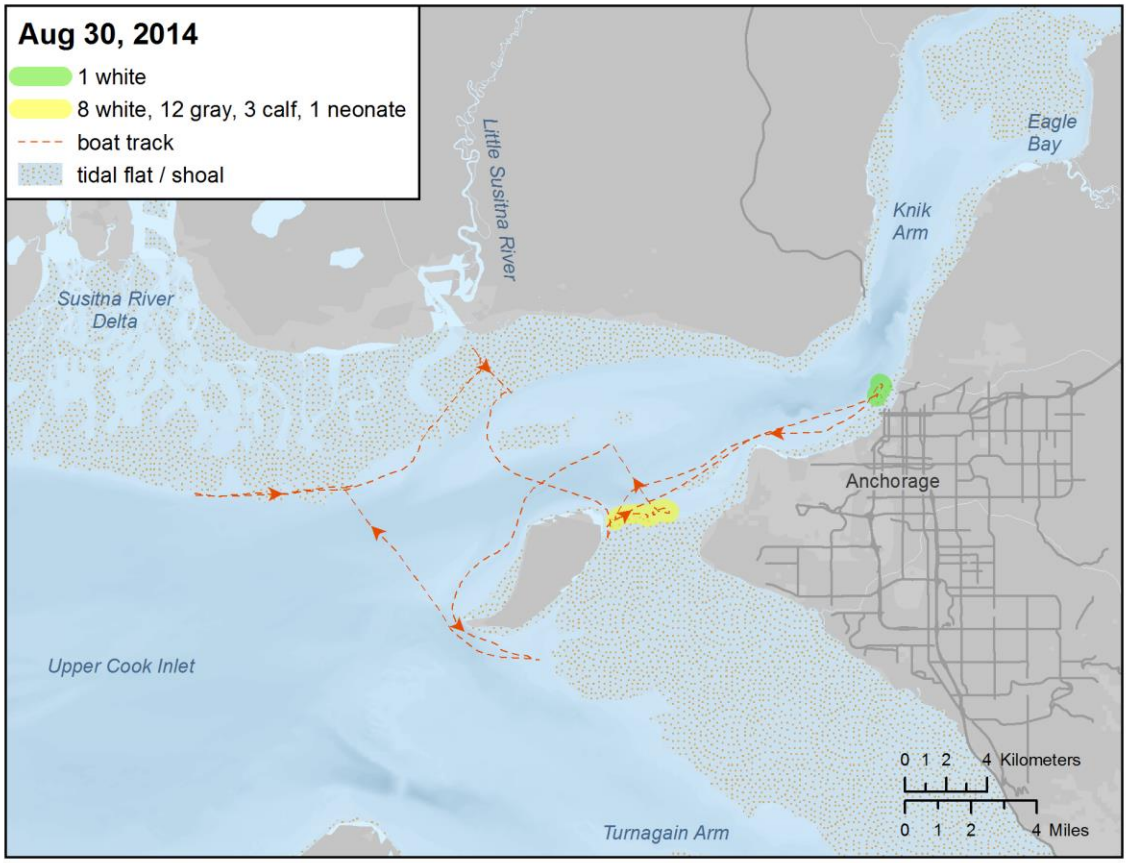

Figure 4. Route and beluga whale group(s) encountered during the vessel-based survey of August 30, 2014, in Upper Cook Inlet, Alaska.

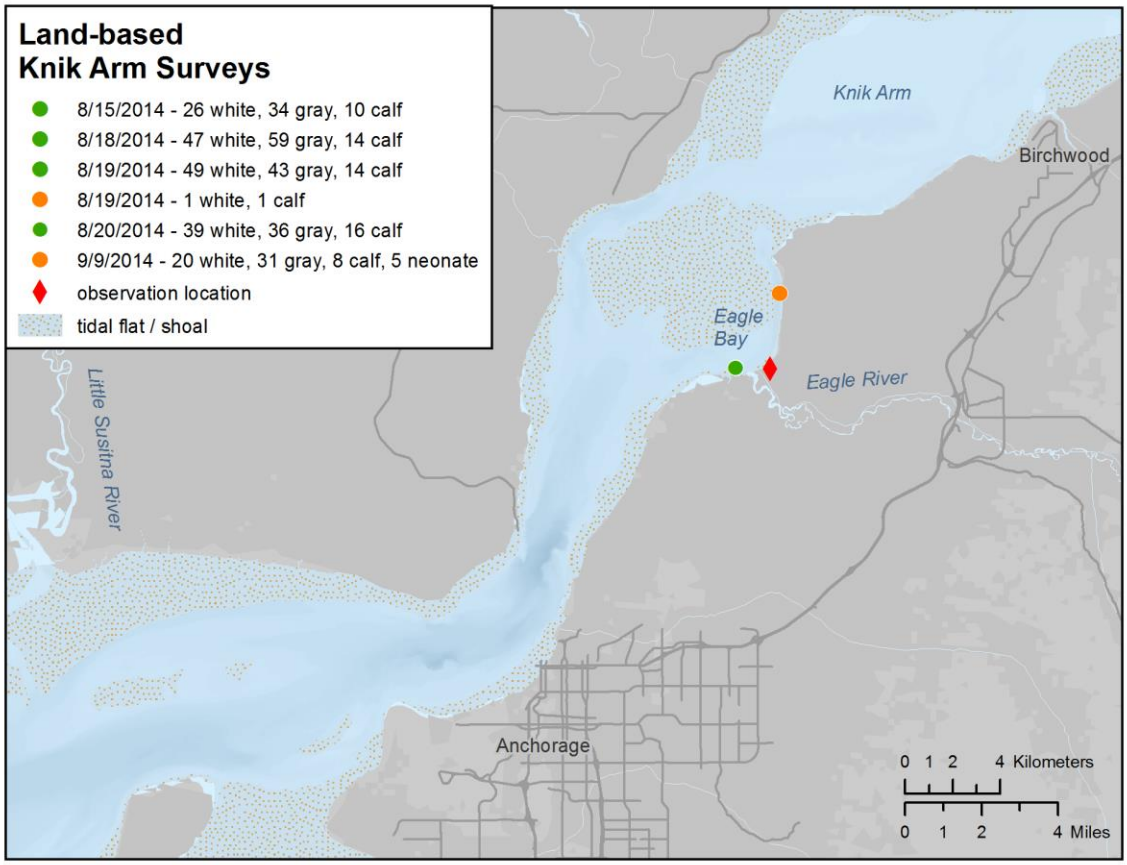

Figure 5. Beluga whale groups encountered during land-based surveys of Knik Arm, Upper Cook Inlet, Alaska in 2014.

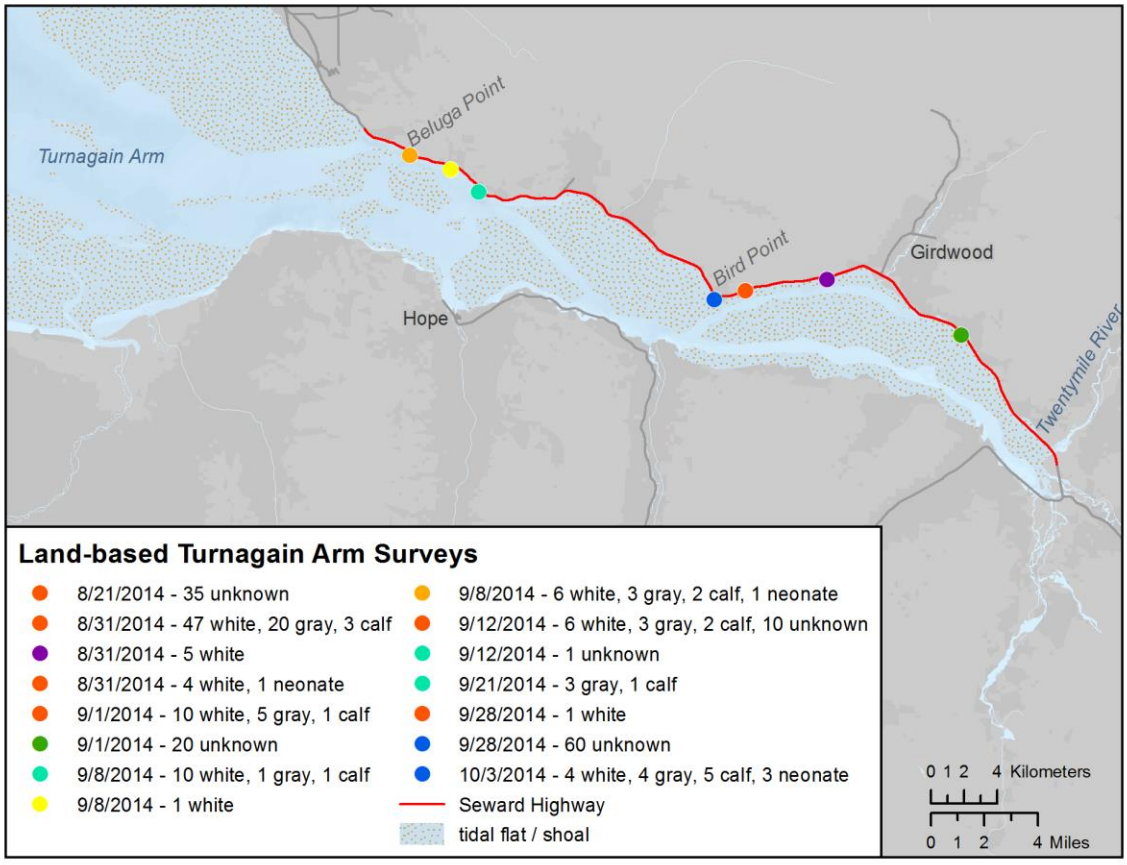

Figure 6. Beluga whale groups encountered during land-based surveys of Turnagain Arm, Upper Cook Inlet, Alaska in 2014.

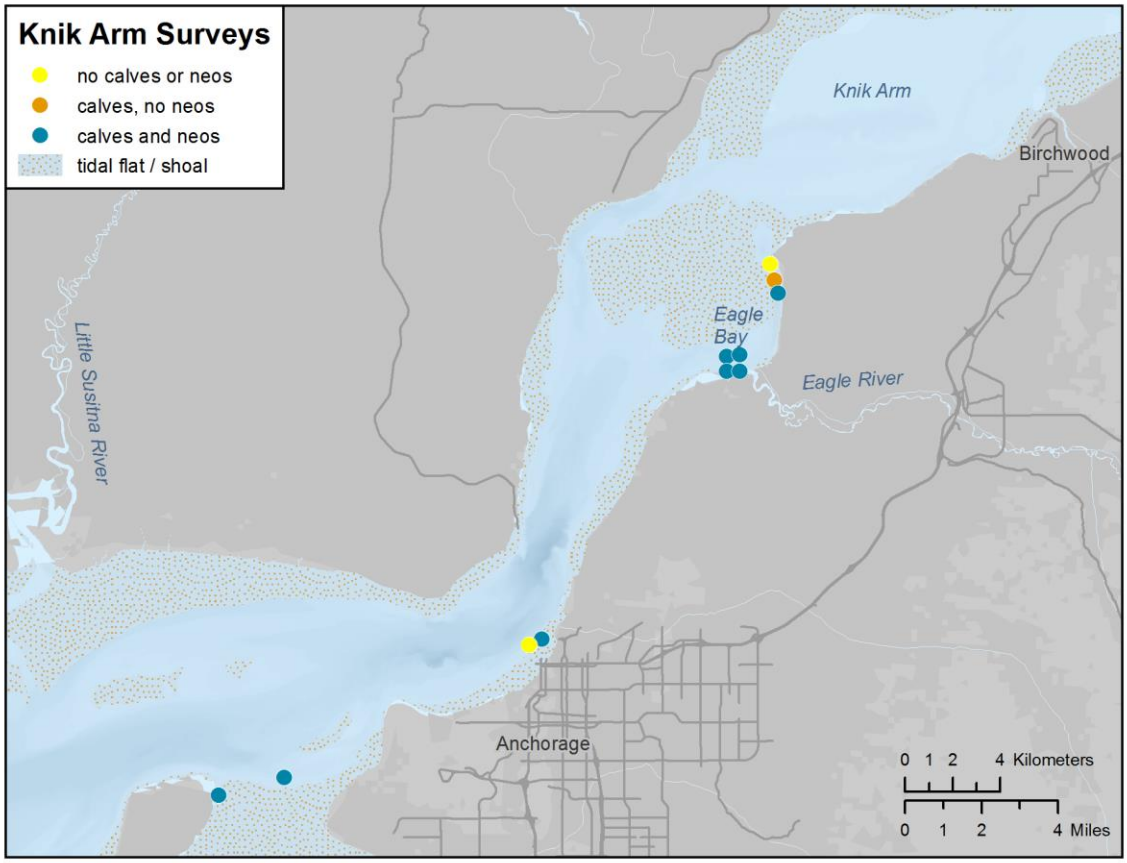

Figure 7. Location of groups with and without calves and neonates encountered during land- and vessel-based photo-id surveys of Knik Arm, Upper Cook Inlet, Alaska in 2014.

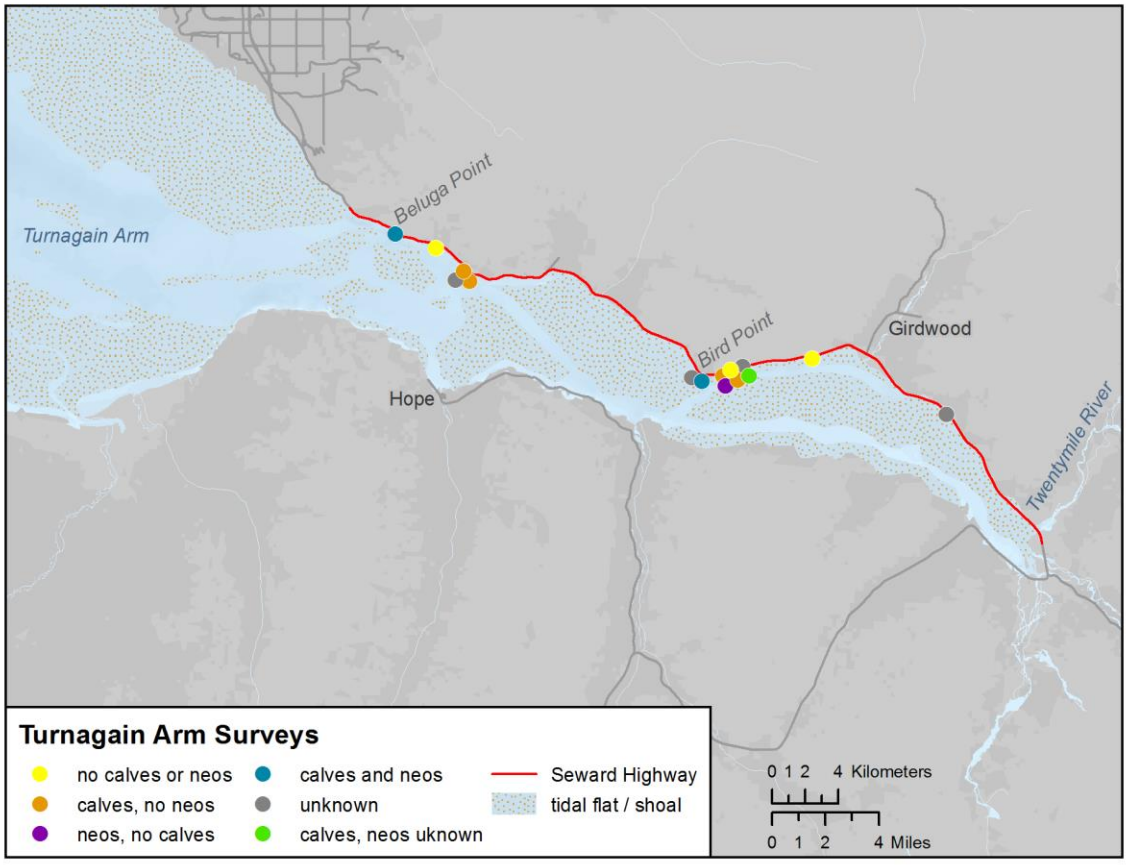

Figure 8. Location of groups with and without calves and neonates encountered during land-based photo-id surveys of Turnagain Arm, Upper Cook Inlet, Alaska in 2014.

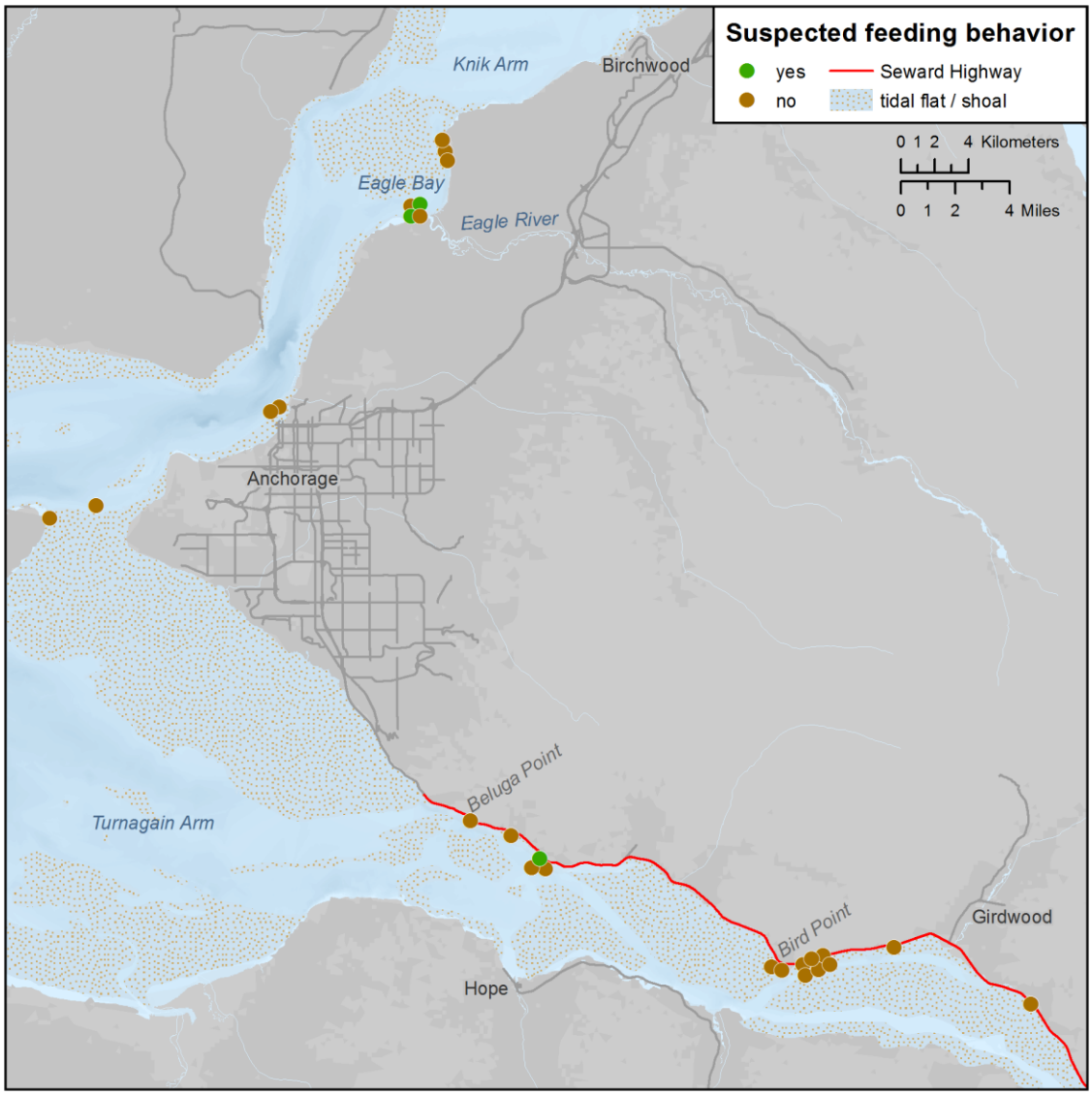

Figure 9. Location of groups with and without observations of feeding behavior (suspected or confirmed) during land- and vessel-based photo-id surveys of Knik and Turnagain Arms, Upper Cook Inlet, Alaska in 2014.

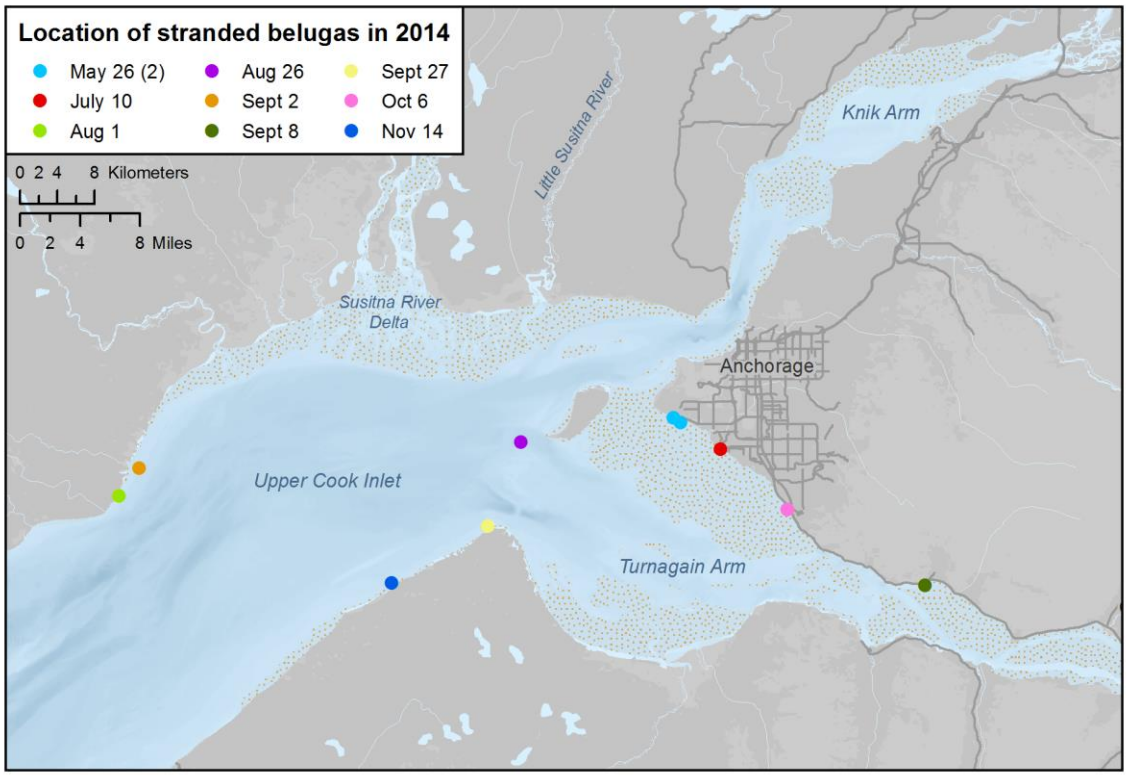

Figure 10. Location of dead Cook Inlet beluga whales with photographs provided to or taken by the CIBW Photo-ID Project in 2014.

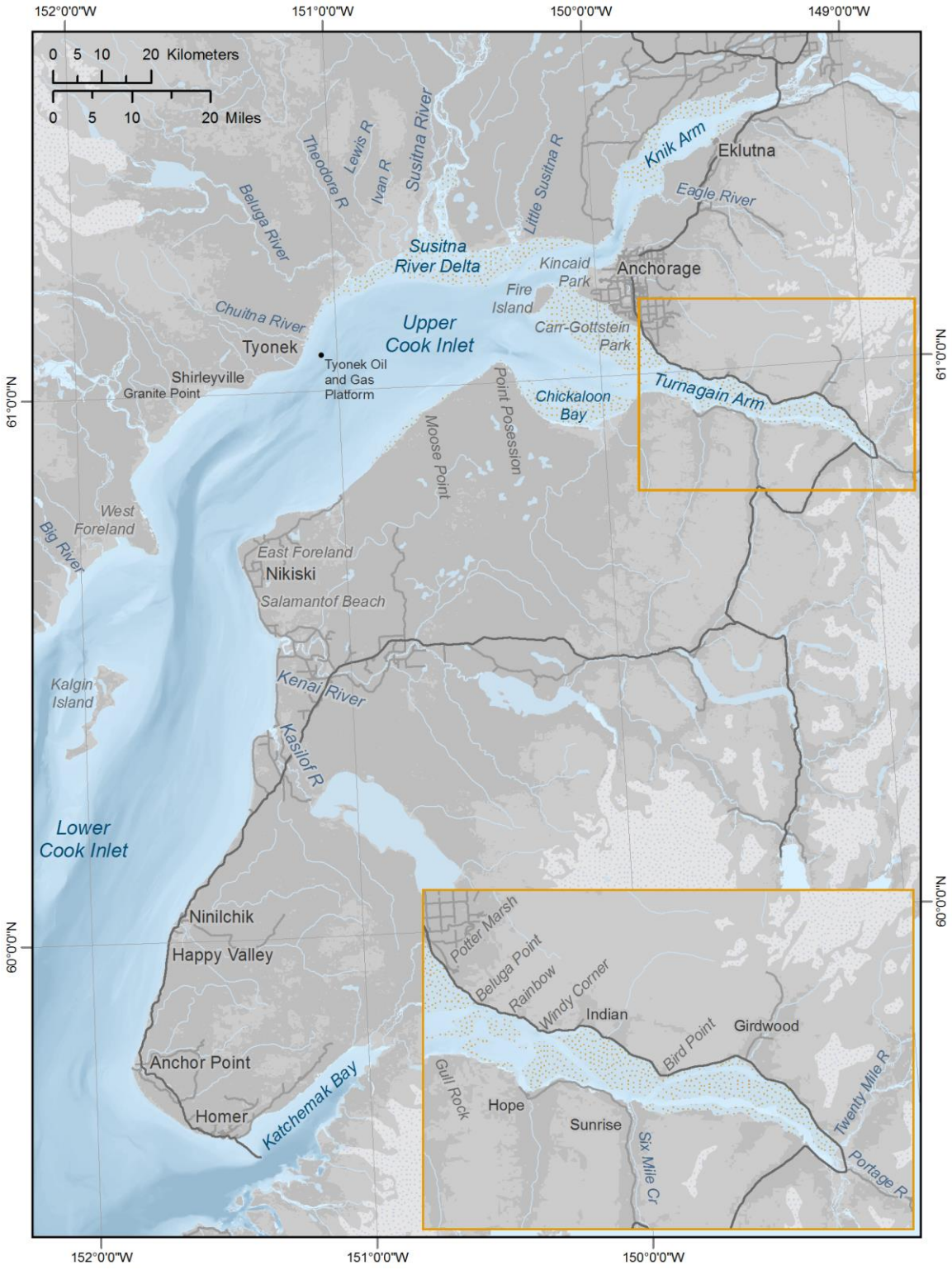

Figure 11. Map showing place names given in stranded and incidental sighting reports for CIBWs in 2014 (Table 10).