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

Final Report of Field Activities in 2011 and 2012 and Belugas Re-sighted in 2011

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ConocoPhillips Alaska, Inc.

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

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EXECUTIVE SUMMARY

Introduction

Alaska's Cook Inlet beluga whale (CIBW) population (*Delphinapterus leucas*) was listed as endangered in 2008 under the Endangered Species Act (ESA). 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.

The CIBW photo-identification study has been ongoing since 2005, and has demonstrated that a large number of 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-identification catalog and associated surveys from eight field seasons (2005-2012) provide information about the distribution, movement patterns, and life-history characteristics of individually identified beluga whales, including mothers with calves.

The original objectives of this study were to:

1. assess the feasibility and utility of photo-identification for studying CIBWs,
2. build a photo-identification catalog of distinctively marked individuals, describing re-sight rates and discoveries of new individuals over time,
3. describe population characteristics of beluga whales in Cook Inlet, including age-class distribution, residency/movement patterns, behavior, and social group structure, and
4. develop abundance estimates of CIBWs using mark-recapture models.

A fifth objective, added in 2007, was to:

5. determine CIBW life history characteristics, such as calving frequency, calving interval, period of maternal care/association, survival rates of calves, and survival rates of identified individuals.

This report summarizes field effort and photo-identification surveys in the Susitna River Delta from the 2011 and 2012 field seasons, and presents results from analyses of photos of whales encountered and identified in 2005-2011, including sighting rates, distribution, movement patterns, and group composition.

Methods

Surveys of the Susitna River Delta of Upper Cook Inlet, Alaska were conducted from a small vessel in 2011 (May-October) and 2012 (May-August). All vessel surveys were conducted under National Marine Fisheries Service (NMFS) Marine Mammal Protection Act (MMPA)/Endangered Species Act (ESA) Research Permit # 14210.

Standardized data forms were used to record beluga whale sightings and environmental conditions. Whales were photographed with a digital camera and zoom lens. Locations of beluga whale sightings and survey routes were mapped and figures were prepared showing survey routes, group location, group size, and group color composition for each survey conducted in 2011 and 2012.

Photographs were sorted according to image quality using ACDSee™ photo software. Photographs of belugas in a group were cropped to include a single whale, and were separated into images of the left and right sides of the whales. Images of the left sides of belugas were archived. Daily right-side 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 photos taken of the same individual beluga on a single day, and comprised one to many images. Temporary folders were 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, the new photos were entered into the catalog. Whale profiles were divided into 11 sections along the right half of the whale. Profile completeness was determined by the number of sections with high quality images; a 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 are considered to be individuals in the catalog.

Sighting histories (i.e., dates and locations of sightings) were compiled for all cataloged belugas in order to examine residency and movement patterns. Sighting histories of a subset of the catalog, consisting of all sightings of whales bearing scars from previous satellite tags, were presented graphically. Locations of cataloged beluga whale sightings were mapped in ArcGIS™ Version 10 (http://www.esri.com).

Results

Whales in 30 groups were counted and photographed during 20 survey days in 2011 and 2012, with a maximum group size of 205. The fieldwork completed in 2012 brings the project total to 94 photo-identification surveys conducted in the Susitna River Delta over eight consecutive field seasons, with a total of 152 whale groups sighted 2005-2012.

Mean group size was 53.6 whales in 2011 and 43.5 whales in 2012. Calves were seen throughout the months when beluga groups were encountered during the 2011 and 2012 field season, with the exception of October. In 2011, neonates in the Susitna River Delta were not observed until 27 July and were last observed 26 August. In 2012, neonates were first observed 20 July and were last observed in the Susitna River Delta 17 August (the final survey of the area for 2012).

Revisions to the right-side catalog continued through the addition of photographs from the 2011 field season. Of the belugas photographed in 2011, 66 were previously identified as individual whales in the 2005-2010 catalog, and eight newly identified individuals were added to the catalog. The 2005-2011 right-side catalog currently contains records for 305 individual whales.

Thirty-one belugas in the Susitna River Delta were identified across a seven-year span (that is, they were first seen in 2005 and were also seen in 2011). Of these, five belugas were seen in the Susitna River Delta in each of these seven years.

Seven photo-identified belugas have unique scars from holes used by NMFS to affix satellite tags in 1999-2002. Three of these belugas were sighted in 2011 in the Susitna River Delta. Between 2005 and 2011, three previously tagged belugas were photographed in the Susitna River Delta with calves, and one of these was photographed with a calf in more than one year. Individual sighting histories and photographs of previously tagged belugas are presented in Appendix B.

Dead belugas were not encountered in the Susitna River Delta in 2011 or 2012. A rope-entangled live beluga that was first encountered and photographed throughout the 2010 field season was also photographed in 2011 and 2012. NMFS and the Alaska Marine Mammal Stranding Network were updated annually with sighting information and photographs of this entangled whale.

Discussion

The seasonal pattern of CIBWs in the Susitna River Delta during the ice-free months of 2011 and 2012 was consistent with patterns found in previous years of this study and in other studies: groups are large in mid-late May, become smaller in June through mid-July, then peak in late July through mid-August. The largest beluga groups in Upper Cook Inlet were found in the Susitna River Delta, which was consistent with patterns reported by NMFS from aerial surveys.

Whale groups did not appear to be stratified by color or age-class, and most of the groups encountered contained both white and gray whales. Calves and neonates made up a slightly lower percentage of groups seen in the Susitna River Delta in 2011 and 2012 compared to groups seen there in previous years. Our multi-year observations indicate that calving for CIBWs began in mid-to late July/early August and the first neonates of the season are seen at the Susitna River Delta. The largest groups during each field season were recorded mid-July/early August along the Susitna River Delta. These large groups were observed travelling, socializing, and were suspected to be feeding.

Eighteen CIBWs were tagged with satellite tags by NMFS between 1999 and 2002 (Hobbs et al. 2005). Seven identified belugas have marks on their right sides caused by satellite tags; although the satellite tags are no longer present, we are still able to photographically track and obtain survivorship data from these individuals 3-13 years later.

The 2005-2011 right-side catalog contains records for 305 individual whales; while several individuals in the catalog likely have died during the duration of the eight-year study, and many others in the population have yet to be identified (especially newborns), nevertheless the catalog does contain sighting histories for the majority of the CIBW population (estimated at 312 whales in 2012 by NMFS; Hobbs et al. 2012).

In 2011 and 2012, project results and goals were presented as talks and posters at scientific and public meetings, including: the Alaska Marine Science Symposium; the

BP Cumulative Effects of Noise on Marine Mammals Working Group; ConocoPhillips Alaska; the Society for Marine Mammalogy; the Alaska Marine Mammal Stranding Network; the Joint Base Elmendorf Richardson Conservation Division; the Kenai SetNetters' Association; and the Kenai Senior Center. Project results are presented in reports that are available at: http://www.fakr.noaa.gov/protectedresources/whales/beluga/research.htm#ci., and on the project website: www.cookinletbelugas.org.

Beluga photo-identification surveys in 2011 and 2012 were also conducted in Knik Arm, Turnagain Arm, and Chickaloon Bay, as well as in the Kenai River Delta, however funding for these surveys and associated analysis were provided by other funding sources and their results are not presented here because photo-analysis is still being conducted. A summary and synthesis of results of all surveys of Cook Inlet conducted 2005-2012 will be presented in a comprehensive report, to be issued at a later date.

Conclusion

The Susitna River Delta is an important area for CIBW feeding, socializing, and calf rearing; the largest groups in Cook Inlet are found here seasonally, the first neonates of the season are found here, the earliest large feeding groups of the ice-free season are found here, and identified individual whales return here year after year.

The strength and utility of the photo-identification project grows with the proportion of the CIBW population that is photographed and identified. Photo-identification surveys from the existing eight years of uninterrupted effort will continue to provide information about the distribution, habitat associations, behavior, and age-class compositions of CIBW groups, while identification of whales photographed during the surveys will continue to provide information about movement patterns, social structure, and life history characteristics of individually identified beluga whales. Continuation of a long-term data set that provides insight into the population dynamics and life history of CIBWs will help with the identification of appropriate conservation measures to recover and preserve the population.

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INTRODUCTION

Alaska's Cook Inlet beluga whales (CIBW) population (*Delphinapterus leucas*) is considered a distinct population segment (DPS) by the National Marine Fisheries Service (NMFS) due to geographic and genetic isolation. A dramatic 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). As a result 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 CIBW. 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 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 (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 assessment of 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 identify and characterize critical habitat include the distribution of beluga whales sighted from annual aerial surveys, tidal flow models, and movement data from 15 satellite-tagged individuals from 1999 to 2002 (Rugh et al. 2000, 2004, 2005, 2006; Hobbs et al. 2005, 2008; Goetz et al. 2007; NMFS 2008a; Shelden et al. 2008, 2009a&b, 2010). This information is key in characterizing and understanding habitat needs, as is information on beluga movement and residency patterns obtained from land-based observational studies of CIBWs in Upper Cook Inlet (Funk et al. 2005, Prevel-Ramos et al. 2006, Markowitz and McGuire 2007, Markowitz et al. 2007, Nemeth et al. 2007). Land- and vessel-based photo-identification surveys (McGuire and Bourdon 2012; McGuire et al. 2008, 2009, 2011; McGuire and Kaplan 2009) 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 study has been ongoing since 2005, and has demonstrated that a large number of 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-identification catalog and associated surveys from eight field seasons (2005-2012) 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 et al. 2008, 2009, 2011; McGuire and Kaplan 2009). In the 2008 Conservation Plan for CIBWs, NMFS endorsed photo-identification

as a method of establishing a long-term data set to monitor the CIBW population (NMFS 2008b).

The original objectives of the CIBW photo-identification study were to:

1. assess the feasibility and utility of photo-identification for studying CIBWs,
2. build a photo-identification catalog of distinctively marked individuals, describing re-sight rates and discoveries of new individuals over time,
3. describe population characteristics of beluga whales in Cook Inlet, including age-class distribution, residency/movement patterns, behavior, and social group structure, and
4. develop abundance estimates of CIBWs using mark-recapture models.

A fifth objective, added in 2007, was to:

5. determine CIBW life history characteristics, such as calving frequency, calving interval, period of maternal care/association, survival rates of calves, and survival rates of identified individuals.

This report summarizes field effort and photo-identification surveys in the Susitna River Delta from the 2011 and 2012 field seasons, and presents results from analyses of photos of whales encountered and identified in 2005-2011, including sighting rates, distribution, movement patterns, and group composition.

METHODS

Field Surveys

Survey effort

Dedicated surveys and opportunistic sampling of the Susitna River Delta of Upper Cook Inlet, Alaska (Figures 1 and 2) were conducted from a small vessel in 2011 and 2012. 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 from NMFS aerial surveys (Hobbs et al. 2008) and other studies of CIBWs (Funk et al. 2005, Markowitz et al. 2007, Markowitz and McGuire 2007, McGuire et al. 2008, Nemeth et al. 2007, Prevel-Ramos et al. 2006). 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. The Susitna River Delta (Figure 2) was surveyed May through October during low tide. The Port of Anchorage was included in all of these surveys because the survey vessel was always launched from the small boat ramp at this location. Beluga photo-identification surveys in 2011 and 2012 were also conducted in Knik Arm, Turnagain Arm, and Chickaloon Bay, as well as in the Kenai River Delta, however funding for these surveys and associated analysis were provided by other funding sources and their results are not presented here because photo-analysis is still being conducted. A summary and synthesis of results of all surveys of Cook Inlet conducted from 2005 to2012 will be presented in a comprehensive report, to be issued at a later date.

Vessel surveys

All photographs of CIBWs in the Susitna River Delta were taken 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 crew member. Vessel position was recorded at 2-minute intervals 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 whales. Surveys were not appropriate for line-transect methodology designed to estimate abundance. A whale group was only approached once per survey and 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. Researchers noted the position of whales relative to the vessel and GPS-logged tracks were used to estimate approximate whale group positions. Vessel-based surveys were suspended during NMFS aerial surveys in early June and August. All vessel surveys were conducted under NMFS MMPA/ESA Research Permit # 14210.

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 vessel, magnetic compass bearing to the group, estimated distance of the vessel 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, 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 both observers to be the most accurate. Group size was usually difficult to determine and counts provided estimates rather than actual number of whales in the group.

Behavioral data were collected using focal group sampling (Mann 2000). Behavior was recorded as activities (i.e., states: behavior patterns of relatively long duration, such as prolonged activities) or events (i.e., behavior patterns of relatively short duration, such as discrete body movements or vocalizations; Martin and Bateson 1993). Group activity was sampled at the beginning and end of each group encounter, and every five minutes during the encounter. Events were noted as they were observed throughout the group encounters; although it should be noted the observers were focused on photographing whales, not sampling all events. Activities were classified into primary and secondary activities. Primary activities were behaviors that appeared to be the dominant behavior of the group, and secondary activities were behaviors that occurred sporadically during primary activities. 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 or apparently 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.

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 (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 due to 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, water depth, and habitat type (e.g., mudflat, bay, mid-channel, river mouth, depositional bank, erosional bank, island, and shoal).

Digital photographs of beluga whales were collected using a Nikon D300, 12.3 megapixel digital SLR camera with a Nikkor 70-400 mm zoom telephoto auto focus lens. Typical settings included shutter speed priority, dynamic auto-focus, 800 ISO, and shutter speed of 1,000 or greater. Photographs were taken in RAW (not compressed) format and stored on compact flash memory cards.

Analyses of Data from Field Surveys

Locations of beluga whale sightings and survey routes were mapped in ArcGIS™ Version 10 (http://www.esri.com) and figures were prepared showing survey routes, group location, group size, and group color composition for each survey conducted in 2011 and 2012. Primary and secondary behaviors of beluga whale groups, group size and color composition, and presence of calves and neonates were compared among survey days and seasons.

Processing of Photographs

All RAW format photographs 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 photographs were then reformatted into JPEGs (JPEG files are smaller than RAW files) for more-efficient processing. 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 photographs taken in 2011 and 2012 were archived, however, due to budget restrictions; only photographs from 2011 were further analyzed and considered for cataloging. Photographs from 2012 will be analyzed and cataloged at some point in the future.

When original field photographs 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. Images of the left sides of belugas were archived. In order to conserve project funds, only photographs of the right sides of the whales were further processed.

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 comprised 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, the new photos were entered into the catalog. If no match was made, the new photos were put into a newly created "potential whale" folder.

Cataloging of Photographs

As a beluga surfaced and submerged, different portions of its body were 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 half 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. "Profile completeness" was determined by the number of sections with high quality images; a 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 allowed for the acceptance of a whale into the catalog was if two temporary whale folders that spanned two or more years were matched.

Mark-type categories were created in order to facilitate cataloging. Locations of all visible marks were assigned to sections of the body. This was done for each individual within the catalog. Computer software specialized for beluga whales was developed to allow for computer-aided filtering of the database according to mark type and location.

Sighting Histories

Sighting histories (i.e., dates and locations of sightings) were compiled for all cataloged belugas in order to examine residency and movement patterns. Sighting histories of a subset of the catalog, consisting of all sightings of whales bearing scars from previous satellite tags, were presented graphically. Locations of cataloged beluga whale sightings were mapped in ArcGIS™ Version 10 (http://www.esri.com).

Classification of Mothers and Calves in Photographs

Identified belugas were classified as mothers in photographs if they appeared in the same cropped photo-frame with a calf or neonate alongside. Belugas were classified as calves in photographs if they were dark gray (although light-gray calves were also observed), relatively small (i.e., <2/3 the total length of adult belugas), and photographed swimming and surfacing in synchrony alongside a larger beluga. Neonates were distinguished in photographs by visible fetal folds and often a "peanut-shaped" head.

Additional Information Provided by the Study

Many photographs of Cook Inlet belugas in the catalog contain marks indicative of disease and injury (LGL 2009). Using the cataloging tools within the database application, marks were labeled according to mark type and body segment in which they occurred in a photograph (Figure 3).

Database Development

We continued to work with a database specialist to consolidate all photo-identification data (2005-2012) into a single, comprehensive, and integrated database, and to aid in management of photos during the cataloging process. Data from surveys included the survey route, environmental conditions, 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. Finally, data 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, the number of temporary files yet to be matched, and the number of photos of whales with few or no visible markings.

RESULTS

Surveys

Survey effort and number of whales and whale groups encountered in 2011 and 2012

The fieldwork completed in 2012 brings the project total to 94 photo-identification surveys conducted in the Susitna River Delta over eight consecutive field seasons (Table 1), with 152 beluga whale groups sighted.

Fourteen beluga whale groups were counted and photographed during 11 survey days in 2011 (Table 2), and sixteen beluga whale groups were counted and photographed during nine days in 2012. Survey effort in the Susitna River Delta was greatest in July of both years (Table 3). The number of whales sighted per survey varied by month and year (Table 4). Maps of whale group sighting locations and survey routes in 2011 and 2012 are presented in Appendix A.

In both years combined, a mean of 1.5 groups per survey was observed, with a mean group size of 48.2 whales. Mean group encounter rates were higher in 2012 than in 2011, although mean group size was greater in 2011 than in 2012 (Table 2). In 2011, mean group size was 53.6 whales. In 2012, mean group size was 43.5 whales. Total number of belugas sighted per group ranged between 13 and 136 whales in 2011, and 1 and 205 whales in 2012 (Figure 4). The largest groups per year were recorded on 27 July in 2011, and on 20 July in 2012 in the Susitna River Delta (Table 4).

Color composition, and age class of groups encountered during surveys

Color and age-class composition of all groups varied with month and year (Table 4). In both years combined, groups in the Susitna River Delta contained slightly more white whales than gray whales (excluding calves and neonates), and the average group was composed of 6% calves and 1%-2% neonates (Table 5).

Calves were seen throughout all months when beluga groups were encountered during the 2011 and 2012 field seasons (Table 4), with the exception of October. In 2011, neonates were first observed 27 July and were last observed in the Susitna River Delta 26 August. In 2012, neonates were first observed 20 July and were last observed in the Susitna River Delta 17 August (the final survey of the area for 2012). Calves were seen throughout the Susitna River Delta, while neonates were seen between the Susitna River and Little Susitna Rivers (Figures 5 and 6).

Behavior of whale groups

Traveling was the most-frequently observed primary group activity in 2011, and diving was the most-frequently observed primary group activity in 2012 (Table 6). Suspected feeding (including suspected feeding combined with diving) was the most-frequently observed secondary group activity in both years.

Catalog Development and Current Status

As is typical for a maturing photo-identification catalog, revisions to the right-side catalog continued through the addition of photographs from the 2011 field season. Of the belugas photographed in the Susitna River Delta in 2011, 66 were resightings of individual whales in the 2005-2010 catalog. In addition, eight newly identified individuals were added to the catalog. The 2005-2011 right-side catalog currently contains records for 305 individual whales.

Sighting Histories

Sighting histories of belugas 2005-2011

Thirty-one belugas in the Susitna River Delta were identified across a seven-year span (that is, they were first seen in 2005 and were also seen in 2011). Of these, five belugas were seen in the Susitna River Delta in each of these seven years.

Sighting histories of belugas identified by satellite tag scars

Seven photo-identified belugas had unique right-side scars from holes used by NMFS to affix satellite tags 1999-2002 (Table 7). These individuals were identified photographically based on a combination of natural marks and the tag scars to avoid mistakenly matching similar scar patterns caused by the same tag type. Five of these belugas are presumed to be mothers, based on photographs with an accompanying calf taken sometime during their sighting history. Three of these belugas were sighted in 2011 in the Susitna River Delta. Between 2005 and 2011, three previously tagged belugas were photographed in the Susitna River Delta with calves, and one of these was photographed with a calf in more than one year (Table 7). Individual sighting histories and photographs of previously tagged belugas are presented in Appendix B.

Additional Information Provided by the Study

Dead and injured belugas encountered in 2011 and 2012

Dead belugas were not encountered in the Susitna River Delta by LGL biologists or others (NMFS, unpublished data) in 2011 or 2012. A rope-entangled live beluga that was first encountered and photographed throughout the 2010 field season (McGuire and Bourdon 2012) was also photographed in 2011 and 2012 (Figure 7). NMFS and the Alaska Marine Mammal Stranding Network were updated annually with sighting information and photographs of this entangled whale.

DISCUSSION

Whales Encountered During Surveys

The seasonal pattern of CIBWs in the Susitna River Delta during the ice-free months of 2011 and 2012 was consistent with patterns found in previous years of this study (McGuire and Bourdon 2012; McGuire et al. 2008, 2009, 2011; McGuire and Kaplan 2009) and in other studies (Moore et al. 2000, Funk et al. 2005, Hobbs et al. 2005, Markowitz and McGuire 2007, Nemeth et al. 2007): groups are large in mid-late May, become smaller in June through mid-July, then peak in late July through mid-August). These patterns are likely in response to patterns of seasonal migrations of fish (eulachon runs in May, followed by salmon runs late July-early August; NMFS 2008b) on which the belugas feed. The occurrence of large beluga groups in the Susitna River Delta relative to groups found in other areas of Cook Inlet was consistent with patterns reported by NMFS from aerial surveys conducted in June and August of multiple years (Shelden et al. 2010, 2011, 2012).

Mean group sighting rates (number of groups encountered per survey) were similar among surveys conducted in 2012, 2011, 2010, 2009, and 2008 (1.8, 1.3, 1.5, 1.3 and 1.5, respectively), although they were slightly lower in these years than in previous years (2.0 in 2007, 4.9 in 2006, and 2.4 in 2005). Mean group size during photo-identification surveys of the Susitna River Delta was 43.5 in 2012, 53.6 in 2011, 44.2 in 2010, 38.1 in 2009, 62.9 in 2008 and 13.5 in 2007. Shelden et al. (2008, 2009a) also reported larger and fewer groups of beluga whales seen during aerial surveys in June 2009 and 2008 compared to June 2007.

Color and Age Composition of Groups

Whale groups did not appear to be segregated by age-class or color, and most of the groups encountered in 2011 and 2012 contained both white and gray whales. Although not quantified, observers on the survey vessel had the impression that white whales were more likely to be detected than gray whales, as gray whales 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 whales may have been more likely to be photographed from vessels, possibly resulting in better photographs of gray individuals and a higher rate of identification. Environmental conditions, most notably ambient light, may also have resulted in some variability in color assigned to whales during surveys.

Calves and neonates made up a slightly lower percentage of groups seen in the Susitna River Delta in 2011 and 2012 compared to previous years: on average groups consisted of 6% calves and 1-2% neonates in 2012 and 2011, and 7-8% calves and 1-3% neonates 2007-2010.

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 indicate that calving for CIBWs in the Susitna River Delta begins in mid-late July/early August, with an annual variation of up to two-weeks; neonates were first seen on 20 July 2012, 27 July 2011, 16 July 2010, 1 August 2009, 24 July 2008 and 27 July 2007. The first year we sub-classified calves as neonates was 2007. The "calf" category used during field surveys 2005-2006 did not differentiate newborn calves from those now known to be one- and two-year old calves (determined photographically by sighting histories of calves of identified mothers; McGuire et al. 2008), which suggested that any peak in newborn calf numbers may not have been captured in the data recorded during these field surveys.

During 2007-2012, the first neonates of the season were always seen at the Susitna River Delta, and were later seen in Knik Arm and Turnagain Arm (McGuire and Bourdon 2012). Within the Delta, neonates were seen in the mouths of and between the Susitna River and Little Susitna River. Surveys to the west of the Susitna River were only conducted early in the season, before neonates were observed, so the lack of neonates in groups observed in areas west of the Susitna River Delta is most likely an artifact of the survey schedule/route and not indicative of habitat use of neonates.

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. The largest group recorded during the study (2005-2012) consisted of 205 whales seen 20 July 2012; this audibly vocal group was traveling, milling, socializing, and suspected to be feeding (whales were seen making waves against the shore and in shallow water, which may have been caused by pursuing prey at high speed in short bursts). The second largest group ever encountered during photo-identification surveys consisted of 173 beluga whales encountered in the Susitna River Delta on 16 July 2010, seen traveling and suspected to be feeding. Whales were much easier to 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.

Sighting Histories and Movement Patterns

The photo-identification catalog and associated surveys from eight continuous years of effort provide information about the distribution and movement patterns of individually identified CIBW. The strength and utility of the catalog grows over time

with as the proportion of the population that is identified. Results of continued photo-identification efforts will help to fill gaps in current knowledge about the life history of the CIBW population.

When making inferences about the greater population of CIBW based on sighting histories of individually identified whales, it is important to consider the results within the context of survey effort. Photo-identification surveys were not systematic relative to the entire Upper Cook Inlet. Instead, effort was focused in certain areas during particular times of the year that would maximize the probability of encountering whales. The maximum number of beluga whales encountered in a single photo-identification survey day from 2005 to 2012 was never more than 205 whales, which indicates that some of the CIBW population was elsewhere given that NMFS estimated the population at 312 CIBWs in 2012 (Hobbs et al. 2012). In addition, sighting histories that were obtained from cataloged whales were a function of which whales within a group were photographed and which of these had marks that could be reliably identified through time. The 2005-2011 right-side catalog contains records for 305 individual whales; while several individuals in the catalog likely have died during the duration of the eight-year study, and many others in the population have yet to be identified (especially newborns), nevertheless the catalog does contain sighting histories for the majority of the CIBW population.

Life History

With the exception of a few whales first photographed as young-of-the-year calves, the ages of most of the whales in the catalog are unknown. Eighteen CIBWs were satellite tagged by NMFS between 1999 and 2002 (Hobbs et al. 2005). Seven identified belugas have marks on their right sides caused by satellite tags; although the satellite tags are no longer present, we are still able to photographically track and obtain survivorship data from these individuals up to 13 years later. To date, the movement patterns and sighting histories of these previously tagged whales have been no different from photographically identified whales that were never tagged (McGuire and Bourdon 2012). Knowledge of the years in which the satellite tags were applied allows us to assign a relative age to re-sightings of these previously-tagged whales, because we know that none of the whales were calves at the time of tagging. Details from the time of capture/tagging, such as total length and girth, may provide more information about the relative age of these whales. Satellite tag type and attachment method varied among years (Rod Hobbs and Barbara Mahoney, NMFS, personal communication) and it may be possible to assign a capture/tagging date based on scar type, which in turn would provide information on survivorship, wound healing, and longevity of these types of marks. In addition to documenting the survival of at least seven of the 18 previously-tagged whales, five of these whales are presumed mothers who gave birth post-tagging. We use the term “presumed mother” because we can only make informed guesses about maternity based on reasonable evidence (in this case, physical proximity and behavior). In the future, combined photo-identification and genetic sampling from remote-biopsy would allow us to test our assumptions of maternity and reproductive histories.

Additional Information Provided by the Study

Several photographs of belugas contained marks indicative of trauma and disease. By documenting the occurrence and frequency of these marks and attempting to identify mark sources, more can be learned about the incidence of risk factors that may be preventing the recovery of the endangered CIBW population. The roped whale photographed 2010-2012 is an example.

Photo-identification has been used to characterize and quantify epidermal lesions on adult and young delphinids, providing information relevant to coastal environmental health (Wilson et al. 1999; Van Bressem et al. 2003, 2009; Bearzi et al. 2009). By collaborating with other investigators, particularly those authorized to investigate mortalities (NMFS, stranding groups, and subsistence users), we could increase the utility of our documentation of skin lesions. We have created and distributed a protocol for photographing beluga mortalities (McGuire et al. 2009) to guide stranding responders who are willing to photo-document markings on beluga mortalities. Matching of photographs of dead belugas to identified individuals in the catalog will provide information necessary for understanding survivorship and population dynamics.

Progress Made in 2011 and 2012 and Dissemination of Project Results

Progress made in 2011 and 2012 may be 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. Project results are presented in reports that are available at http://www.fakr.noaa.gov/protectedresources/whales/beluga/research.htm#ci.

In 2011 and 2012, project results and goals were presented as talks and posters (Figures 8 and 9) at scientific and public meetings including: the Alaska Marine Science Symposium; the BP Cumulative Effects of Noise on Marine Mammals Working Group; ConocoPhillips Alaska; the Society for Marine Mammalogy; the Alaska Marine Mammal Stranding Network; the Joint Base Elmendorf Richardson Conservation Division; the Kenai SetNetters' Association; and the Kenai Senior Center. Communication of project results and collaboration with colleagues continue to be productive and remain project priorities. Examples of existing partnerships we plan to maintain in the future 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 and harassment; circulating photographs of injured or infected belugas to the Alaska Marine Mammal Stranding Network for expert opinion; exchange of whale sighting reports, photographs, and sighting history with wildlife biologists employed by the U.S. Army at Fort Richardson (now the DOD Joint Base); pairing our visual observations of CIBWs with visual and acoustic recordings of belugas collected by the Alaska SeaLife Center, the National Marine Mammal Laboratory, the Alaska Department of Fish and Game, and the University of Hawaii; and sharing our beluga observations

with the Friends of the Anchorage Coastal Refuge and Defenders of Wildlife's "Anchorage Coastal Beluga Survey Citizen Science Project".

Project Status and Future Work

Fieldwork in the Susitna River Delta from 2012 was completed 17 August. Cataloging of photographs from 2011 was completed in 2012, and results are presented in the current report. Plans for 2013 include May-August photo-identification surveys of the Susitna River Delta. Beluga photo-identification surveys in 2011 and 2012 were also conducted in Knik Arm, Turnagain Arm, and Chickaloon Bay, as well as in the Kenai River Delta, however, funding for these surveys and associated analysis were provided by other funding sources and their results are not presented here because photo-analysis is still ongoing. A summary and synthesis of results of all surveys of Cook Inlet conducted 2005-2012 will be presented in a comprehensive report, to be issued at a later date.

Conclusion

The Susitna River Delta is an important area for CIBW feeding, socializing, and calf rearing; the largest groups in Cook Inlet are found here seasonally, the first neonates of the season are found here, the earliest large feeding groups of the ice-free season are found here, and identified individual whales have been seen to return here year after year.

The strength and utility of the photo-identification project grows with the proportion of the CIBW population that is photographed and identified. Photo-identification surveys from the existing eight years of uninterrupted effort will continue to provide information about the distribution, habitat associations, behavior, color, and age-class compositions of CIBW groups, while identification of whales photographed during the surveys will continue to provide information about movement patterns, social structure, and life history characteristics of individually identified beluga whales. Continuation of a long-term data-set that provides insight into the population dynamics and life history of Cook Inlet beluga whales will help with the identification of appropriate conservation measures to recover and preserve the population.

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Table 1. Total photo-identification survey effort and beluga whale group encounters 2005-2012, Susitna River Delta, Upper Cook Inlet, Alaska.

	2005	2006	2007	2008	2009	2010	2011	2012	*8 -YearTotal*
Number Photo-identification Survey Days	17	16	4	8	15	14	11	9	***94***
Number Groups Encountered	40	20	14	9	17	22	14	16	***152***
Range of Surveys	30 May-21 Oct	12 May-5 Oct	28 Jun-27 Jul	21 May-6 Aug	19 Jun-6 Oct	26 May-31 Aug	17 May-12 Oct	23 May-17 Aug	
Season Survey Span (Months)	5	5	1	3	4	3	5	3	***29***

Table 2. Photo-identification survey effort and beluga whale groups encountered in 2011 and 2012, Susitna River Delta, Upper Cook Inlet, Alaska.

Susitna River Delta	2011	2012
Number of Surveys	11	9
Total Number of Beluga Whale Groups	14	16
Total Number of Beluga Whale Sightings	751	696
Mean Number of Groups per Survey	1.3	1.8
Mean Number of Whales per Survey	68.3	77.3
Mean Number of Whales per Group	53.6	43.5

Table 3. Distribution of photo-identification survey effort by month, week, and location in 2011 and 2012 in the Susitna River Delta, Upper Cook Inlet, Alaska.

Month	Week	2011	2012
May	**1**	0	0
	2	0	0
	3	1	0
	4	1	1
June	**1**	0	0
	2	0	0
	3	1	1
	4	1	1
July	**1**	1	1
	2	1	1
	3	0	1
	4	1	1
August	**1**	0	1
	2	1	0
	3	0	1
	4	1	0
	5	1	0
September	**1**	0	0
	2	0	0
	3	0	0
	4	0	0
October	**1**	0	0
	2	1	0
	3	0	0
	4	0	0

Table 4. Group size, color, composition, and total belugas sighted during vessel surveys in the Susitna River Delta in 2011 and 2012. Group numbers were assigned by day and will not sum to the total number of groups. (Neonates are separate from calf total. Unknown = beluga of unknown color and size.)

Date	Beluga Group #	# White	# Gray	# Calves	# Neonates	# Unknown	*Total Beluga Sightings*
17-May-2011	1	25	30	10	0	0	65
27-May-2011	1	60	60	4	0	0	124
17-Jun-2011	1	20	20	2	0	0	42
29-Jun-2011	1	25	15	5	0	0	45
29-Jun-2011	2	7	5	1	0	0	13
5-Jul-2011	1	11	7	4	0	0	22
5-Jul-2011	2	20	15	5	0	0	40
13-Jul-2011	1	25	15	5	0	0	45
27-Jul-2011	1	13	0	0	0	0	13
27-Jul-2011	2	0	0	0	0	45	45
27-Jul-2011	3	80	50	4	2	0	136
10-Aug-2011	1	25	18	3	2	0	48
26-Aug-2011	1	30	25	5	2	0	62
29-Aug-2011	1	0	0	1	0	50	51
12-Oct-2011	0	0	0	0	0	0	0
Total 2011	**14**	**341**	**260**	**49**	**6**	**95**	***751***
23-May-2012	1	60	55	20	0	0	135
16-Jun-2012	1	10	4	0	0	0	14
16-Jun-2012	2	20	15	2	0	0	37
22-Jun-2012	1	4	3	1	0	0	8
22-Jun-2012	2	3	0	0	0	0	3
6-Jul-2012	1	1	0	0	0	0	1
14-Jul-2012	1	2	1	0	0	0	3
14-Jul-2012	2	3	2	0	0	0	5
14-Jul-2012	3	2	3	0	0	0	5
14-Jul-2012	4	4	4	0	0	0	8
14-Jul-2012	5	2	0	0	0	0	2
20-Jul-2012	1	0	0	0	5	200	205
28-Jul-2012	0	0	0	0	0	0	0
3-Aug-2012	1	25	20	10	4	0	59
3-Aug-2012	2	20	20	5	2	0	47
17-Aug-2012	1	30	20	4	3	57	114
17-Aug-2012	2	0	0	0	0	50	50
Total 2012	**16**	**186**	**147**	**42**	**14**	**307**	**696**
Total Both Years	**30**	**527**	**407**	**91**	**20**	**402**	**1447**

Table 5. Percent color composition of beluga whale groups sighted during surveys conducted in 2011 and 2012 from vessels in the Susitna River Delta, Upper Cook Inlet, Alaska.

Date	Survey Method	# Beluga Sightings	% White	% Gray	% Calves	% Neonates	% Unknown
2011	vessel	751	45	35	6	1	13
2012	vessel	696	27	21	6	2	44

Table 6. Summary of primary and secondary activities of beluga groups encountered in 2011 and 2012 during photo-identification surveys in the Susitna River Delta, Upper Cook Inlet.

		Percent of all Group Activity Recorded per Area					
Year	Group Activity	% Traveling	% Milling	% Suspected Feeding	% Diving	% Socializing	% Unknown
2011	primary	86	0	0	14	0	0
	secondary	0	8	58	17	17	0
2012	primary	33	20	0	47	0	0
	secondary	15	15	31	31	8	0

Table 7. Susitna River Delta sighting records of seven individual belugas that were identified by scars from satellite tags applied by NMFS between 1999 and 2002, according to year photographed 2005-2011. (P = Photographed, C=Photographed with a calf)

	Susitna River Delta						
	2005	2006	2007	2008	2009	2010	2011
	# of Surveys						
WHALE ID	**17**	**21**	**4**	**8**	**15**	**14**	**11**
R96[M]		P	P	C	P	C	C
R103[M]	P	P	P	P	P	P	
R114	P		P				
R115[M]	P		P	C	P	P	P
R549*[M]							
R243	P			P	P	P	
R111[M]	P		P	P	C	P	P

* seen elsewhere in Cook Inlet, but not in the Susitna River Delta

[M]=presumed mother, based on photographs with accompanying calf sometime during its sighting history

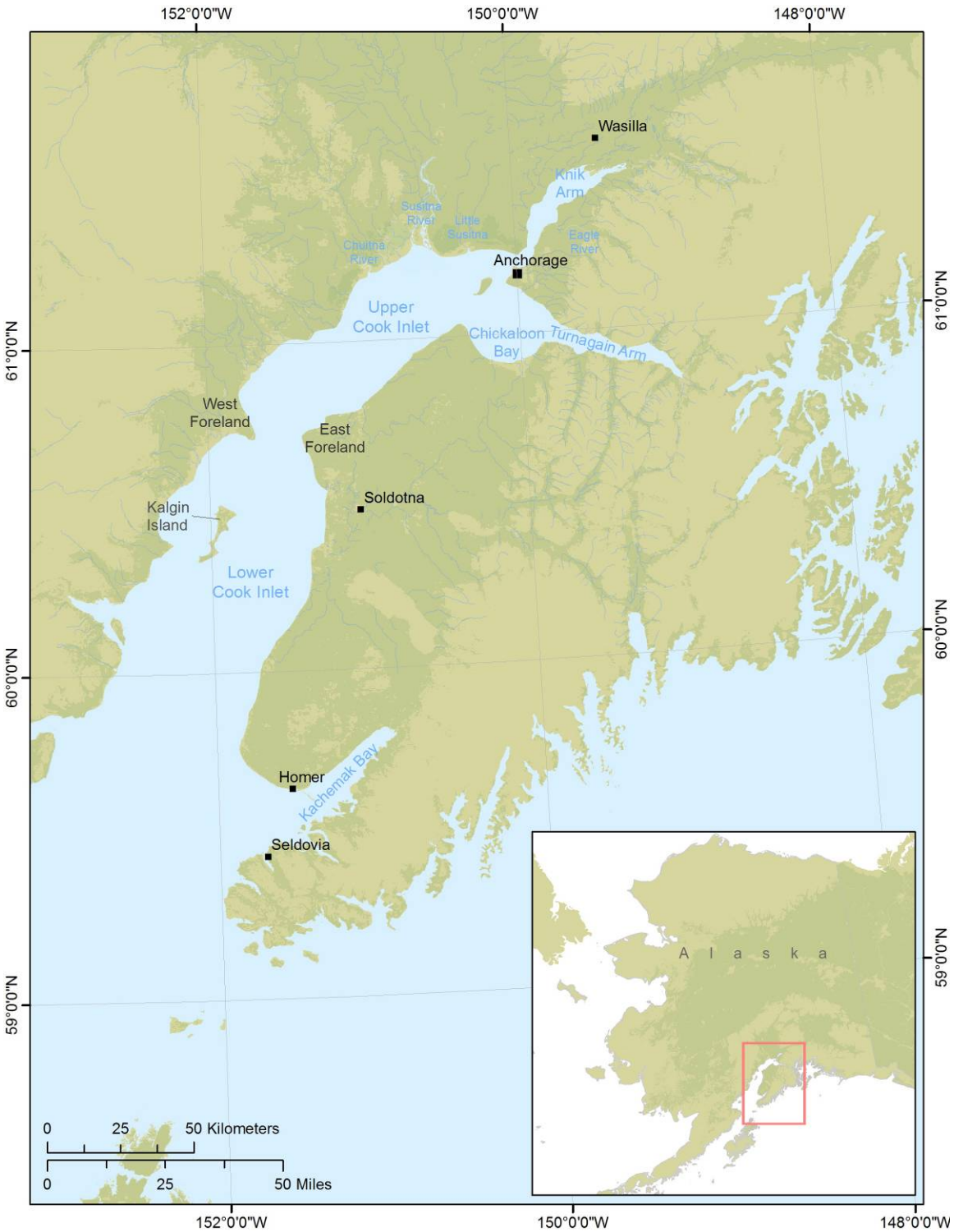

Figure 1. Map of Cook Inlet, Alaska, showing major features discussed in text.

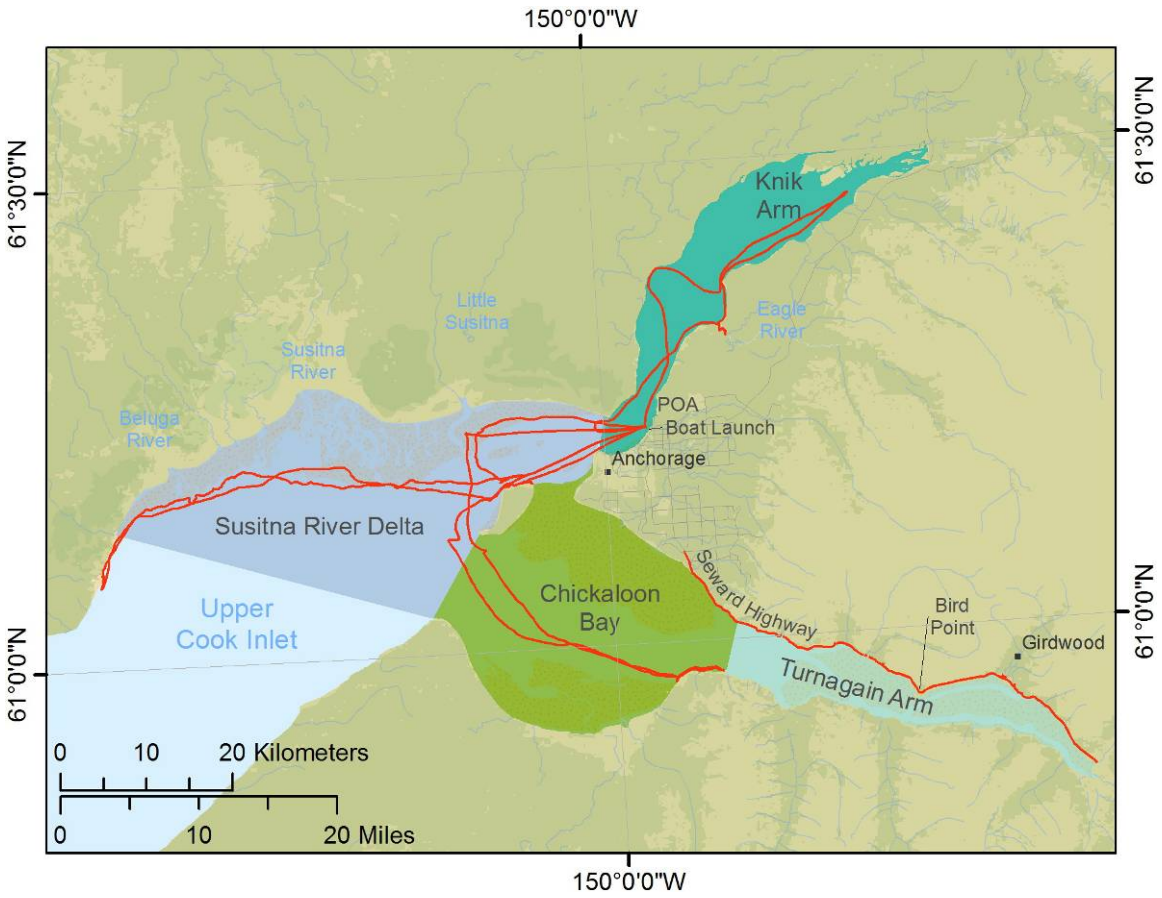

Figure 2. Map of Upper Cook Inlet, Alaska, showing boundaries of four sub-areas within the study area and the vessel- and land-based survey routes used during 2005-2012.

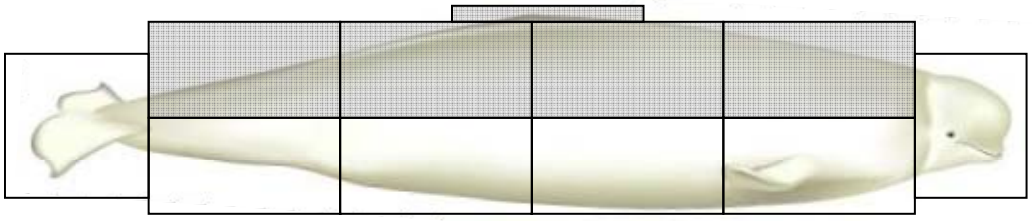

Figure 3. Diagram showing the various segments used when cataloging. The five shaded areas were the critical sections used in matching marks. Beluga illustration courtesy of Uko Gorter.

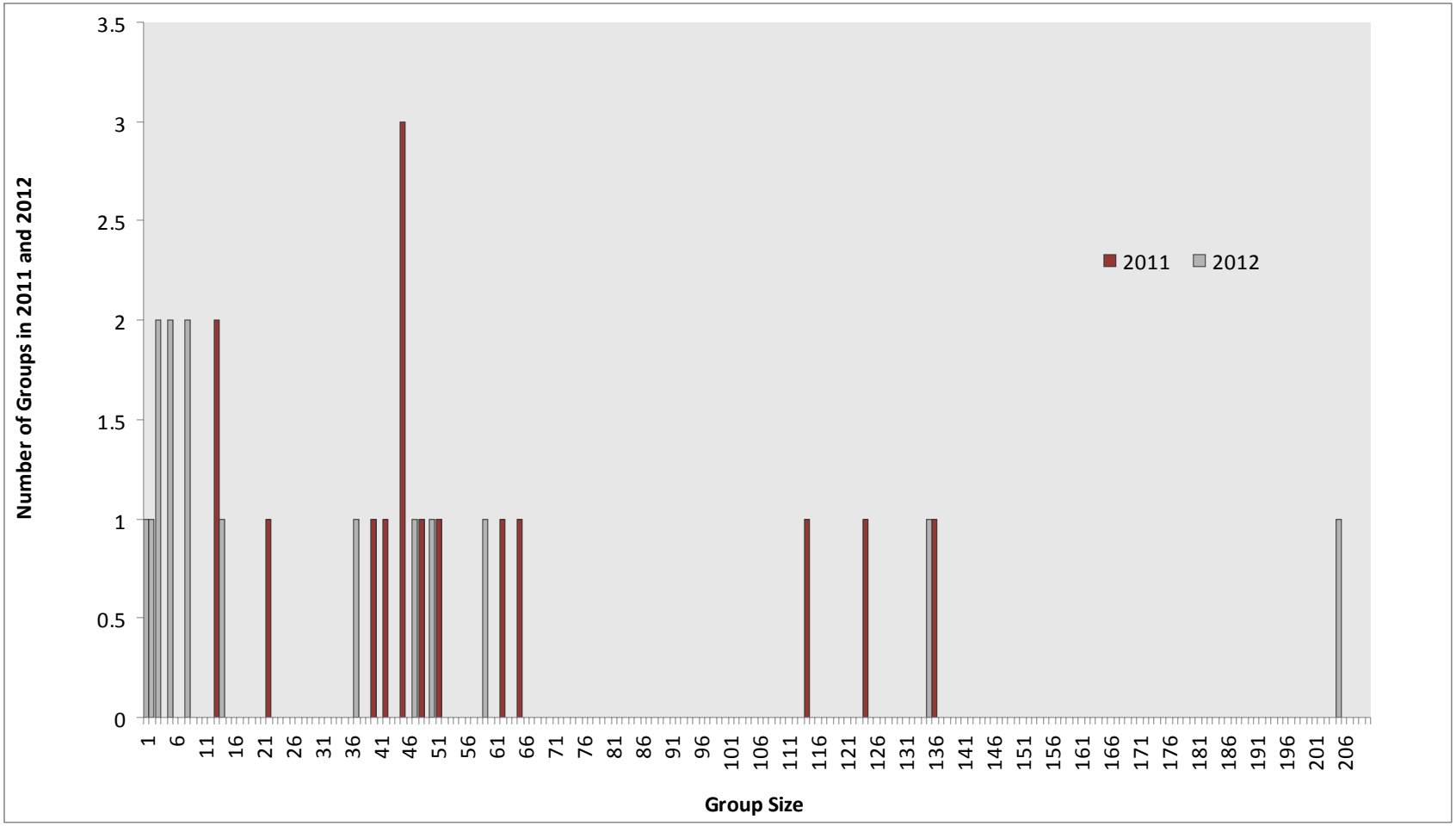

Figure 4. Group-size frequency distribution of beluga whales encountered during photo-identification surveys of the Susitna River Delta in 2011 and 2012 (14 groups, and 16 groups, respectively).

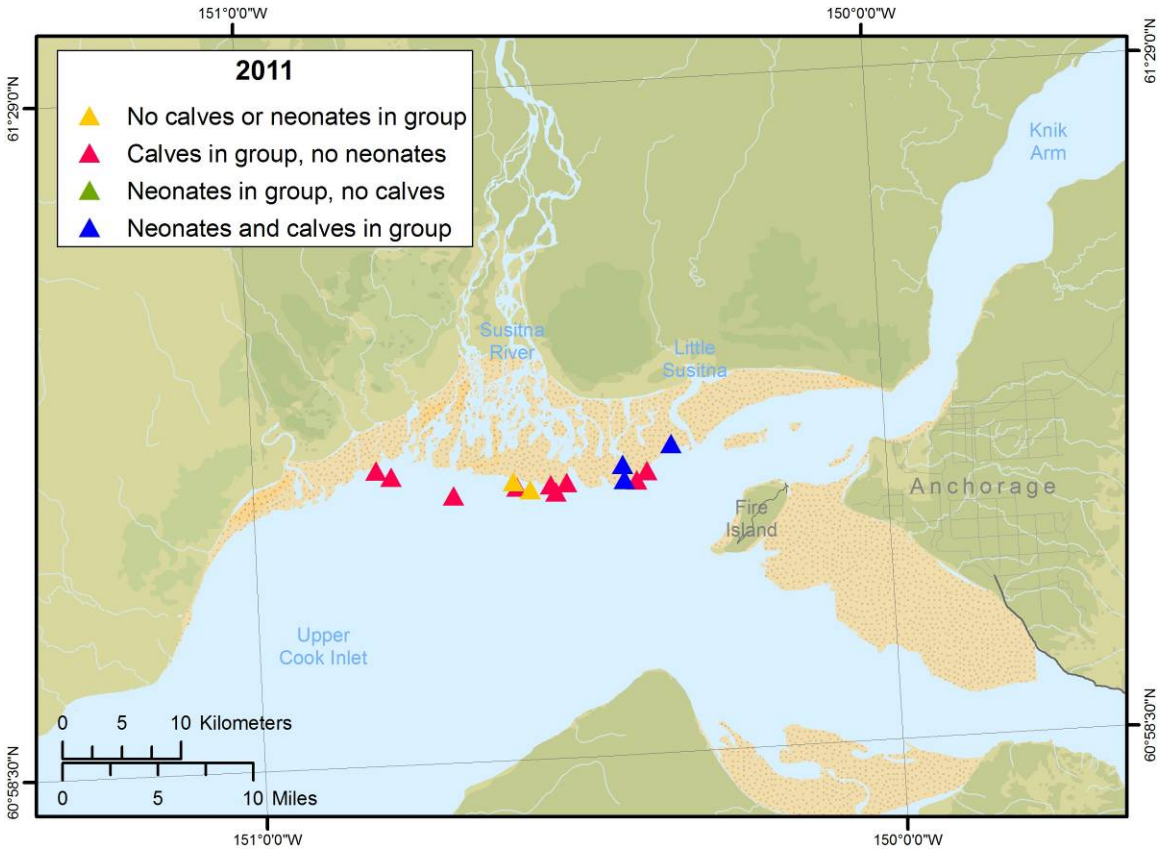

Figure 5. Location of groups with and without calves and neonates encountered during vessel-based photo-identification surveys of the Susitna River Delta, Upper Cook Inlet, Alaska in 2011.

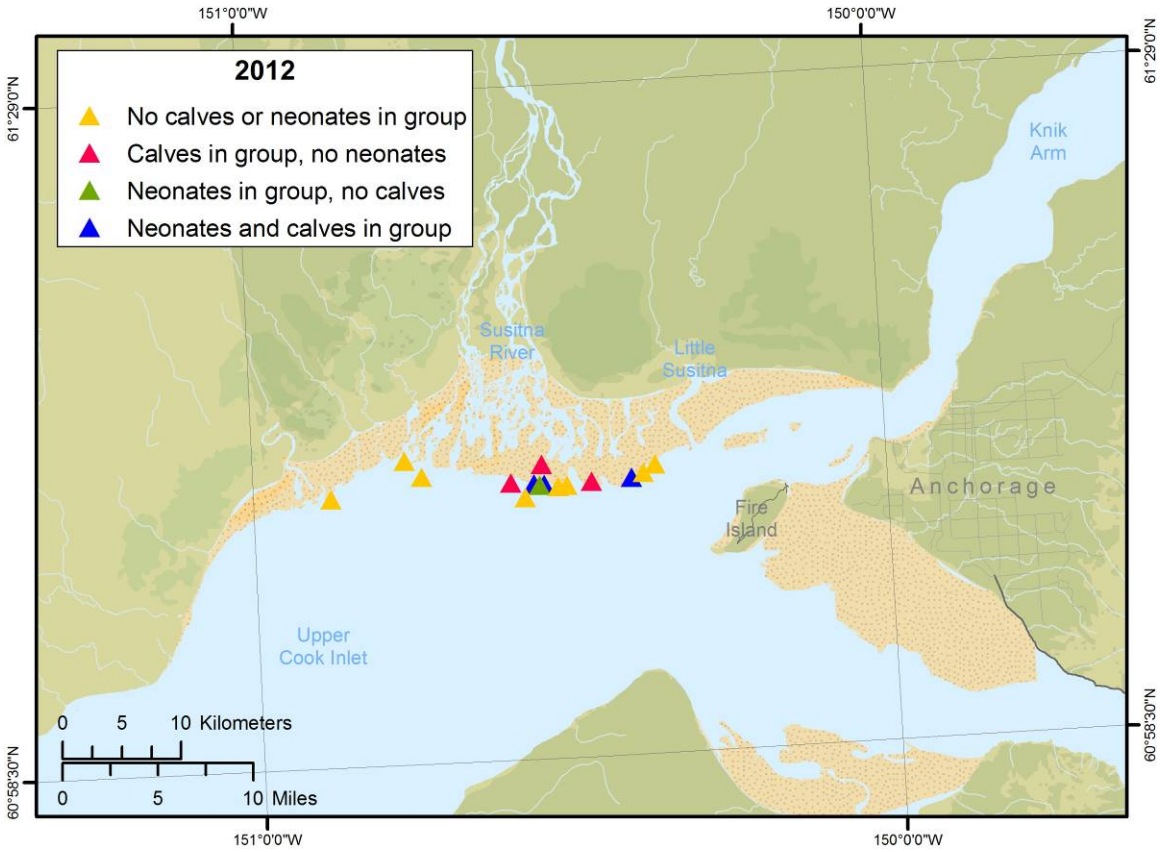

Figure 6. Location of groups with and without calves and neonates encountered during vessel-based photo-identification surveys of the Susitna River Delta, Upper Cook Inlet, Alaska in 2012.

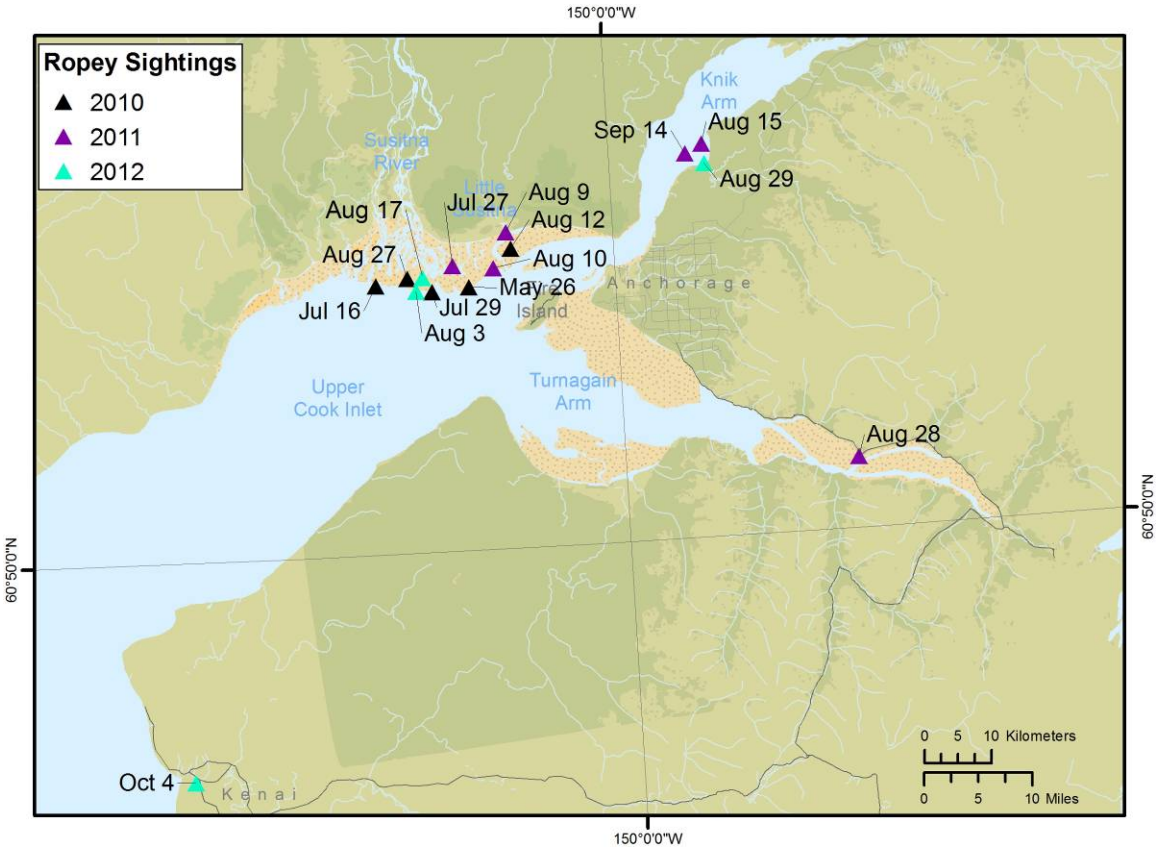

Figure 7. Sighting history of an entangled Cook Inlet beluga whale, "Ropey", during the 2010-2012 field season in Cook Inlet, Alaska.

Figure 8. Project poster presented at the 2011 Alaska Marine Science Symposium.

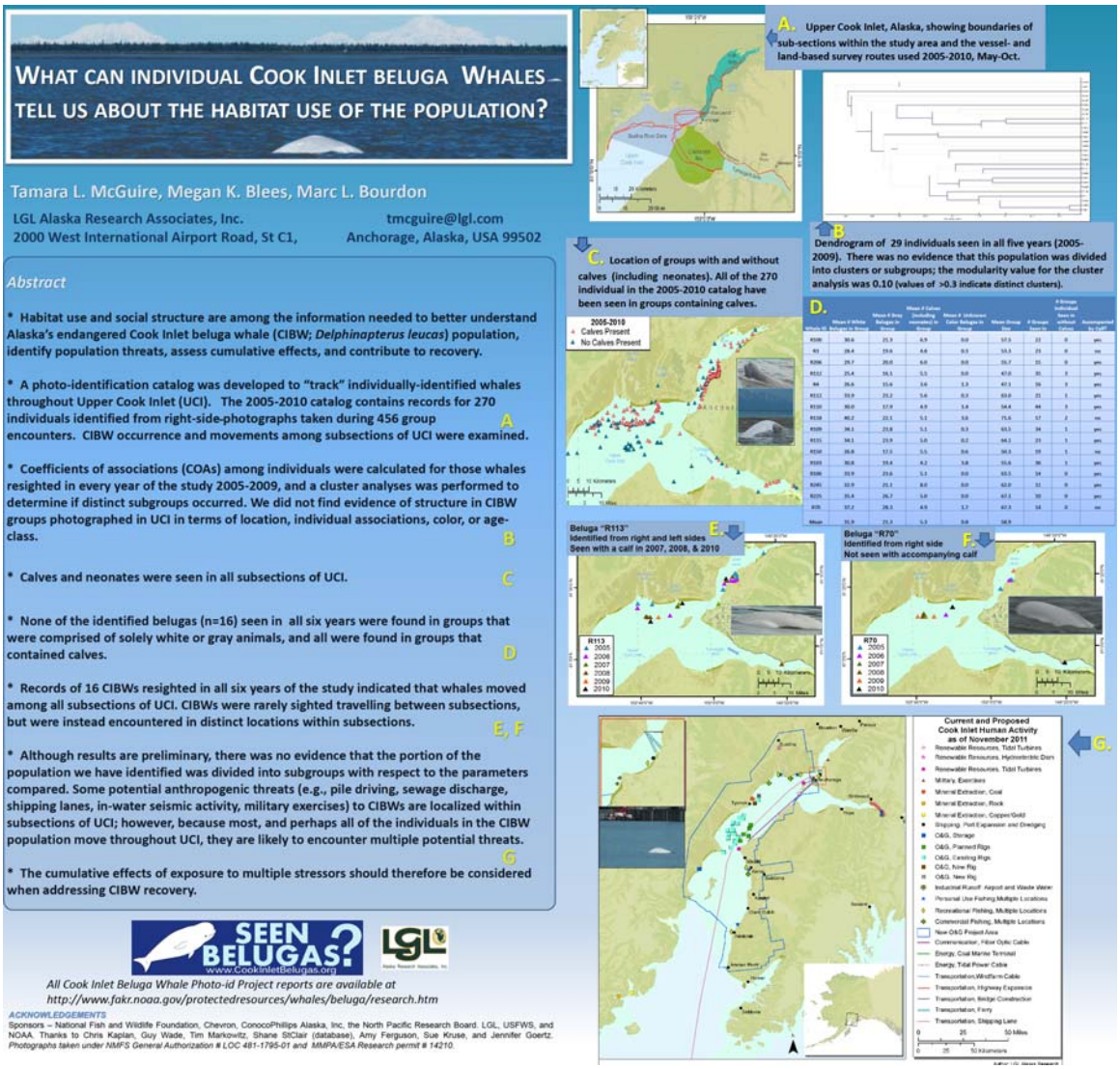

Figure 9. Project poster presented at the 2011 Society for Marine Mammalogy Biennial Conference.

APPENDIX A

BELUGA WHALE GROUPS ENCOUNTERED DURING VESSEL-BASED SURVEYS CONDUCTED IN THE SUSITNA RIVER DELTA, UPPER COOK INLET, ALASKA.

DAILY SURVEY TRACKS AND LOCATIONS OF WHALES,

2011 AND 2012 FIELD SEASONS

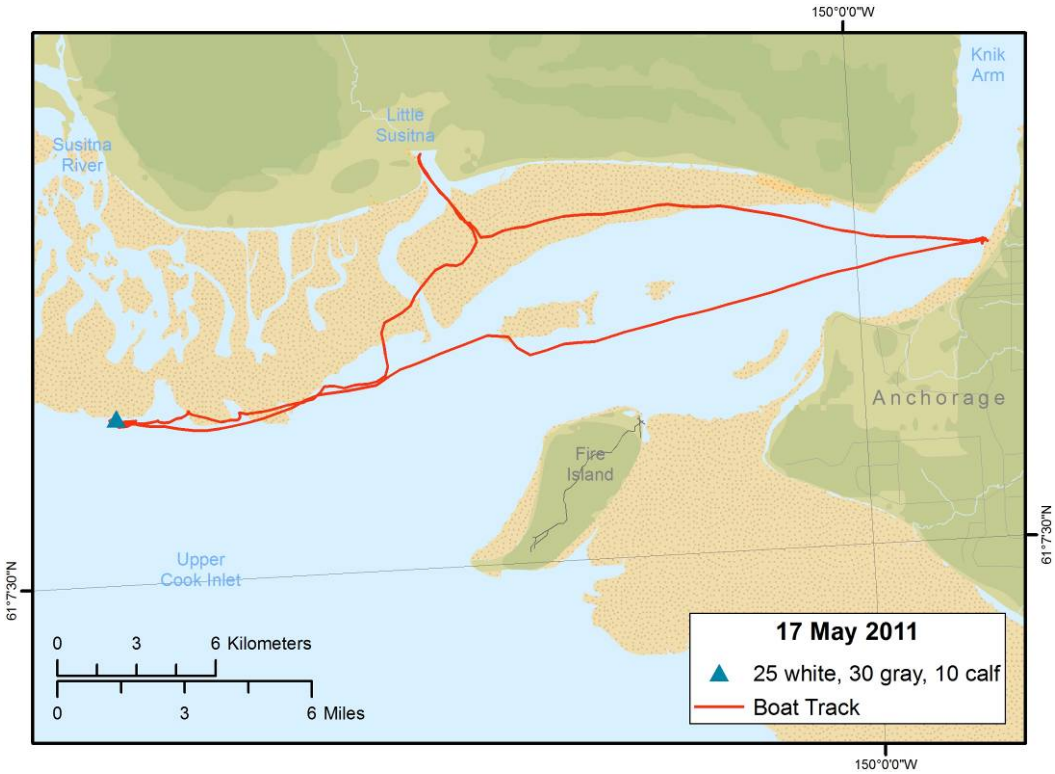

Figure A1. Route and beluga whale group(s) encountered during the vessel-based survey route of 17 May 2011 in Upper Cook Inlet, Alaska.

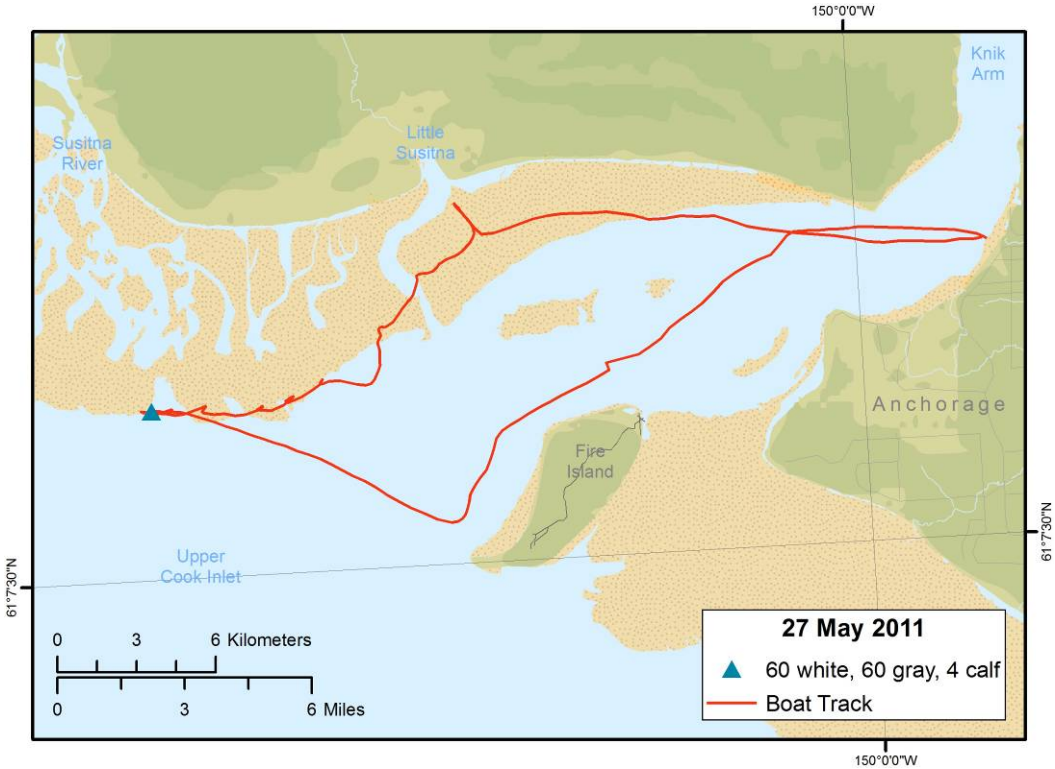

Figure A2. Route and beluga whale group(s) encountered during the vessel-based survey route of 27 May 2011 in Upper Cook Inlet, Alaska.

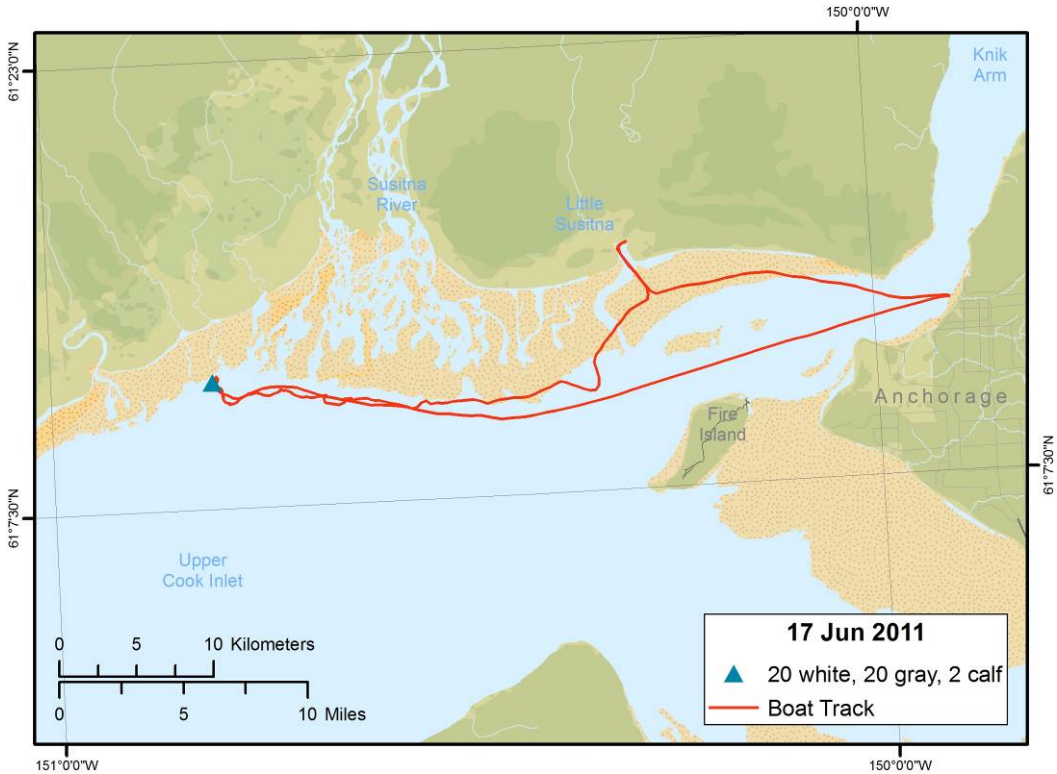

Figure A3. Route and beluga whale group(s) encountered during the vessel-based survey route of 17 June 2011 in Upper Cook Inlet, Alaska.

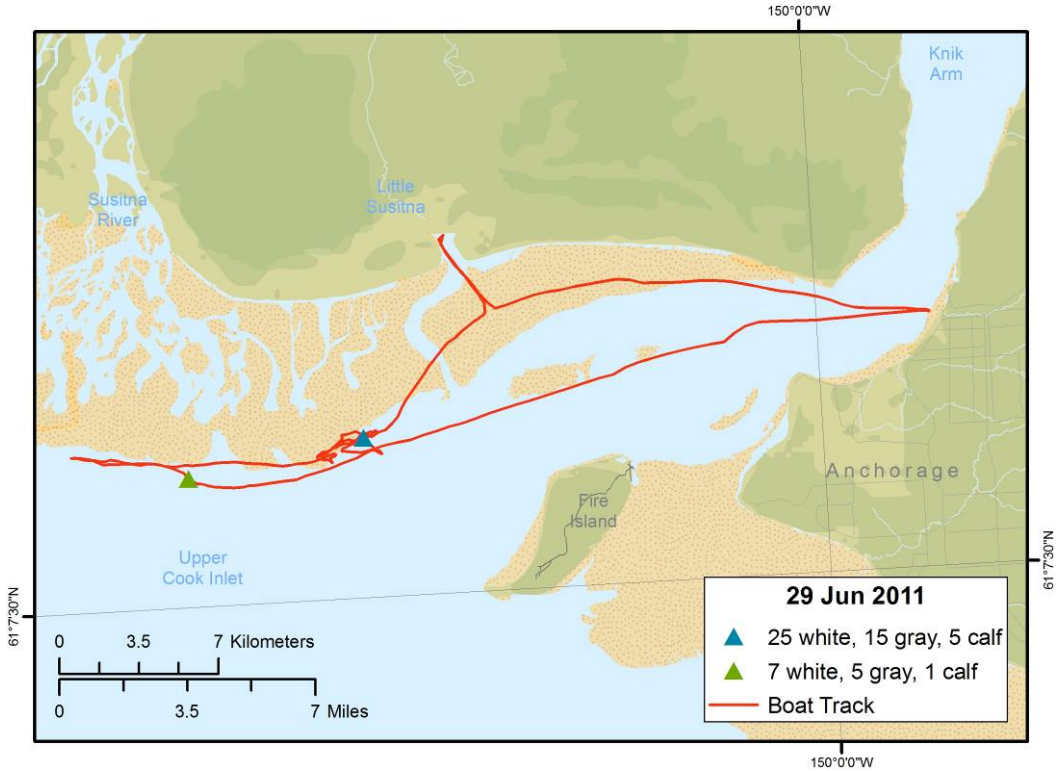

Figure A4. Route and beluga whale group(s) encountered during the vessel-based survey route of 29 June 2011 in Upper Cook Inlet, Alaska.

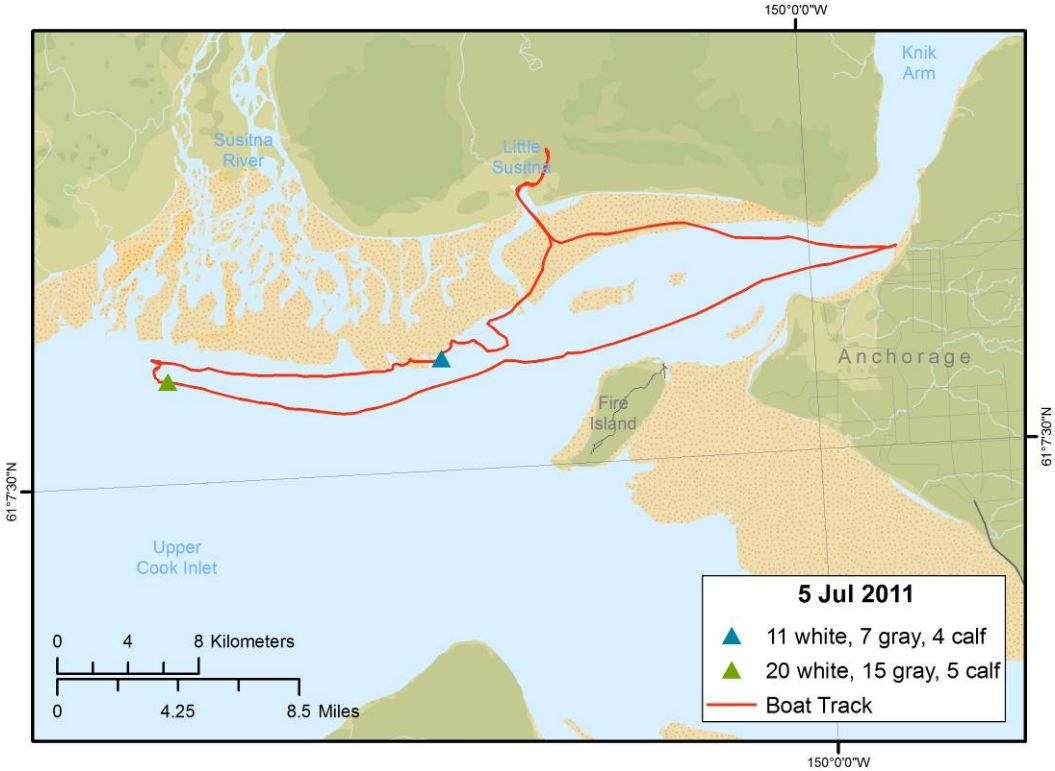

Figure A5. Route and beluga whale group(s) encountered during the vessel-based survey route of 5 July 2011 in Upper Cook Inlet, Alaska.

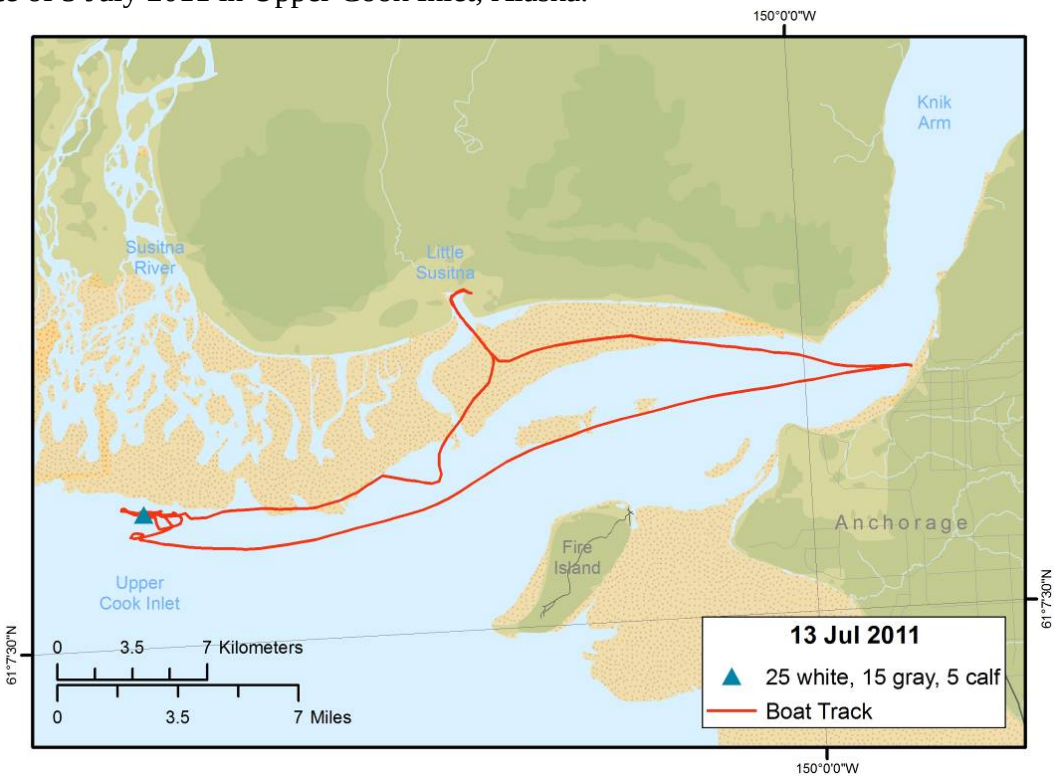

Figure A6. Route and beluga whale group(s) encountered during the vessel-based survey route of 13 July 2011 in Upper Cook Inlet, Alaska.

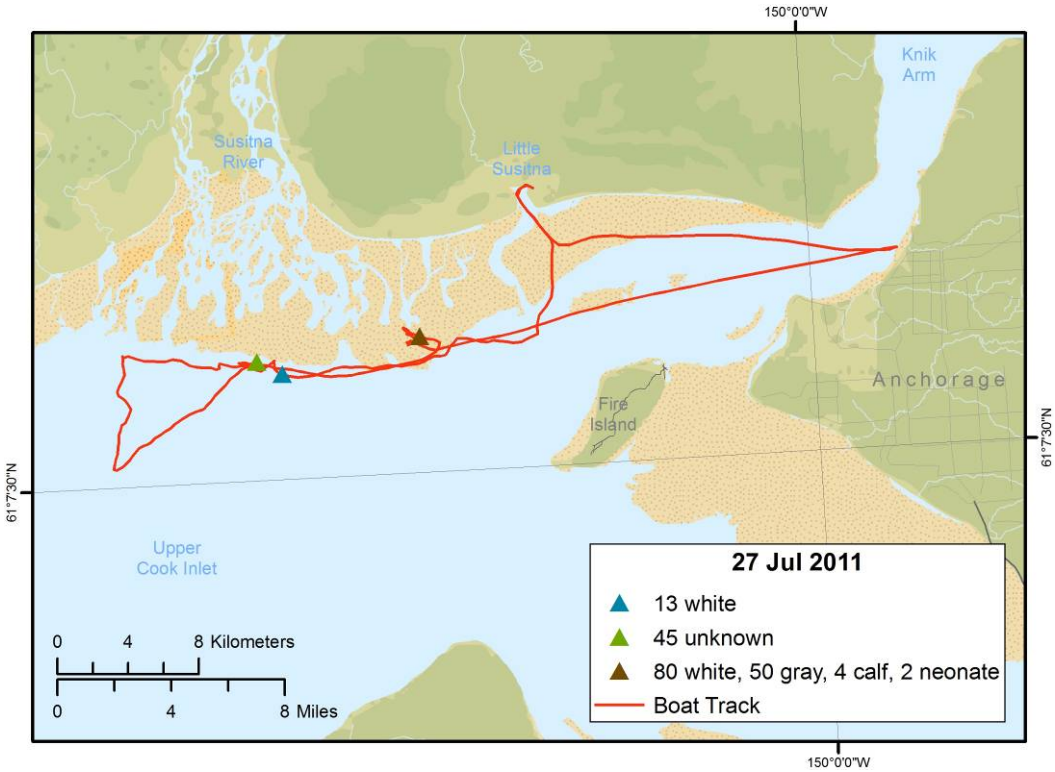

Figure A7. Route and beluga whale group(s) encountered during the vessel-based survey route of 27 July 2011 in Upper Cook Inlet, Alaska.

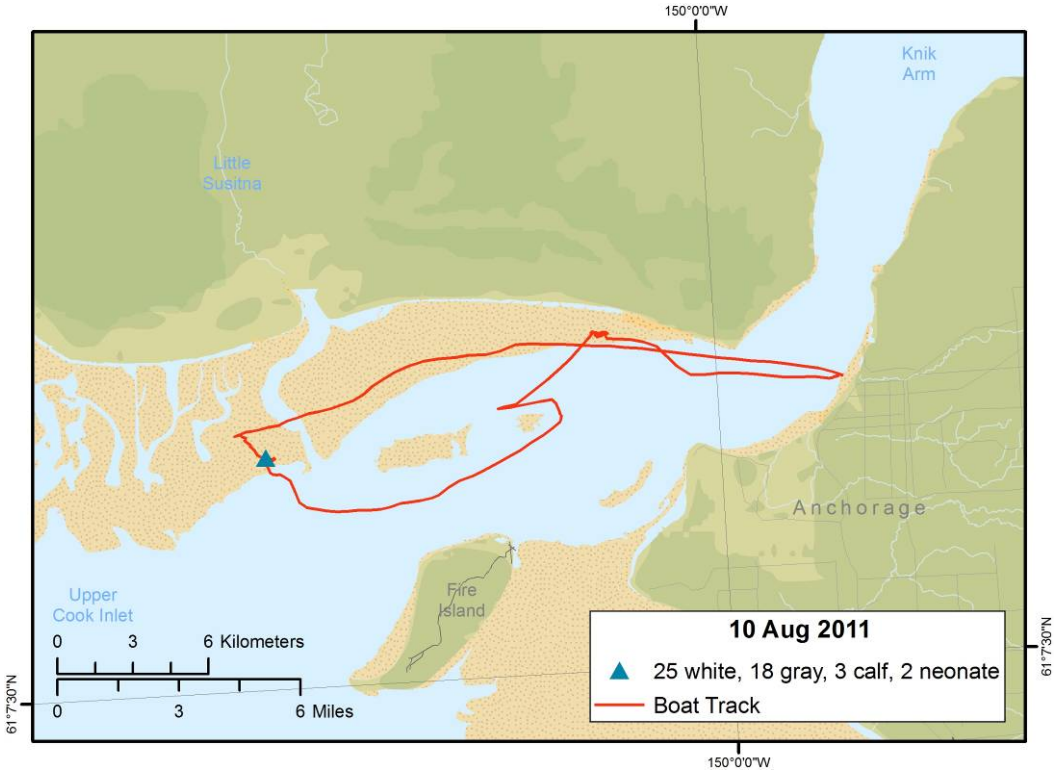

Figure A8. Route and beluga whale group(s) encountered during the vessel-based survey route of 10 August 2011 in Upper Cook Inlet, Alaska.

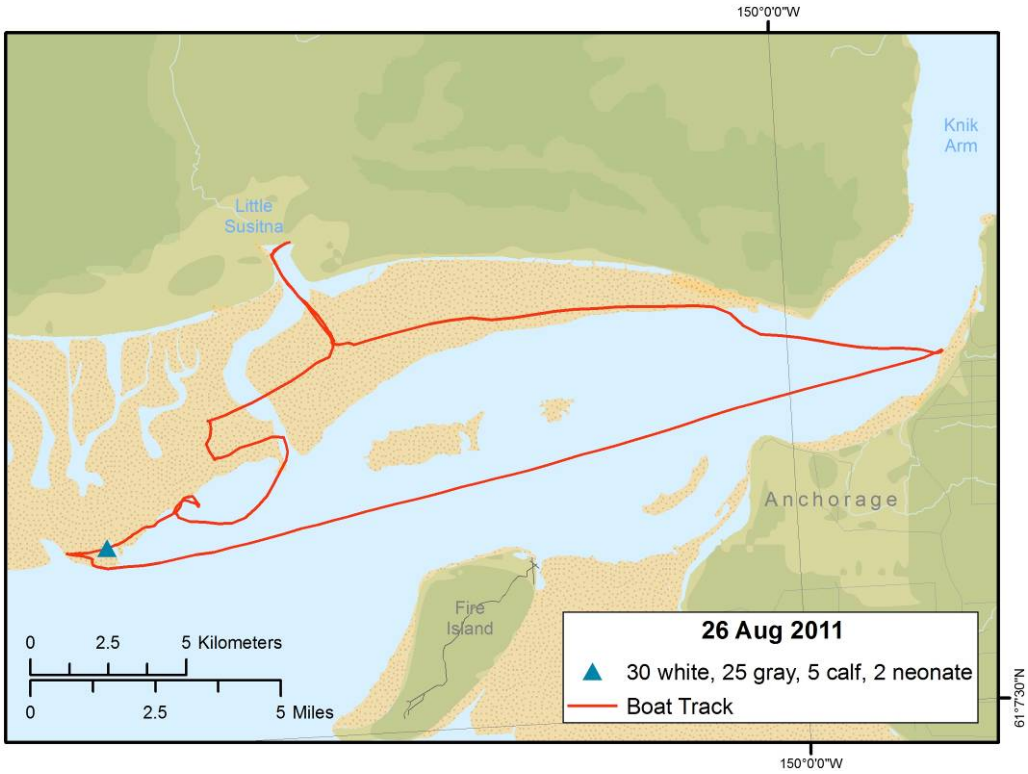

Figure A9. Route and beluga whale group(s) encountered during the vessel-based survey route of 26 August 2011 in Upper Cook Inlet, Alaska.

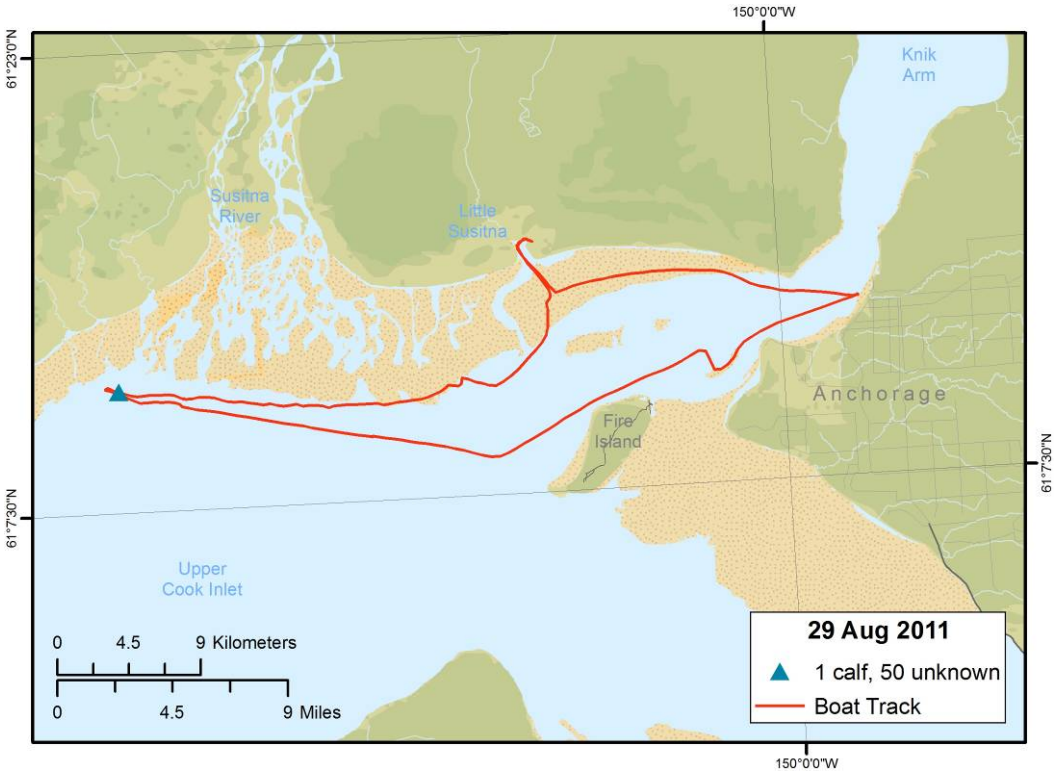

Figure A10. Route and beluga whale group(s) encountered during the vessel-based survey route of 29 August 2011 in Upper Cook Inlet, Alaska.

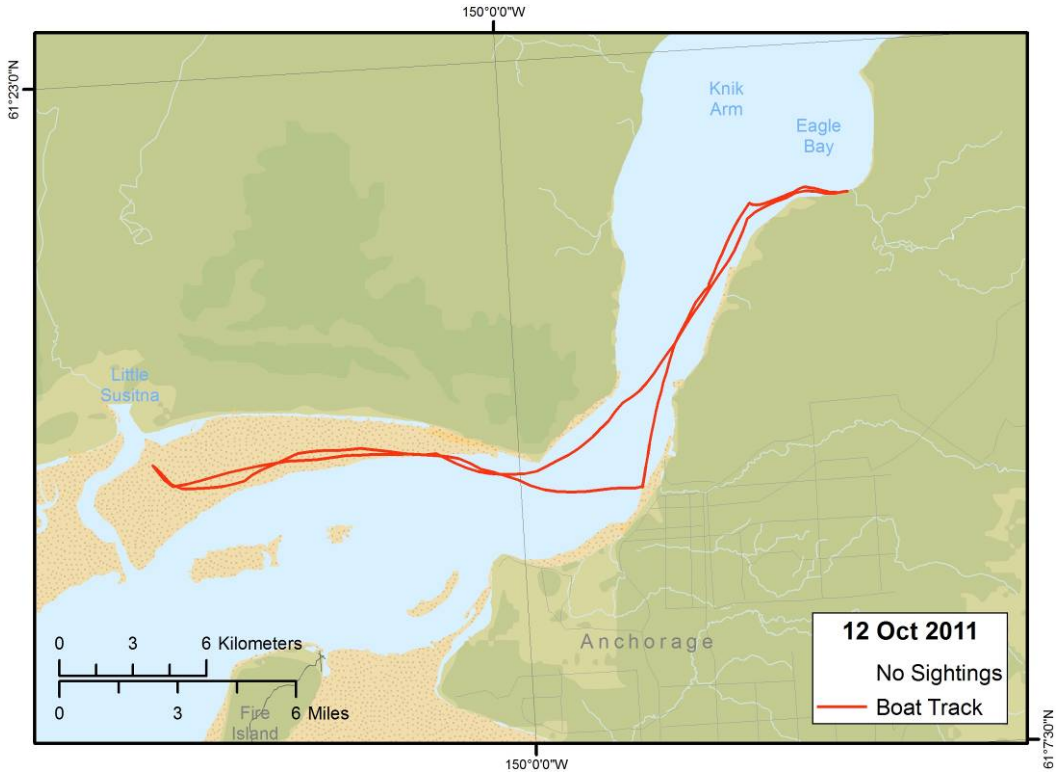

Figure A11. Route of the vessel-based survey route of 12 October 2011 in Upper Cook Inlet, Alaska. No belugas were encountered during this survey.

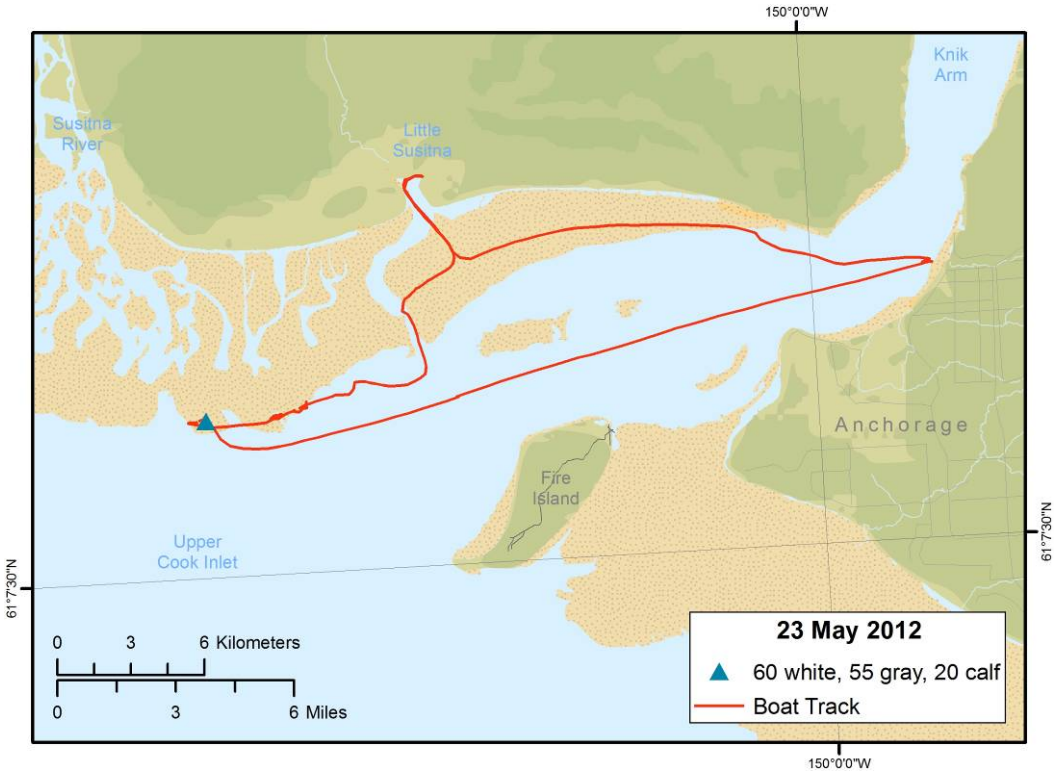

Figure A12. Route and beluga whale group(s) encountered during the vessel-based survey route of 23 May 2012 in Upper Cook Inlet, Alaska.

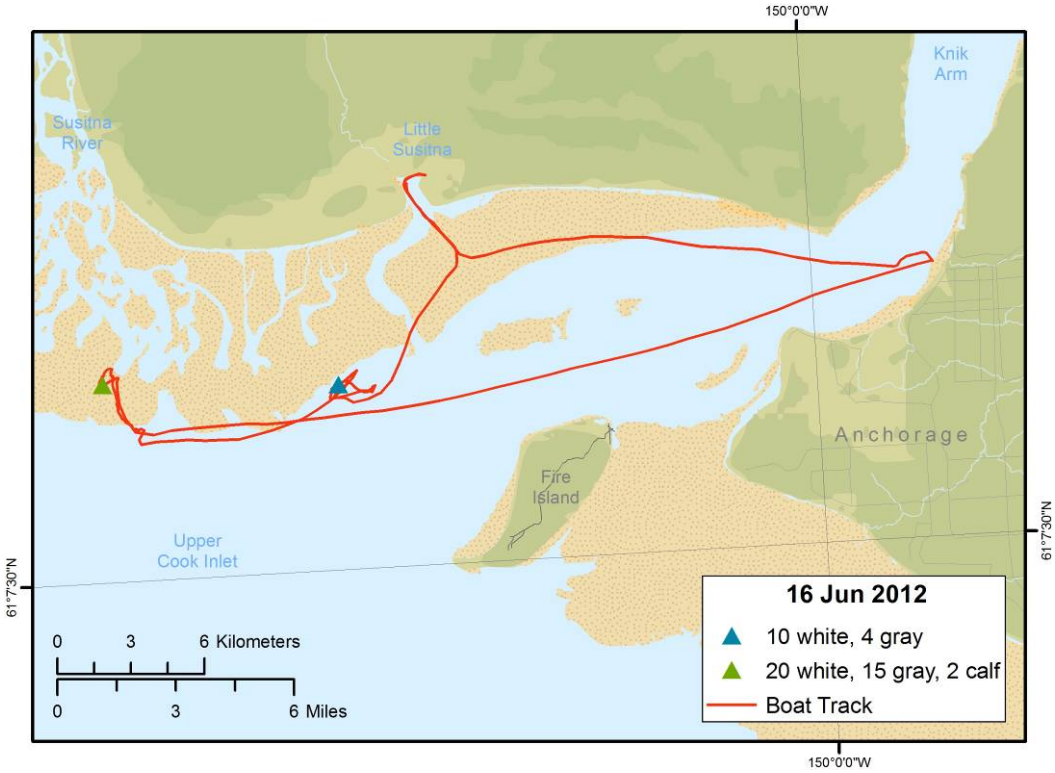

Figure A13. Route and beluga whale group(s) encountered during the vessel-based survey route of 16 June 2012 in Upper Cook Inlet, Alaska.

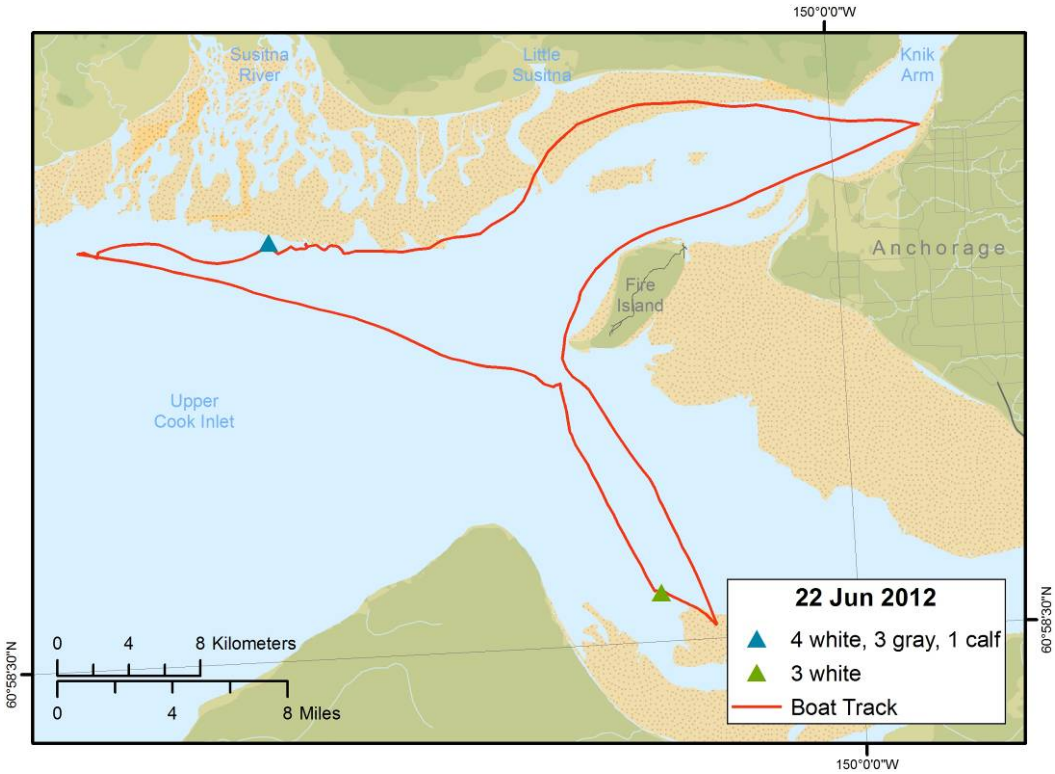

Figure A14. Route and beluga whale group(s) encountered during the vessel-based survey route of 22 June 2012 in Upper Cook Inlet, Alaska.

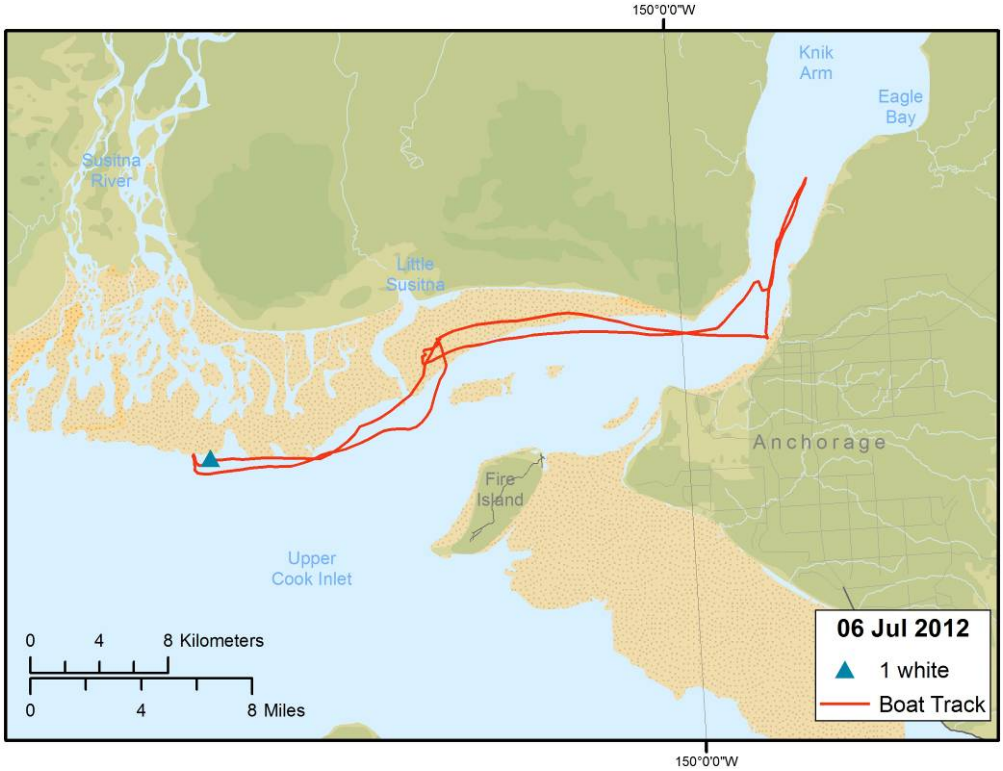

Figure A15. Route and beluga whale group(s) encountered during the vessel-based survey route of 6 July 2012 in Upper Cook Inlet, Alaska.

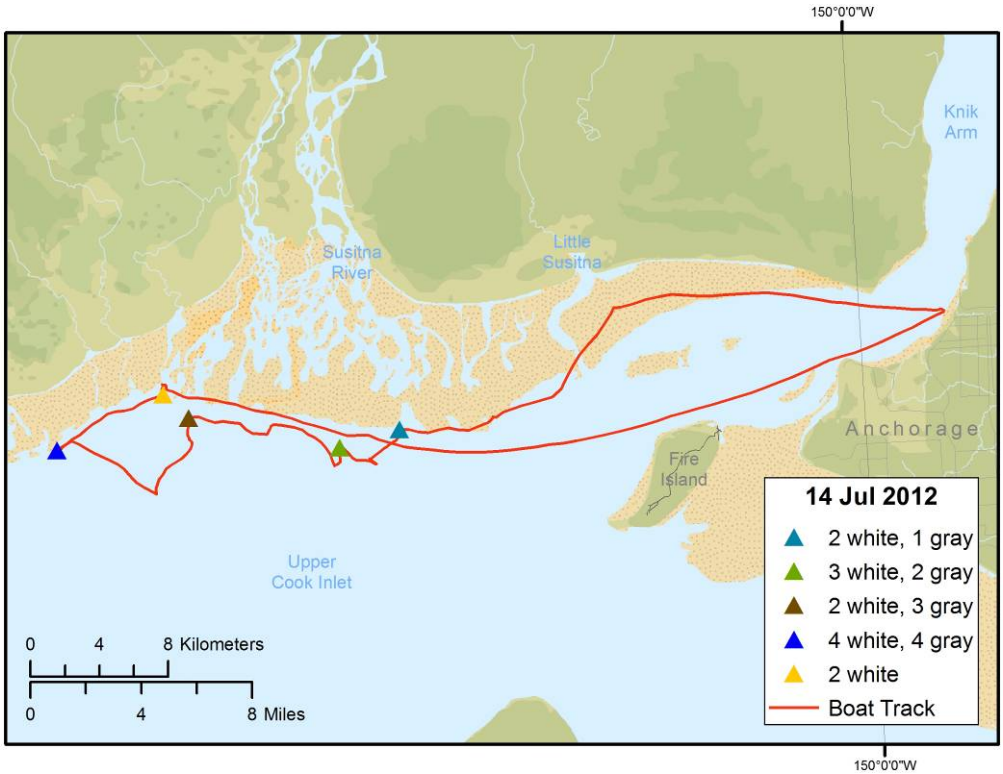

Figure A16. Route of the vessel-based survey route of 14 July 2012 in Upper Cook Inlet, Alaska.

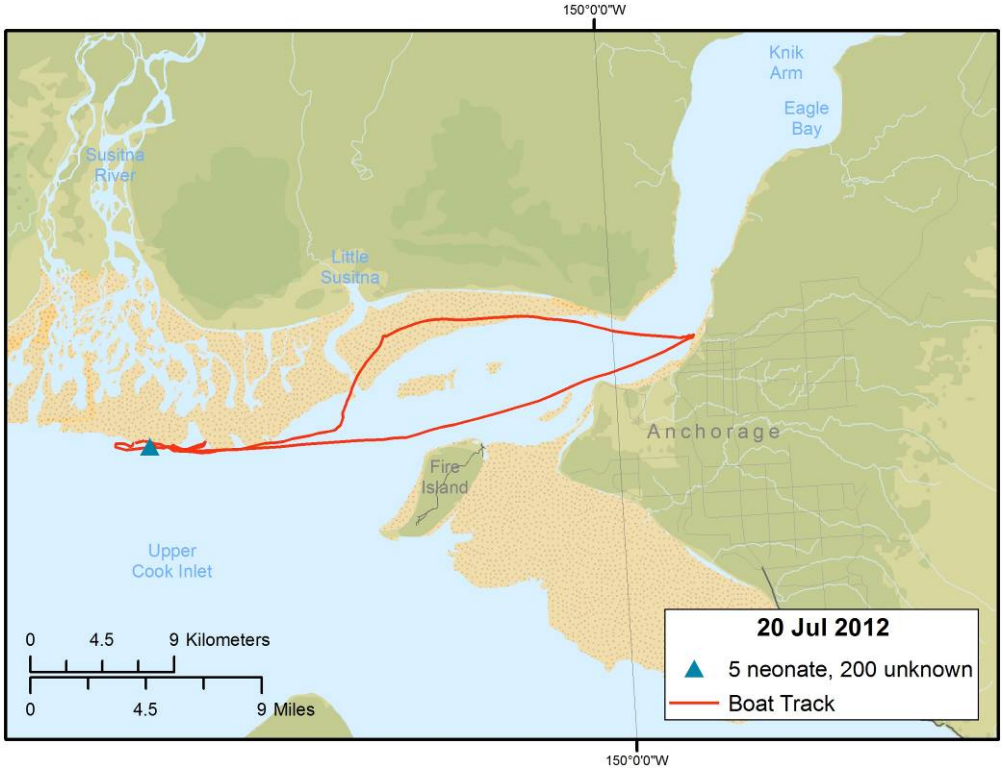

Figure A17. Route of the vessel-based survey route of 20 July 2012 in Upper Cook Inlet, Alaska.

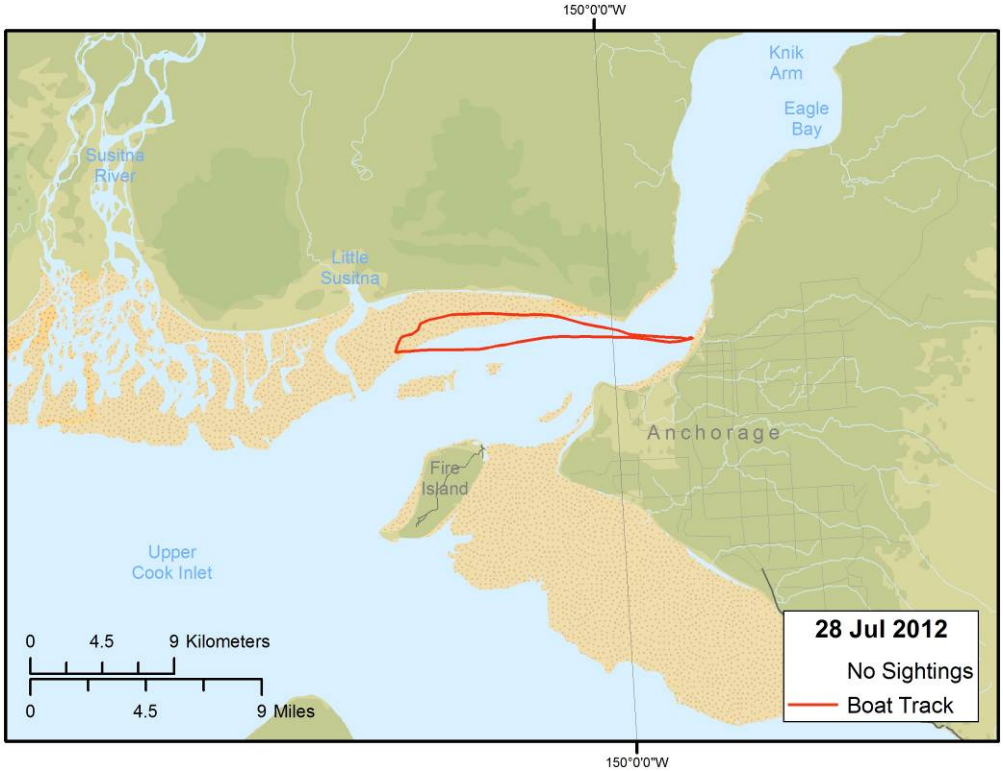

Figure A18. Route and beluga whale group(s) encountered during the vessel-based survey route of 28 July 2012 in Upper Cook Inlet, Alaska. No belugas were encountered during this survey.

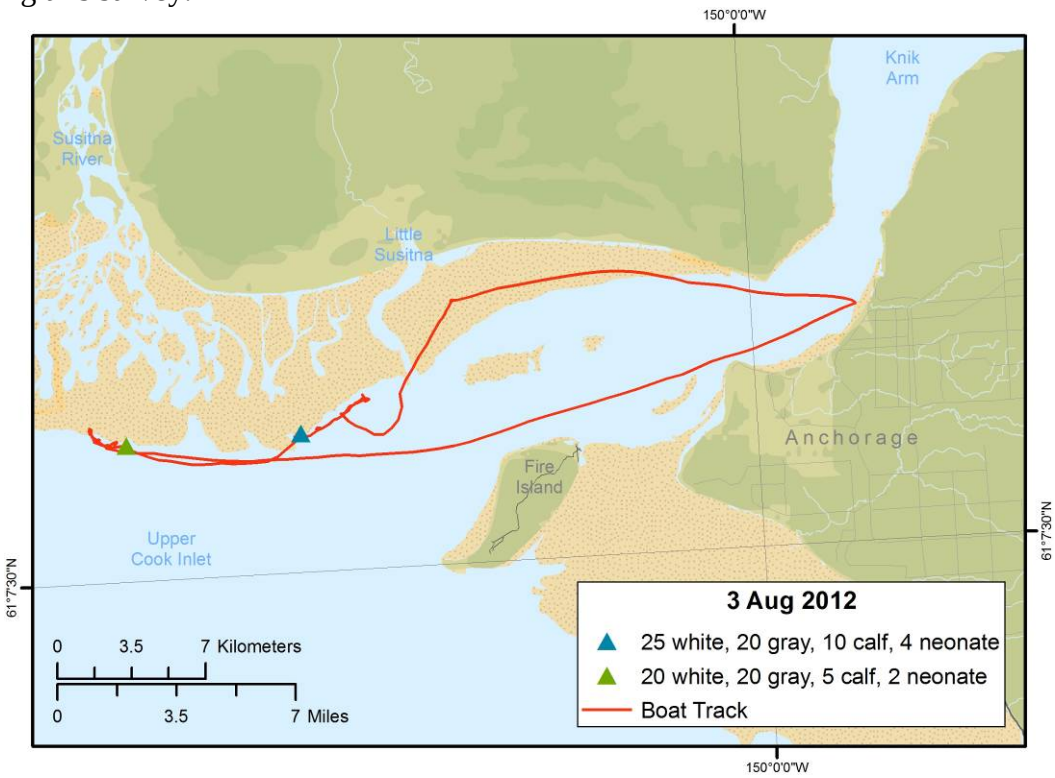

Figure A19. Route and beluga whale group(s) encountered during the vessel-based survey route of 3 August 2012 in Upper Cook Inlet, Alaska.

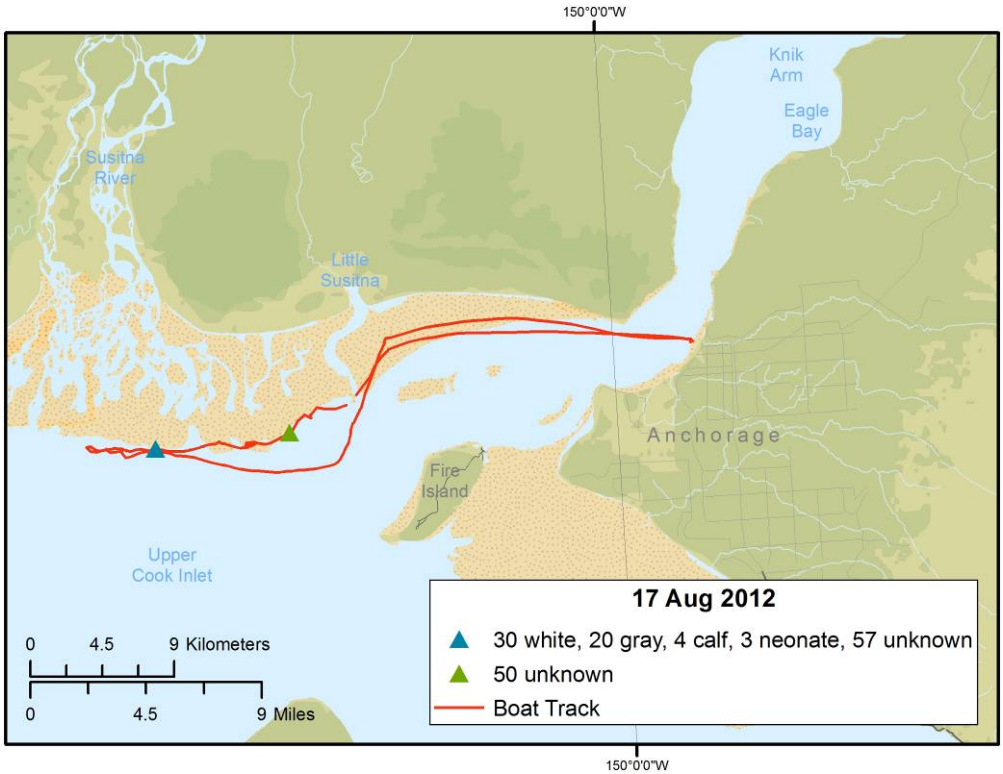

Figure A20. Route and beluga whale group(s) encountered during the vessel-based survey route of 17 August 2012 in Upper Cook Inlet, Alaska.

APPENDIX B

INDIVIDUAL SIGHTING-HISTORY MAPS AND RIGHT SIDE PHOTOGRAPHS OF CATALOGED WHALES IDENTIFIED 2005-2011 BY SCARS FROM SATELLITE TAGS APPLIED BY NMFS BETWEEN 1999 AND 2002.

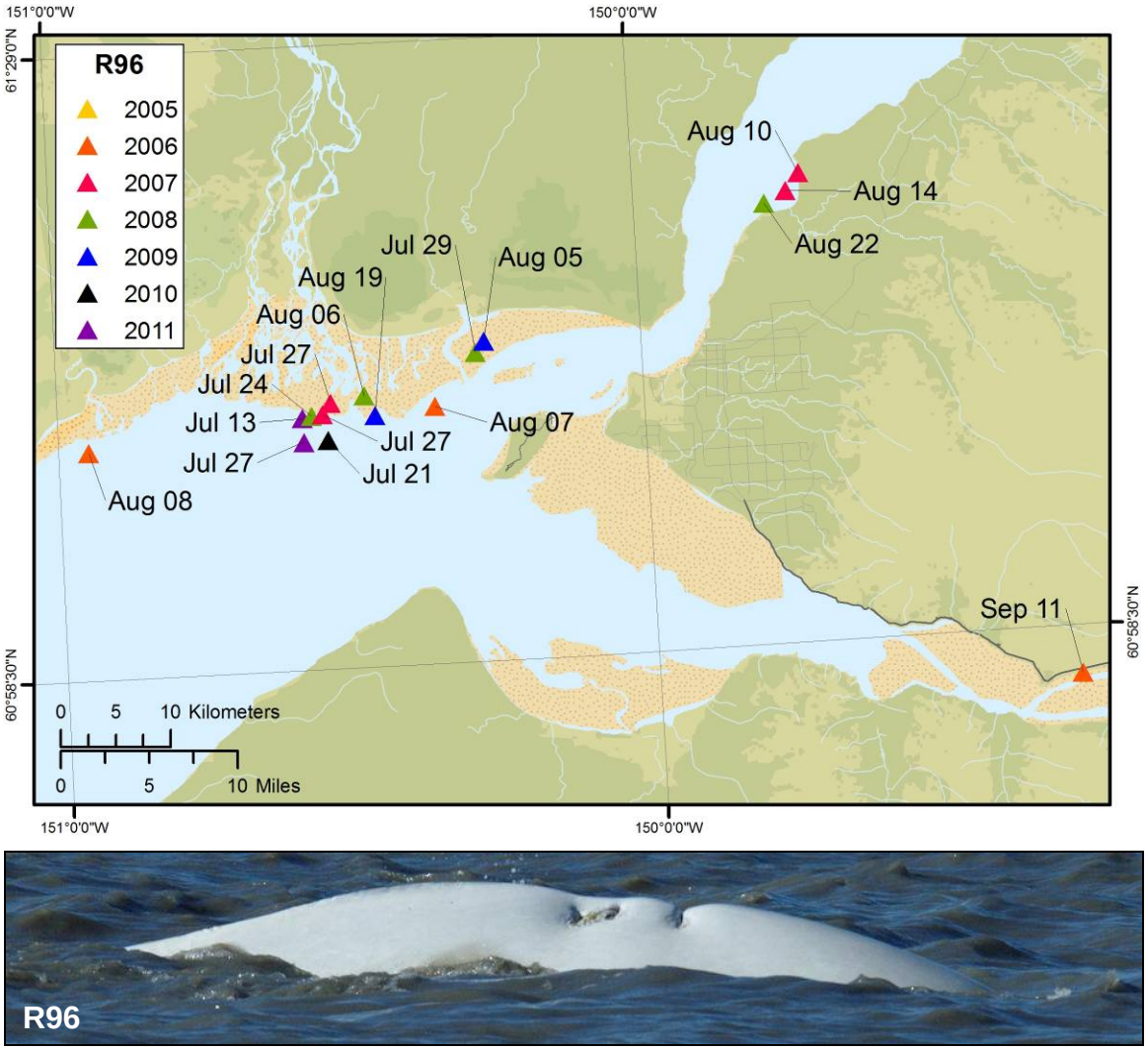

Figure B1. Sighting history and photograph of beluga R96. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf. The sighting history from 2011 does not yet include sightings outside of the Susitna River Delta (Cook Inlet-wide results from 2011 will be presented in a future report).

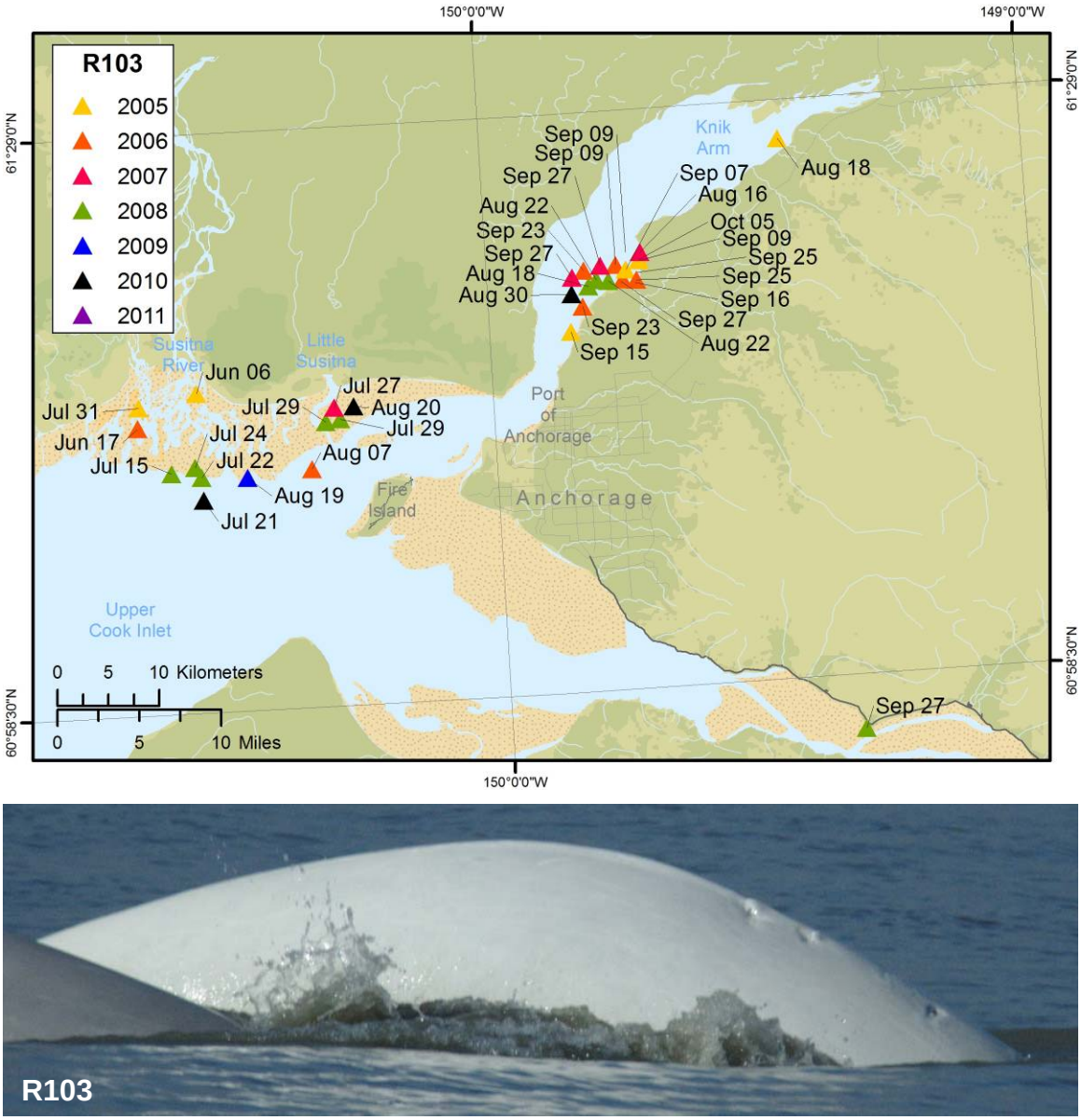

Figure B2. Sighting history and photograph of beluga R103. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf. The sighting history from 2011 does not yet include sightings outside of the Susitna River Delta (Cook Inlet-wide results from 2011 will be presented in a future report).

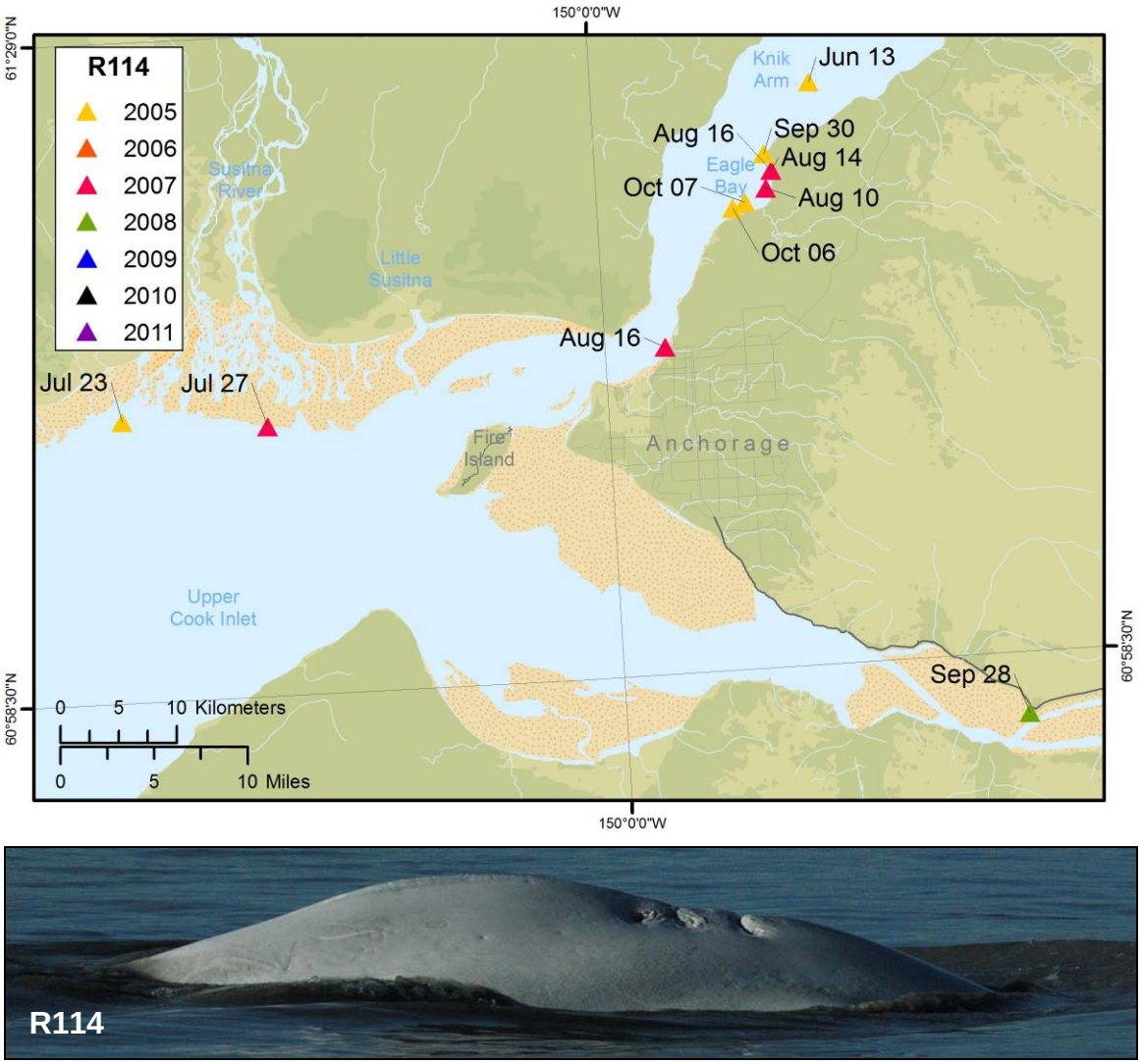

Figure B3. Sighting history and photograph of beluga R114, who was photographed in 2005 and 2007. This beluga was tagged by NMFS sometime between 1999 and 2002.

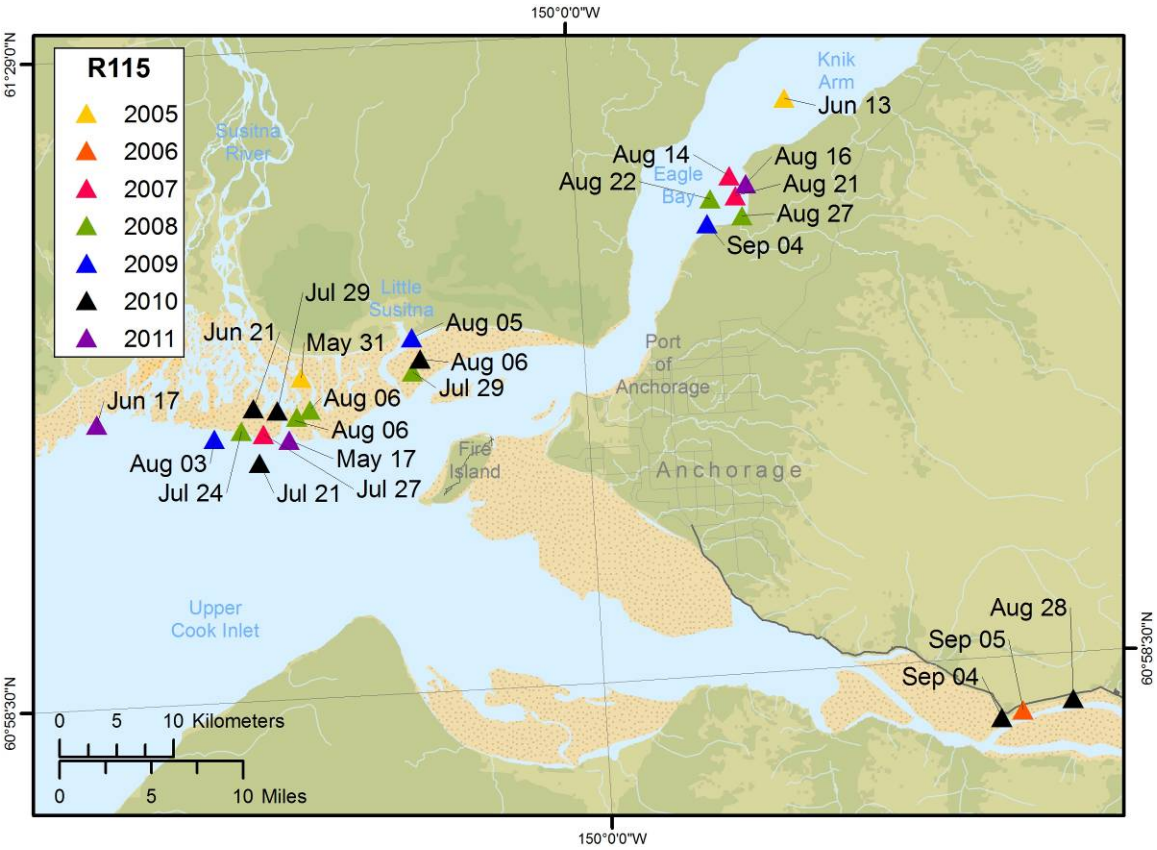

Figure B4. Sighting history and photograph of beluga R115. This beluga was tagged by NMFS sometime between 1999 and 2002. This beluga is a presumed mother based on photographs with an accompanying calf. The sighting history from 2011 does not yet include sightings outside of the Susitna River Delta (Cook Inlet-wide results from 2011 will be presented in a future report).

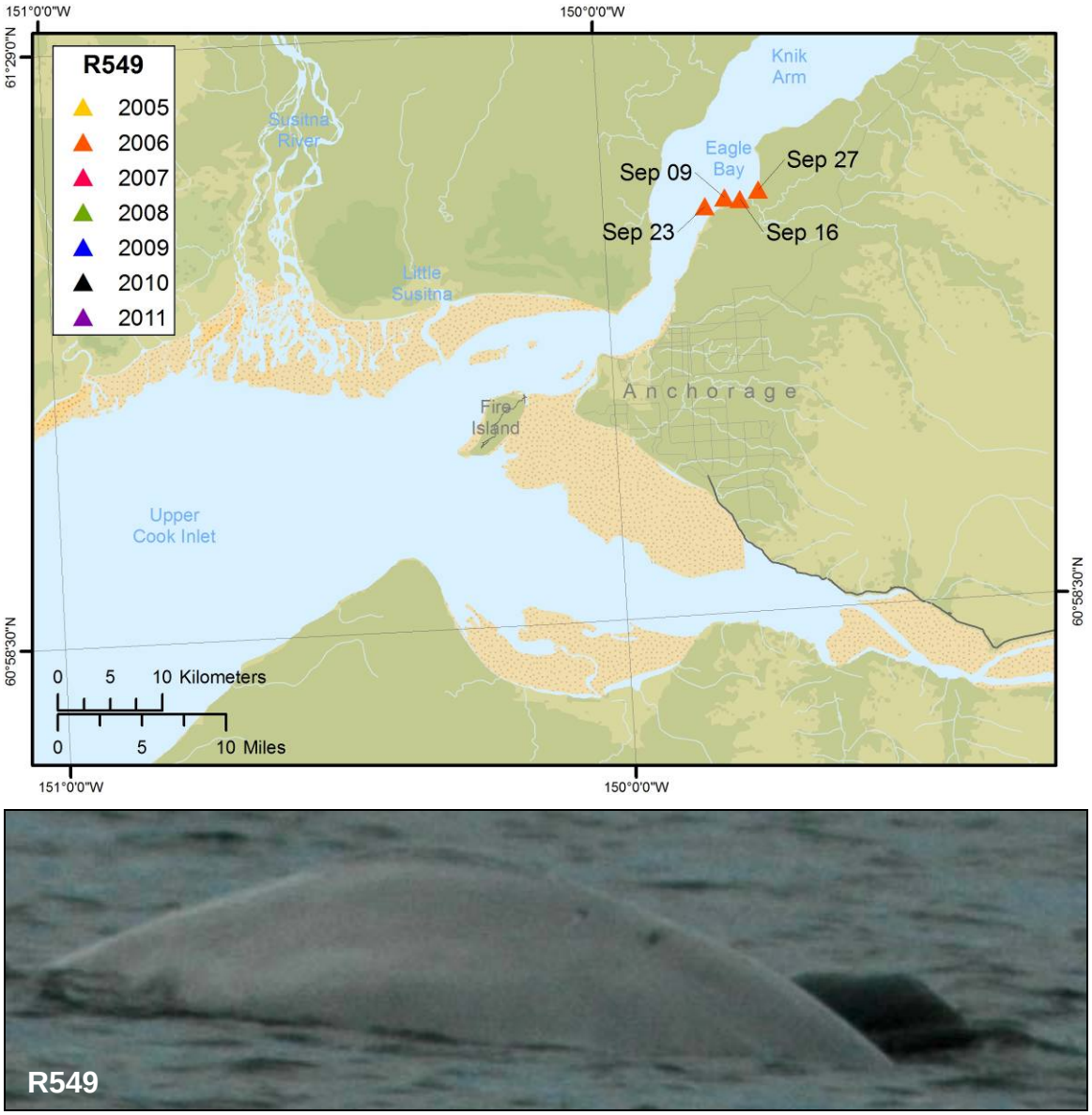

Figure B5. Sighting and photograph of beluga R549. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf. The sighting history from 2011 does not yet include sightings outside of the Susitna River Delta (Cook Inlet-wide results from 2011 will be presented in a future report).

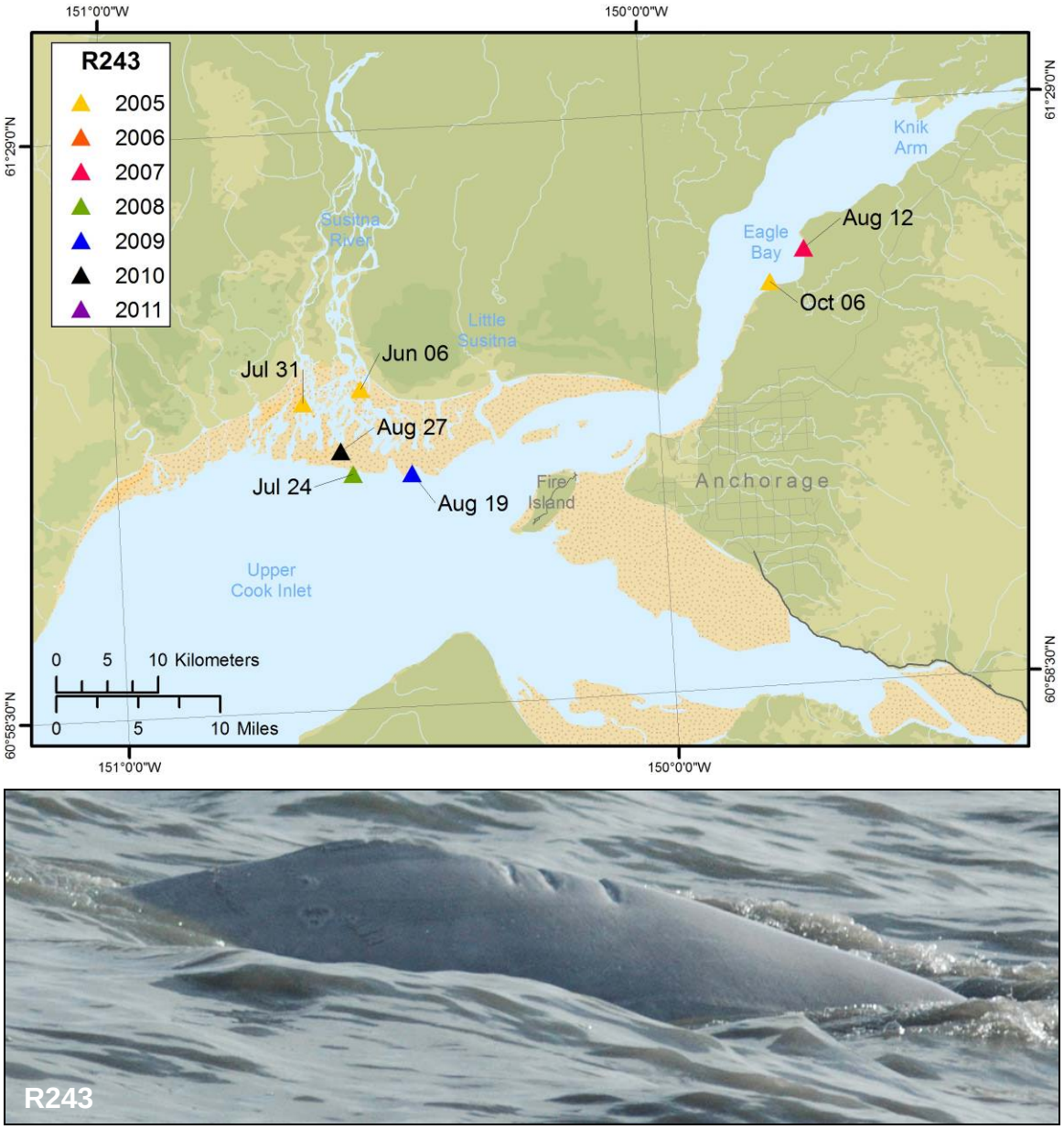

Figure B6. Sighting and photograph of beluga R243. This beluga was tagged by NMFS sometime between 1999 and 2002. The sighting history from 2011 does not yet include sightings outside of the Susitna River Delta (Cook Inlet-wide results from 2011 will be presented in a future report).

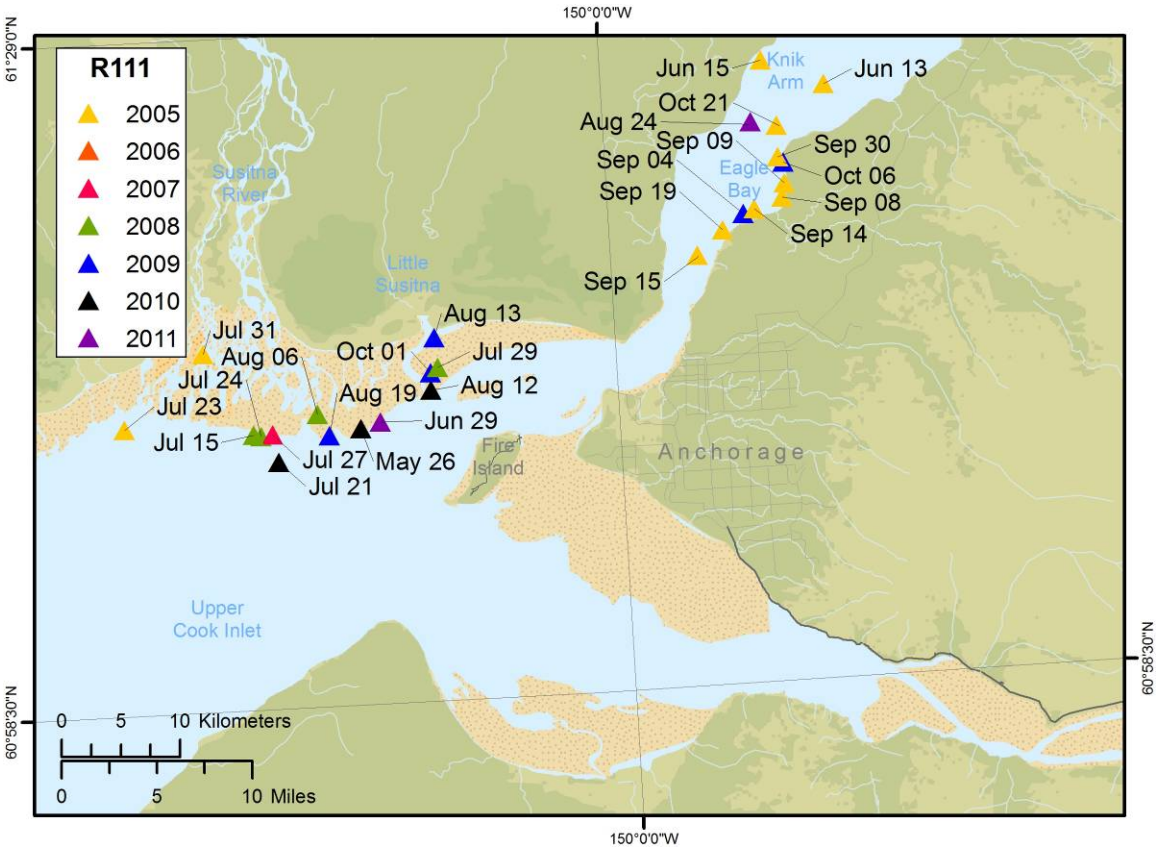

Figure B7. Sighting and photograph of beluga R111. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf. The sighting history from 2011 does not yet include sightings outside of the Susitna River Delta (Cook Inlet-wide results from 2011 will be presented in a future report).