

Photo-identification of Beluga Whales in Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska

Final Report of Field Activities and Belugas Identified in 2011

Prepared by:



Alaska Research Associates, Inc.

2000 West International Airport Road, Suite C1
Anchorage, AK 99502

Prepared for:

**Department of Defense
U.S. Air Force
Joint Base Elmendorf-Richardson
and
Alaska Department of Fish and Game**

August 2013

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Prepared by:

Tamara McGuire, Amber Stephens, Lauren Bisson, and Marc Bourdon

LGL Alaska Research Associates, Inc.

2000 West International Airport Road, Suite C1, AK 99502
(907) 562-3339

Prepared for:

Department of Defense

U.S. Air Force

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EXECUTIVE SUMMARY

Introduction

Cook Inlet beluga whales (CIB) were listed by the National Marine Fisheries Service as endangered pursuant to the Endangered Species Act in 2008. In 2009, Joint Base Elmendorf Richardson (JBER) submitted its biological assessment on Alternative 2 of its Environmental Impact Statement for the Resumption of Year-Round Firing Opportunities. Monitoring of the health and welfare of CIB was mandated by the Eagle River Flats Settlement Agreement.

The Photographic Identification of CIB in Eagle Bay in 2011 Project was an amendment to the CIB Whale Passive Acoustic Monitoring (PAM) Study conducted by a research team led by the Alaska Department of Fish and Game and JBER. The PAM study used non-invasive monitoring techniques to increase knowledge about the CIB, its environment and its usage of waters of Cook Inlet, including the Eagle Bay area of Knik Arm adjacent to JBER. Since 2005, LGL Alaska Research Associates, Inc. (LGL) has conducted the CIB Photo-Id Project which uses photo-id methods to study distribution and movement patterns of individual CIB throughout Upper Cook Inlet, including Knik Arm and Eagle Bay.

The Photographic Identification of Beluga Whales in Eagle Bay in 2011 Project had two objectives:

Objective 1: Document Individual CIB usage of Eagle Bay;

Objective 2: Assess/ monitor relative health of CIB in Eagle Bay.

This report summarizes field effort and CIB photo-id surveys in Eagle Bay during the 2011 and 2012 field seasons, and presents results from analyses of photographs of whales identified in Eagle Bay in 2011.

Methods

Surveys of Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska were conducted from shore and from a small vessel in 2011 and 2012. Photo-id surveys were concentrated in August of both years so they would coincide with increased JBER land-based observer effort during that time. Additional beluga photo-id surveys by LGL, supported by other funding sources, were conducted 2005-2012 in Knik Arm, the Susitna River Delta, Turnagain Arm, and Chickaloon Bay, as well as in the Kenai River Delta in 2011. All LGL vessel surveys were conducted under NMFS MMPA/ESA Research Permit #14210. Observers recorded beluga whale sightings and environmental conditions, and took digital photographs of whales. All photographs taken in 2011 and 2012 were archived; however, due to budget constraints, only right-side photographs from 2011 were analyzed and cataloged.

Sighting histories (i.e., dates and locations of sightings) were compiled for all identified CIB seen in Eagle Bay in 2011 in order to examine residency and movement patterns. Sighting histories of a subset of the catalog, consisting of all sightings of whales seen on the Eagle Bay in 2011 and also every year of the 2005-2011 study period are presented graphically. Sighting histories of whales bearing scars from previous satellite tags are also presented, as these whales are of particular interest to those wondering if the sighting histories of tagged whales are similar to those of untagged whales. Identified belugas were classified as presumed reproductive females if they appeared in the same photo-frame with a calf alongside.

Results

Twenty-two beluga whale groups were counted and photographed during 14 photo-id survey days in 2011 and fourteen beluga whale groups were counted and photographed during twelve days in 2012. In total, 20,427 photographs were taken.

The largest group in 2011 consisted of 96 whales, and mean group size was 31. For all surveys of Eagle Bay in 2011 combined, groups contained slightly more gray belugas than white belugas; the average group was composed of 41% white belugas, 45% gray belugas, and 14% calves.

The mean daily identification rate was 25% (i.e., a quarter of all whales seen during the average day were identified). There were 69 different individual belugas identified in Eagle Bay in 2011; 61 were re-sightings of individual whales in the 2005-2011 catalog, and eight newly identified individuals were added to the catalog.

The 2005-2011 right-side catalog currently contains records for 307 individual whales; 239 individuals have been photographed at least once in Knik Arm, and 24 individuals have only ever been photographed in Knik Arm. One whale was re-sighted in Knik Arm nine times within the same field season, and most of the other individuals were seen in Knik Arm multiple times within a field season. Of the 69 belugas identified in Eagle Bay in 2011, 53 were seen in the Susitna River Delta, and 16 were also seen in Turnagain Arm. Thirteen individuals were only ever seen in Knik Arm. One individual that was seen throughout Upper Cook Inlet was also seen in the Kenai River.

From the 69 belugas identified in Eagle Bay in 2011, 58% identified belugas were presumed to be reproductive females based on photographs in which they were closely accompanied by a calf at least once in 2005-2011. Twenty-six identified belugas were photographed with calves in Eagle Bay in 2011.

Marks on whales found in Eagle Bay fell into nine categories: infection, general trauma, rake marks, molting, satellite tag scars, puncture wounds, entanglement, pigment, and mud/silt. All of the belugas identified in Eagle Bay in 2011 displayed rake marks, and 62% had signs of infection. Indications of injury were associated with the “general trauma, rake marks, satellite tag scars, puncture wound”, or “entanglement” categories. One live whale showed signs of rope entanglement. Dead belugas were not encountered in Knik Arm by LGL biologists in 2011 or 2012.

Discussion

This study provides evidence that most, and perhaps all, of the CIB population uses Eagle Bay on a seasonal basis. With the inclusion of CIB identified in Eagle Bay in 2011, sighting records in the 2005-2011 CIB photo-id catalog indicate that 78% of the 307 identified CIB have used this area at least once.

Most of the CIB photo-identified in Eagle Bay in 2011 have also been seen elsewhere in Upper Cook Inlet, and one individual was seen with a small group of whales in the Kenai River in the middle Inlet. Ninety percent of the identified whales in the 2005-2011 catalog that were seen in Eagle Bay were also seen elsewhere in Upper Cook Inlet. Beluga whales encountered during photo-id surveys of Upper Cook Inlet 2005-2011 were rarely observed traveling between areas, but were instead encountered in distinct areas (i.e., along the Susitna River Delta, in Knik Arm, or traveling up and down Turnagain Arm; McGuire et al. 2008, 2011a).

Long-term surveys by LGL and JBER have indicated that Knik Arm, and particularly Eagle Bay, are used seasonally by groups with calves and newborns. The photographic records of individuals in the catalog underscore the use of Eagle Bay by reproductive females and their calves: 58% of whales identified here in 2011 were presumed to be reproductive females based on sighting records in the 2005-2011 catalog, and 39% were seen here with calves in 2011.

Several of the identified belugas in Eagle Bay display marks indicative of injury and disease. Because CIB likely move freely around the upper and middle Inlet, it cannot be known if the injury occurred in Knik Arm or elsewhere in the Inlet. Marks indicative of injury may have been caused by vessel strikes (bow and propeller), gunshots, harpoons, other belugas, other marine mammals, or even sharks, but without witnessing the injury as it occurred and monitoring the resulting marks, we can only guess based on photographs of known injuries of other marine mammals. Even when the cause of injury is known, as in the case of the CIB entangled in a rope, it is unknown if this rope was from unattended fishing gear, floating debris, or the attempted capture of a whale. A high percentage of individual CIB identified in Eagle Bay in 2011 bore signs of infection. Without knowing the cause of the marks (bacterial, viral, parasitic, and fungal infections have all been found in dead CIB; Burek *et al.* in review), we cannot say if these infections pose a risk to the health of individuals or to the population.

Conclusion

When considering the possible effects on CIB from military activities on JBER, it should be noted that most, and possibly all, of the CIB population could be seasonally exposed to these activities. Such exposure would very likely occur for neonates, calves and adults, and the same individuals may be exposed multiple times within a year, as well as year after year.

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INTRODUCTION

The distinct population segment of Cook Inlet beluga whales (CIB) was listed by the National Marine Fisheries Service (NMFS) as endangered pursuant to the Endangered Species Act (ESA) in 2008 (73FR62919, October 22, 2008). The designation of CIB Critical Habitat (CH) was finalized in 2011 (76 FR 20180; 50 CFR part 226.220). Despite protective legislation and regulation of human activities including subsistence hunting, the CIB population has not shown signs of recovery (Hobbs et al. 2008). A CIB Recovery Plan (RP) is currently being reviewed by NMFS. Until the RP is finalized, management of the species will be heavily influenced by the CIB Conservation Plan (NMFS 2008), which was developed by NMFS as mandated by the Marine Mammal Protection Act. This plan identifies potential threats that might impede CIB recovery, including military training at Eagle River Flats, development, anthropogenic noise, and the reduction of prey.

The ESA (Title 16 United States Code, Sections 1531-1544), requires protection and conservation of federally listed threatened and endangered (T/E) plants and animals and their habitats. Conservation includes the use of all methods and procedures which are necessary to bring any T/E species to the point where the measures pursuant to the ESA are no longer necessary (i.e., down-listing and de-listing). All activities with a federal nexus must be evaluated for their potential to affect a T/E species or its CH. The CIB use the waters on and adjacent to Joint Base Elmendorf Richardson (JBER), including Eagle Bay and Eagle River for feeding, socializing, and transiting (JBER 2010). Conducting endangered and threatened species management is required by the Endangered Species Act, Public Law 106-65 (Military Land Withdrawal Act) as mitigation for the land withdrawal LEIS and Public Law 86-797 (Sikes Act).

In 2009, JBER submitted its biological assessment on Alternative 2 of JBER's Environmental Impact Statement (EIS) for the Resumption of Year-Round Firing Opportunities. Monitoring of the health and welfare of CIB was mandated by the Eagle River Flats Settlement Agreement. The Conservation Recommendation Section of the Biological Opinion (BO) prepared by NMFS recommended photo-identification of CIB as a means to understand CIB presence and use of the Eagle River Flats/Eagle Bay area (<http://alaskafisheries.noaa.gov/protectedresources/esa/section7/ftrichardson/biop052011.pdf>).

The Photographic Identification of Beluga Whales in Eagle Bay in 2011 Project was an amendment to the CIB Whale Passive Acoustic Monitoring (PAM) Study conducted by a research team led by the Alaska Department of Fish and Game (ADF&G) and JBER. The PAM study used non-invasive monitoring techniques to increase knowledge about the CIB, its environment and its usage of waters of Cook Inlet, including Knik Arm adjacent to JBER. This project satisfies JBER's requirement under the ESA to establish programs that further the conservation of endangered and threatened species. Furthering conservation of endangered and threatened species and species of conservation concern addresses a principle goal and managerial objective of the JBER Integrated Natural Resources Management Plan (INRMP) and the NMFS Conservation Plan.

Unlike other cetacean species that have distinctive fins and flukes (with identifying morphometric geometries, scars, and pigmentation) that regularly break the surface, CIB most often surface with only their finless dorsal ridge visible and rarely show their tail flukes. In addition, the white skin of older belugas can make detection of diagnostic scars, which often turn white with age, difficult in the field. Photographs of these animals allow for a more thorough examination. Photo-identification (photo-id) has been used to study the distribution, population dynamics, and social structure of beluga whales in Canada's St. Lawrence Estuary (Michaud 1996), and in the White Sea of Russia (Kryukova 2005). Photo-id can be used to characterize life history parameters (age at maturity, female reproductive biology, mating systems and population structure), assess relative health through documentation of injuries and disease (gross examination), and understand distribution and movement patterns of individual beluga whales, which can augment critical habitat information from aerial surveys and tagging-tracking studies.

Since 2005, LGL Alaska Research Associates, Inc. (LGL) has conducted the Cook Inlet Beluga Whale Photo-Id Project, which uses photo-id methods to study distribution and movement patterns of individual CIB throughout Upper Cook Inlet, with emphasis on Knik Arm, the Susitna River Delta, Chickaloon Bay, and Turnagain Arm (LGL 2009; McGuire et al. 2008, 2009, 2011a,b, 2013; McGuire and Bourdon 2012). In 2011, the study was expanded to include the Kenai River Delta. The data collected from this long-term study will assist resource managers and regulators in assessing the population and distribution of CIB. In particular, it may provide useful information for the JBER Command and NMFS to examine the CIB use of areas in or adjacent to the Eagle River Flats Impact Area during the resumption of year-round firing.

The Photographic Identification of Beluga Whales in Eagle Bay in 2011 Project had two objectives:

Objective 1: Document Individual CIB usage of Eagle Bay

Describe the usage of Eagle Bay by individually identified CIB, including historical data available on each animal, photos of the identifying marks with changes over time, other sighting locations, and associations with calves.

Objective 2: Assess/ monitor relative health of CIB in Eagle Bay

Describe all injuries, infections, or mortalities sustained by CIB encountered in Eagle Bay.

This report summarizes field effort and CIB photo-id surveys in Eagle Bay during the 2011 and 2012 field seasons, and presents results from analyses of photographs of whales encountered in Eagle Bay in 2011.

METHODS

Field Surveys

Survey effort

Dedicated surveys of Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska (Figures 1 and 2) were conducted from shore and from a small vessel in 2011 and 2012. Shore-based surveys were conducted by a team of observers lead by JBER/ADF&G, with occasional participation by LGL. Boat-based surveys were conducted by LGL. Surveys were scheduled around the low tide, as this provided the greatest likelihood of detecting whales at this location (Funk et al. 2005, McGuire et al. 2008, JBER 2010). Photo-id surveys of Eagle Bay were conducted August through October of 2011, and in August of 2012. Photo-id surveys were concentrated in August of both years so they would coincide with increased JBER land-based observer effort during that time. The land-based JBER effort was associated with acoustic-tagging attempts scheduled to occur at the historic seasonal peak in beluga abundance in Eagle Bay (JBER 2010). Additional beluga photo-id surveys by LGL, supported by other funding sources, were conducted 2005-2012 in Knik Arm, the Susitna River Delta, Turnagain Arm, and Chickaloon Bay (Figure 3), as well as in the Kenai River Delta in 2011. A summary and synthesis of results of all surveys of Cook Inlet conducted from 2005 to 2012 will be presented in a comprehensive report to be released at a later date.

Vessel surveys

All photographs of CIB in Knik Arm 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 photographer. Vessel position was recorded with a Garmin™ GPS (Global Positioning System) Map 76C. A whale group was usually 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. All LGL 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 the time of day, position, number of groups, group size, group color composition (white, gray), and number of calves. 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-size beluga. LGL observers further 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. JBER observers did not differentiate newborns from older calves. For beluga groups with multiple records on a single day, the best record was selected at the end of the survey, which was either the highest count (for groups that merged), or the count considered by all observers to be the most accurate. Information on group behavior was also collected, but will not be presented in this report. Locations of beluga whale sightings were mapped in ArcGIS™ Version 10 (<http://www.esri.com>).

Digital photographs of beluga whales were collected by LGL with 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. Photographs were also taken by JBER/ADF&G team members and shared with LGL for inclusion in the photo-id study.

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 constraints, only right-side photographs from 2011 were analyzed and cataloged. Photographs from 2012 may be analyzed and cataloged at some point in the future, pending funding.

All suitable quality images were cropped to show only the focal whale. When original field photographs contained two or more whales, each whale was cropped individually and saved as a separate file with a unique 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 (funding has since been provided by the North Pacific Research Board that will allow for the processing and cataloging of left-side photos taken 2009-2011; results will be presented in a report that will be issued publically July 2014).

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 contained 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 surfaces and submerges, different portions of its body are available to photograph. Side-profile photographs are most useful for matching marks used to identify individual whales. Profile images were divided into 11 sections along the right half of the whale (Figure 4). 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 unique 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 (Figure 4). This was done for each individual within the catalog. Computer software developed by LGL for photo-id of beluga whales was used 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 seen in Knik Arm in 2011 in order to examine residency and movement patterns. Sighting histories of a subset of the catalog, consisting of all sightings of whales seen in Knik Arm in 2011 and also every year of the 2005-2011 study period were presented graphically. Sighting histories of whales bearing scars from previous satellite tags were also presented, as these whales are of particular interest to those wondering if the sighting histories of tagged whales are similar to those of untagged whales. 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 presumed mothers if they appeared in the same 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.

Database Development

We continued to consolidate all photo-id data (2005-2012) into a single, comprehensive, and integrated database. Data from surveys included the survey route, environmental conditions, photographs, and group size, color, and behavior. Data associated with each photograph included the “metadata”, such as the original camera settings, the time the original photograph was taken, and the lighting conditions. Finally, catalog 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, and the number of temporary files yet to be matched.

RESULTS

Results of Objective 1 (Document Individual CIB Usage of Eagle Bay)

Surveys

Survey effort and number of whale groups encountered in Eagle Bay in 2011 and 2012

Twenty-two beluga whale groups were counted and photographed during 14 photo-id survey days in 2011 (Table 1), and fourteen beluga whale groups were counted and photographed during twelve days in 2012. In total, 20,427 photographs were taken.

Color composition, and age class of groups encountered during surveys in 2011

Size, color and age-class composition of all groups photographed in Eagle Bay in 2011 varied by day (Table 2). The largest group consisted of 96 whales, and mean group size was 31. For all surveys of Eagle Bay in 2011 combined, groups contained slightly more gray belugas than white belugas (even after excluding calves and neonates); the average group was composed of 41% white belugas, 45% gray belugas, and 14% calves (Table 2). Neonates were recorded in two groups, although it should be noted that observers only attempted to differentiate neonates from calves for three of the 22 groups. Survey results from 2012 are not presented here, but will be analyzed and presented in another report.

Catalog development and current status

Of the 673 beluga sightings during photo-id surveys in Eagle Bay in 2011, between zero and 89% of each day's sightings were of individuals who were later identified photographically (Table 3). The mean daily identification rate was 25% (i.e., a quarter of all whales seen during the average day were identified).

There were 69 different individual belugas identified in Eagle Bay in 2011; 61 were re-sightings of individual whales in the 2005-2011 catalog, and eight newly identified individuals were added to the catalog. Sighting records and photographs of these 69 whales are presented in Appendix A. The 2005-2011 right-side catalog currently contains records for 307 individual whales. In this catalog, 239 individuals have been photographed at least once in Knik Arm, and 24 individuals have only ever been photographed in Knik Arm.

Sighting histories

Sighting histories of belugas 2005-2011

Whales identified in 2011 in Eagle Bay had sighting histories ranging between one and seven field seasons (Figure 5), with one to 37 sighting days per identified whale (Figure 6). Seven belugas identified in Eagle Bay in 2011 were re-sighted in each of the seven years of 2005-2011, and their sighting histories and photographs of their marks over time are shown in Appendix B. One whale was re-sighted in Knik Arm nine times

within the same field season, and most of the other individuals were seen in Knik Arm multiple times within a field season (Figure 7).

Sighting histories of belugas identified by satellite tag scars

Seven photo-identified belugas had unique scars from holes used by NMFS to affix satellite tags 1999-2002 (Table 4). 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 reproductive females, based on photographs with an accompanying calf taken sometime during their sighting history. Each of these belugas had been sighted in Knik Arm multiple times during 2005-2011, and three of them were seen in Eagle Bay in 2011. Individual sighting histories and photographs of previously tagged belugas are presented in Appendix C. Sighting histories of whales bearing scars from previous satellite tags were similar to sighting histories of whales identified by natural markings.

Use of Eagle Bay relative to the rest of Cook Inlet

Of the 69 belugas identified in Eagle Bay 2011, 53 were seen in the Susitna River Delta, and 16 were also seen in Turnagain Arm (Table 5). Thirteen individuals were only ever seen in Knik Arm. One individual that was seen throughout Upper Cook Inlet was also seen in the Kenai River (Figure 8); this number may increase as photographs taken in the Kenai River 2011-2013 are still being analyzed and updated results will be available in a report due October 2013.

Sighting histories of reproductive females and calves

From the 69 belugas identified in Eagle Bay in 2011, forty (58%) identified belugas were presumed to be reproductive females based on photographs in which they were closely accompanied by a calf at least once in 2005-2011 (Table 6). Twenty-six identified belugas were photographed with calves in Eagle Bay in 2011.

Results of Objective 2 (Assess/Monitor Relative Health of Cook Inlet Belugas in Eagle Bay)

Signs of injuries and infections sustained by CIB encountered in Knik Arm

Marks on whales found on in Eagle Bay fell into nine categories: infection, general trauma, rake marks, molting, satellite tag scars, puncture wounds, entanglement, pigment, and mud/silt. Photographic examples of the different mark types, along with brief descriptions, are found in Appendix D.

All of the 69 belugas identified in Eagle Bay in 2011 displayed rake marks (Table 7), and 62% had signs of infection (healed or active lesions). Indications of injury were associated with the “general trauma, rake marks, satellite tag scars, puncture wound”, or “entanglement” categories. After removing rake marks ($n=69$) and satellite tag scars ($n=3$) from the injury category, four whales showed signs of other trauma, with three of these cases associated with puncture wounds. Additionally, two whales had signs of

possible infection, five had signs of possible trauma, and two had possible puncture wounds; photographs did not show enough of the marks and/or were not clear enough images of the marks to allow them to be definitively classified.

One live whale showed signs of rope entanglement (Figure 8). This whale was first encountered and photographed throughout the 2010 field season (McGuire and Bourdon 2012) and was also photographed in 2011 and 2012 throughout Upper and Middle Cook Inlet (Figure 8). NMFS and the Alaska Marine Mammal Stranding Network have been updated annually with sighting information and photographs of this entangled whale.

In 2005, an unidentified whale was photographed in Eagle Bay, entangled in an unknown object (Figure 9). This whale was only seen on one occasion, and the object causing the entanglement remains unknown (a tire rim or a culvert liner have been suggested as possibilities).

Mortalities sustained by CIB encountered in Knik Arm in 2011 and 2012

Dead belugas were not encountered in Knik Arm by LGL biologists in 2011 or 2012. The NMFS Cook Inlet Beluga Whale Strandings Database (accessible to the public at <http://www.alaskafisheries.noaa.gov/belugas/>) reports the stranding of two live beluga whales on August 10, 2011 in Knik Arm.

On October 5, 2012, LGL assisted the Alaska Marine Mammal Stranding Network with a response to a dead beluga first reported in the water near Tyonek. Marks on the dead beluga were matched to photo-id records of an identified beluga in the LGL catalog. This whale, an adult male, had been seen live in the upper part of Knik Arm in 2005, and in Eagle Bay and the Susitna River Delta in 2009 (Figure 10). Results of the necropsy conducted by Dr. Kathy Burek-Huntington can be requested from NMFS via <http://www.alaskafisheries.noaa.gov/belugas/>. Although this whale was not photographed in Eagle Bay in 2011, we report it here because it had used Eagle Bay in its lifetime.

DISCUSSION

Individual CIB usage of Eagle Bay

When making inferences about the greater population of CIB 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 Inlet. Instead, effort was focused in certain areas during particular times of the year that would maximize the probability of encountering whales. 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 307 individual whales; 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 CIB population. NMFS estimated that the size of the CIB population was 284 whales in 2011 (<https://alaskafisheries.noaa.gov/newsreleases/2012/cibelugas010912.htm>).

This study provides evidence that most, and perhaps all, of the CIB population uses Eagle Bay on a seasonal basis. Based on the relatively large groups (e.g., 71 whales; 96 whales) that have been reported by JBER (2010, this report; respectively) in Eagle Bay in August/September in multiple field seasons, researchers had long suspected this was the case, but without knowing the individual composition of the groups, it could not be determined if these groups contained the same individuals and therefore represented only some portion of the population that had a preference for Eagle Bay or if these groups were fluid and open to the entire CIB population. With the inclusion of CIB identified in Eagle Bay in 2011, sighting records in the 2005-2011 CIB photo-id catalog indicate that 78% of the 307 identified CIB have used this area at least once.

It has been the experience of the CIB photo-id project that re-sighting and identification rates increase with sampling effort, and it is highly likely that an increased sampling effort in Eagle Bay, as well as the cataloging of left-side photos from 2011 and 2012, will indicate that 100% of the CIB in the photo-id catalog uses this area at some point in their lifetime. For example, although LGL has been conducting photo-id surveys in Knik Arm since 2005, photographic effort in Eagle Bay was much greater in 2011 than in any other year due to the focused studies of JBER and ADF&G, and eight new individuals were added to the catalog as a result of this effort.

Use of Eagle Bay relative to the rest of Cook Inlet

Most of the CIB photo-identified in Eagle Bay in 2011 have also been seen elsewhere in Upper Cook Inlet, and one individual was seen with a small group of whales in the Kenai River in the middle Inlet. Ninety percent of the identified whales in the 2005-2011 catalog that were seen in Eagle Bay were also seen elsewhere in Upper Cook Inlet. Beluga whales encountered during photo-id surveys of Upper Cook Inlet 2005-2011 were rarely observed traveling between areas, but were instead encountered in

distinct areas (i.e., along the Susitna River Delta, in Knik Arm, or traveling up and down Turnagain Arm; McGuire et al. 2008, 2011a). Similar patterns of localized aggregations and rapid and directed travel among areas of localized aggregations have been reported for satellite-tagged CIBs (Hobbs et al. 2005) and beluga whales in Norway (Lydersen et al. 2001). About 8% of the whales in the catalog have only ever been photographed in Knik Arm; however, this may be an artifact of low sampling rates rather than an indication of site fidelity, and it is predicted that with more photo-id surveys over time, these whales will be seen throughout Upper and Middle Cook Inlet.

Use of Eagle Bay by reproductive females and their calves

Long-term surveys by LGL and JBER have indicated that Knik Arm, and particularly Eagle Bay, are used seasonally by groups with calves and newborns (McGuire and Bourdon 2012, JBER 2010). The photographic records of individuals in the catalog underscore the use of Eagle Bay by reproductive females and their calves: 57% of whales identified here in 2011 were presumed to be reproductive females based on sighting records in the 2005-2011 catalog, and 38% were seen here with calves in 2011. We use the term “presumed” because we can only make informed guesses about maternity based on reasonable evidence such as physical proximity and behavior. It is possible that some of the whales classified as presumed mothers were in fact other companions to the calves (Figure 11). In the future, combined photo-id and genetic sampling from remote biopsy would allow for the testing of assumptions of maternity and reproductive histories. Regardless of designation of maternal lineages, Eagle Bay appears to be an important area for groups with calves.

Sighting histories of belugas identified by satellite tag scars

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 CIB were satellite tagged by NMFS between 1999 and 2002 (Hobbs et al. 2005); although the satellite tags are no longer present, we are still able to photographically track and obtain survivorship data from seven of these individuals up to 13 years later. In addition to documenting the survival of seven of the 18 previously tagged whales, five of these whales are presumed to be reproductive females who gave birth post-tagging. 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 et al. 2013). All seven of these previously tagged whales have been seen at least once in Eagle Bay in 2005-2011.

Relative health of CIB in Eagle River

Several of the identified belugas in Eagle River display marks indicative of injury and disease. Because CIB likely move freely around the upper and middle Inlet, it cannot be known if the injury occurred in Knik Arm or elsewhere in the Inlet. Marks indicative of injury may have been caused by vessel strikes (bow and propeller), gunshots, harpoons, other belugas, other marine mammals, or even sharks (LGL 2009), but without witnessing the injury as it occurred and monitoring the resulting marks, we can only

guess based on photographs of known injuries of other marine mammals (Moore et al. 2013). Even when the cause of injury is known, as in the case of the CIB entangled in a rope, it is unknown if this rope was from unattended fishing gear, floating debris, or the attempted capture of a whale.

A high percentage of individual CIB identified in Eagle Bay in 2011 bore signs of infection. Without knowing the cause of the marks (bacterial, viral, parasitic, and fungal infections have all been found in dead CIB; Burek et al. in review), we cannot say if these infections pose a risk to the health of individuals or to the population. The herpes virus has been identified as cause of death for one CIB, and other dead CIB have tested positive for the virus (Burek et al. in review). Herpes-like lesions have been photographed on several CIB in the catalog, but cannot be conclusively attributed to the herpes virus by visual analysis alone. By continuing to collaborate with other investigators, particularly those authorized to investigate mortalities (NMFS, the Alaska Marine Mammal Stranding Network, and subsistence users), we can increase the utility of our documentation of skin lesions by pairing photographs of skin lesions on stranded animals with tests of these lesions for infectious disease, thus creating a photo-catalog of known skin diseases. 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 CIB population. To this end, 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. This application of photo-id 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 Bresse et al. 2003, 2009; Bearzi et al. 2009). In addition, matching of photographs of dead belugas to identified individuals in the catalog provides information necessary for understanding survivorship and population dynamics.

Continued photo-id work

The strength and utility of the CIB Photo-id Project grows with the proportion of the CIB population that is re-sighted. Continuation of a long-term, Inlet-wide data set provides insight into the population dynamics and life history of CIB, and will help with the identification of appropriate conservation measures to recover and preserve the population. Project results are ongoing, and are updated in reports that are available at www.cookinletbelugas.org and <http://www.fakr.noaa.gov/protectedresources/whales/beluga/research.htm#ci>.

Conclusion

Eagle Bay is an important area for CIB: it is used seasonally by most, and likely all, of the CIB population; calves and newborns are found here; and identified individual whales have been seen to return here year after year, and multiple times within a year. Many CIB in Eagle Bay bear signs of infection and a few bear signs of injury, although the ultimate sources of the injuries and infections could not be determined.

When considering the possible effects on CIB from military activities on JBER, it should be noted that most, and possibly all, of the CIB population could be seasonally exposed to these activities. Such exposure would very likely occur for neonates, calves, and adults, and the same individuals may be exposed multiple times within a year, as well as year after year. Other potential anthropogenic threats to CIB (e.g., pile driving, sewage discharge, shipping lanes, in-water seismic activity) are also present in Upper Cook Inlet, and because all of the individuals in the CIB population move throughout Upper Cook Inlet seasonally, whales are likely exposed to multiple potential threats. For example, the same individual whale might be exposed to noise from seismic exploration in the Susitna River Delta, vessel traffic in the shipping lanes for the Port of Anchorage, military exercises near Eagle Bay, and physical habitat alteration and noise from in-water highway expansion activities in Turnagain Arm. The cumulative effects of all activities in the range of CIB and their potential to affect the entire population should be considered when making management decisions.

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Table 1. Total photo-identification survey effort and beluga whale groups encountered in 2011 and 2012, in Eagle Bay, Upper Cook Inlet, Alaska.

	2011	2012	Total
Number of Survey Days with Photos	14	12	26
Number Groups Encountered	22	14	36
Number of Photos Taken	15,716	4,711	20,427
Range of Surveys	Aug 14-Oct 12	Aug 13-30	

Table 2. Group size, color, and age-class composition of beluga groups sighted during 14 land- and vessel-based surveys of Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska in 2011.

Date	Study Team	Beluga Group # ¹	# White	# Gray	# Calves	# Neonates ²	# Unknown ³	Total Beluga Sightings
8/14/2011	DOD land	1	3	7	2	na	0	12
8/14/2011	DOD land	2	39	47	10	na	0	96
8/15/2011	DOD land	1	26	22	8	na	0	56
8/16/2011	DOD land	1	18	14	8	na	0	40
8/16/2011	DOD land	2	12	14	2	na	0	28
8/17/2011	DOD land	1	1	2	1	na	0	4
8/17/2011	DOD land	2	21	28	11	na	0	60
8/18/2011	DOD land	1	7	26	5	na	0	38
8/19/2011	DOD land	1	17	23	4	na	0	44
8/21/2011	DOD land	1	2	1	0	na	0	3
8/21/2011	DOD land	2	20	10	4	na	0	34
8/22/2011	DOD land	1	2	7	1	na	0	10
8/22/2011	DOD land	2	14	26	5	na	0	45
8/24/2011	DOD land	1	17	13	4	na	0	34
8/25/2011	DOD land	1	17	17	7	na	0	41
8/26/2011	DOD land	1	12	12	7	na	0	31
9/7/2011	LGL boat	1	8	6	3	1	0	18
9/12/2011	DOD land	1	5	6	3	na	0	14
9/14/2011	LGL boat	1	10	8	3	1	0	22
9/14/2011	LGL boat	2	12	7	1	0	0	20
9/14/2011	DOD land	1	2	2	1	na	0	5
9/14/2011	DOD land	2	9	7	2	na	0	18
Total 2011		22	274	305	92	2	0	673

¹ Group numbers were assigned by day and will not sum to the total number of groups.

² Neonates are separate from calf totals in the LGL counts. Department of Defense(DOD) observers did not differentiate calves from neonates.

³ Unknown = beluga of unknown color and size.

Table 3. Identification rates for belugas encountered during 14 land- and vessel-based surveys of Eagle Bay, Knik Arm, Upper Cook Inlet, Alaska in 2011. (DOD=Department of Defense Team; LGL=LGL Alaska Research Associates, Inc. Team).

Date	Study Team	Total Beluga Sightings	# Identified Whales per Survey Day	% of Daily Sightings that were of Identified Whales
8/14/2011	DOD land	108	6	6%
8/15/2011	DOD land	56	13	23%
8/16/2011	DOD land	68	18	26%
8/17/2011	DOD land	64	9	14%
8/18/2011	DOD land	38	34	89%
8/19/2011	DOD land	44	5	11%
8/21/2011	DOD land	37	0	0%
8/22/2011	DOD land	55	12	22%
8/24/2011	DOD land	34	8	24%
8/25/2011	DOD land	41	22	54%
8/26/2011	DOD land	31	22	71%
9/7/2011	LGL boat	18	5	28%
9/12/2011	DOD land	14	0	0%
9/14/2011	LGL boat	65	15	23%
Total 2011		673	169 identifications	25%

Table 4. Sighting records of seven belugas that were identified by scars from satellite tags applied by NMFS between 1999 and 2002, according to year and location in 2005-2011. (P=photographed, C=photographed with a calf, -=not photographed/sighted).

WHALE ID	Upper Cook Inlet						
	2005	2006	2007	2008	2009	2010	2011
R96 ^M	-	P	P	C	P	C	C
R103 ^M	P	P	C	C	P	C	P
R114	P	-	P	-	-	-	-
R115 ^M	P	P	P	C	P	P	C
R549 ^M	-	C	-	-	-	-	-
R243	P	-	P	P	P	P	-
R111 ^M	P	-	P	P	C	P	P

^M presumed mother, based on photographs with accompanying calf sometime during the 2005-2011 sighting history.

Table 5. The areas of Upper and Middle Cook Inlet in which whales identified in Eagle Bay in 2011 were re-sighted during the 2005-2011 study period ($n=69$ identified whales).

	Areas of Upper Cook Inlet						
	Knik Arm (only)	Knik Arm Chickaloon Bay	Knik Arm Susitna River Delta	Knik Arm Susitna River Delta Chickaloon Bay	Knik Arm Susitna River Delta Turnagain Arm	Knik Arm Susitna River Delta Turnagain Arm Kenai River	Knik Arm Turnagain Arm
# Identified Whales	13	1	35	4	13	1	2

Table 6. Sighting records of 40 individual beluga whales seen in Eagle Bay in 2011 and presumed to be reproductive females based on the close accompaniment of a calf at least once during 2005-2011. (C=photographed with a calf, P=photographed without a calf, - =not photographed/sighted).

WHALE ID	2005	2006	2007	2008	2009	2010	2011
R245	P	C	P	C	P	P	C
R67	C	-	P	C	-	-	C
R60	P	P	C	C	P	-	C
R125	P	P	-	-	C	C	P
R103	P	P	C	C	P	C	P
R3470	-	-	C	-	C	C	P
R85	C	P	-	P	P	-	P
R165	P	P	P	C	P	P	C
R66	C	KA	C	P	P	-	P
R3121	-	-	-	P	C	-	P
R2995	-	P	-	-	P	-	C
R115	P	P	P	C	P	P	C
R109	P	P	P	C	C	P	C
R6314	-	-	-	-	-	-	C
R1168	-	-	-	P	C	-	C
R84	-	P	-	C	C	-	C
R86	P	C	P	C	-	-	P
R1156	-	-	-	C	-	-	P
R1416	-	P	C	-	P	-	C
R111	P	-	P	P	C	P	P
R521	-	P	-	P	C	C	C
R544	-	C	-	P	P	-	C
R6380	-	-	-	-	-	-	C
R540	-	C	-	P	P	-	C
R112	C	C	P	C	C	P	P
R1086	-	P	-	C	C	-	C
R538	-	C	-	-	-	-	C
R207	P	P	-	-	P	-	C
R49	P	P	-	C	-	P	C
R875	-	-	-	P	C	-	P
R56	P	P	C	-	-	-	P
R1048	-	-	-	C	P	-	C
R242	P	-	P	C	P	-	C
R75	P	C	-	P	C	C	P
R3203	-	P	-	-	P	C	P
R195	P	-	-	C	C	-	C
R6386	-	-	-	-	-	-	C
R6436	-	-	-	-	-	-	C
R6381	-	-	-	-	-	-	C
R542	-	-	P	-	-	P	C

Table 7. Types of marks displayed by the 69 identified whales seen in Eagle in 2011.

Mark Type	Mark Type Seen?		
	Yes	No	Maybe
Infection	43	24	2
General Trauma	4	60	5
Rake Marks	69	0	0
Molting	0	63	6
Satellite Tag Scars	3	66	0
Puncture Wound	3	64	2
Entanglement	1	68	0
Pigment	6	63	0
Mud/Silt	2	67	0

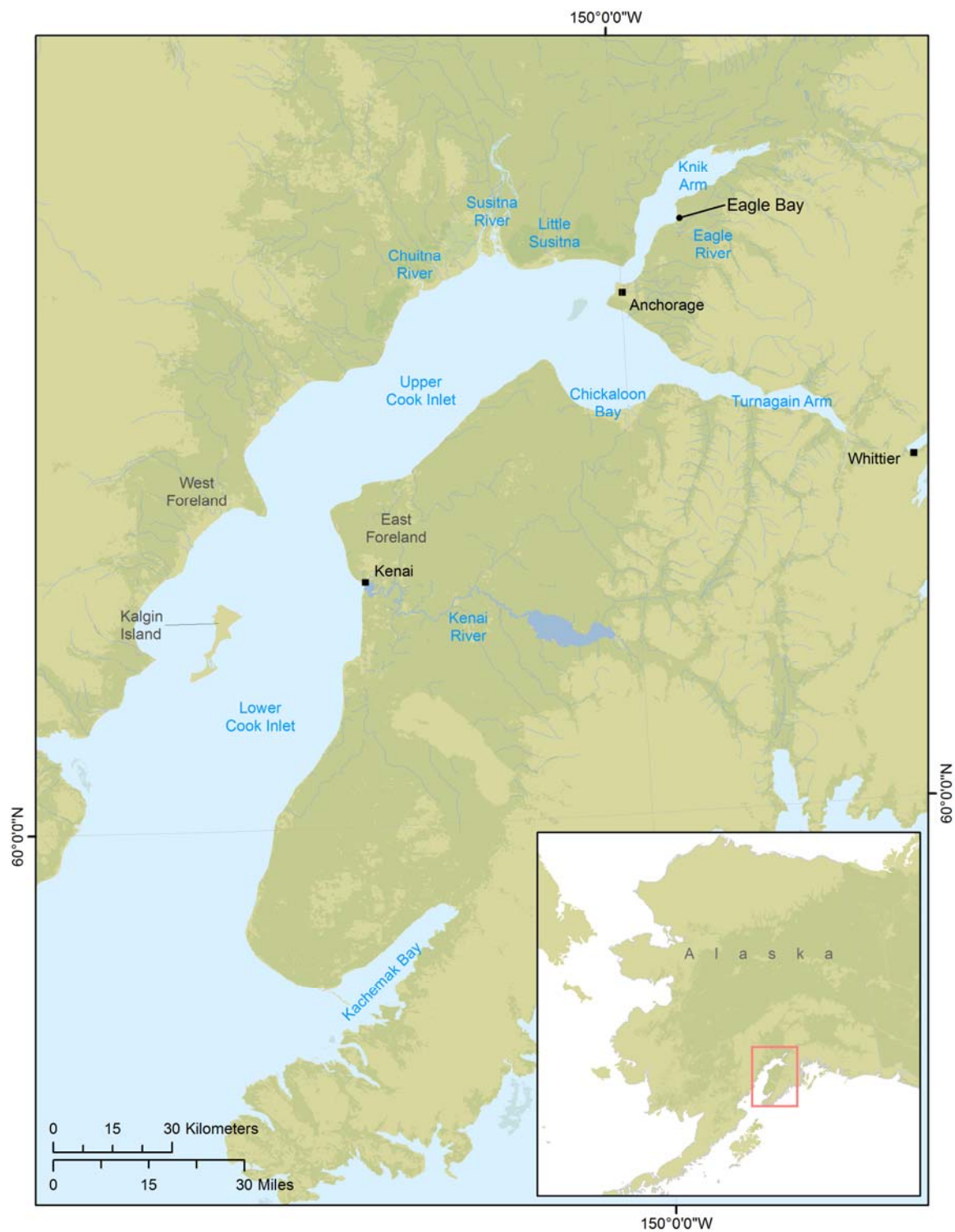


Figure 1. Map of Cook Inlet, Alaska.

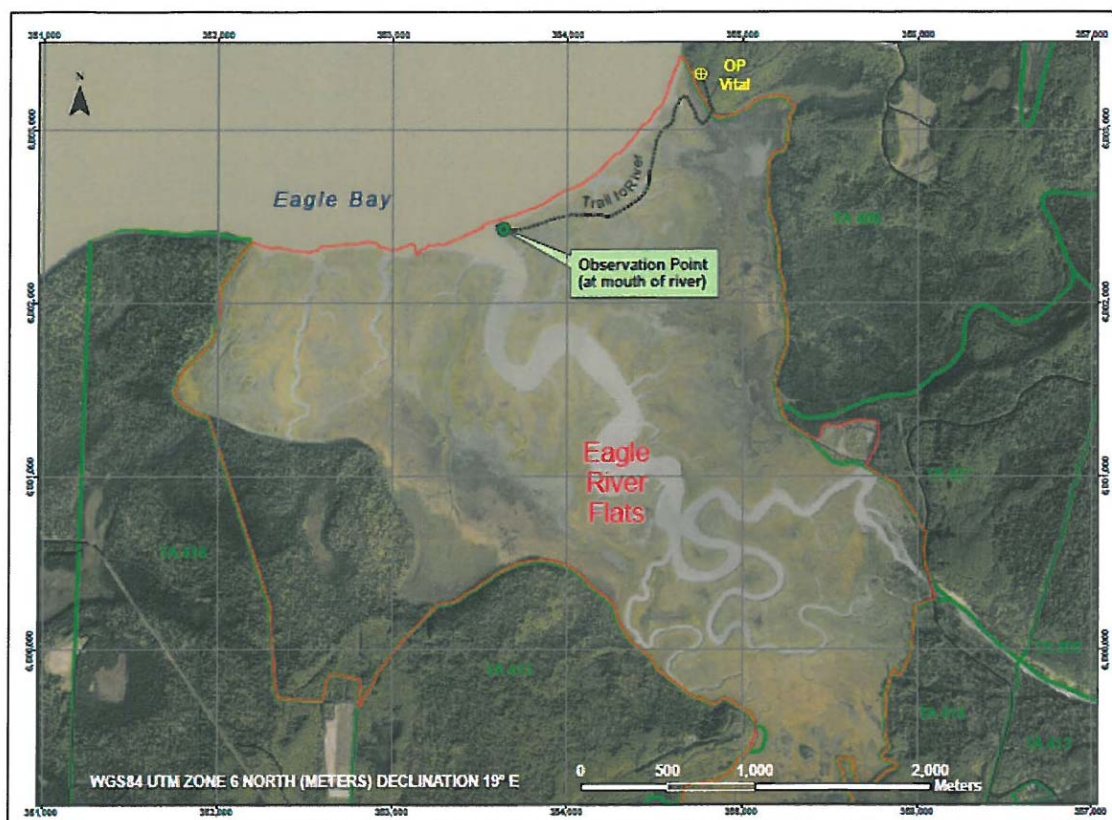


Figure 2. Map of Eagle Bay with primary land-based observation point (map from JBER 2010).

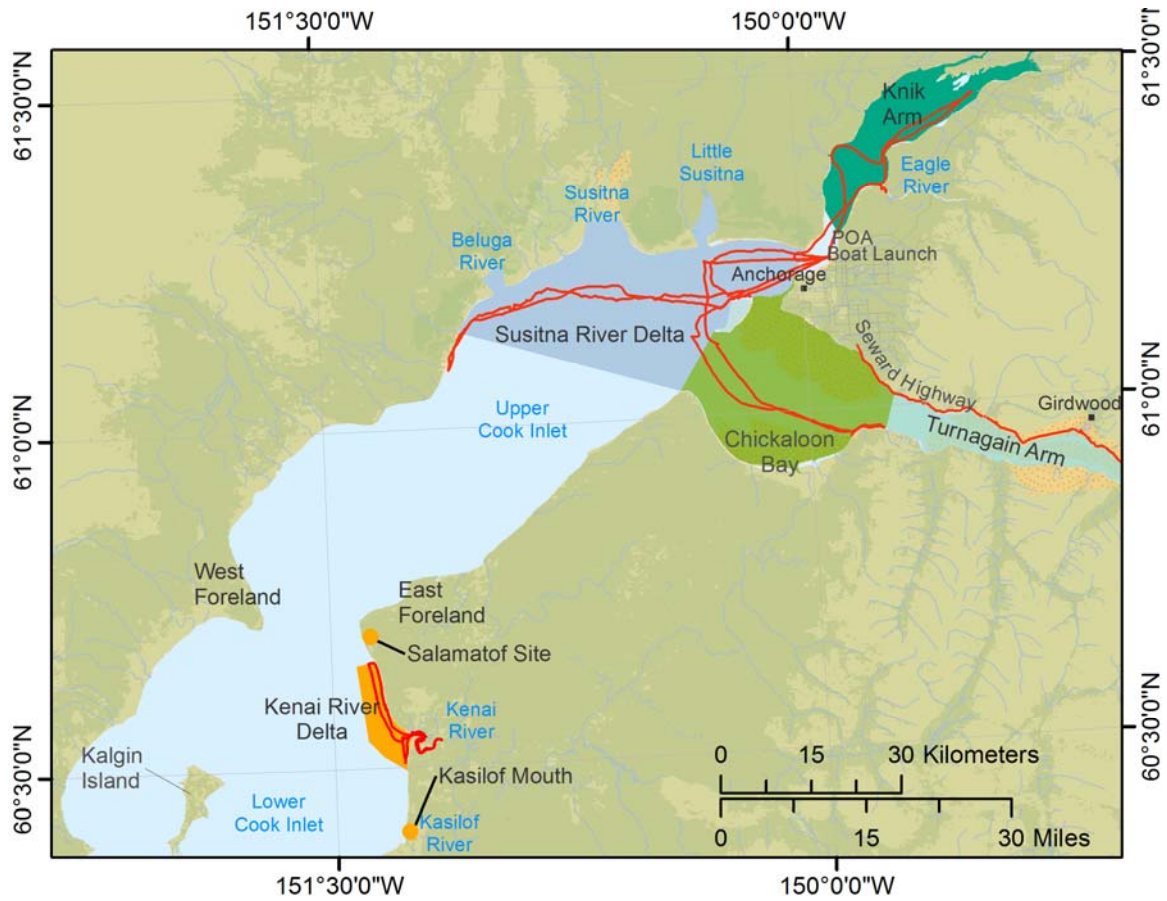


Figure 3. Map of Upper Cook Inlet, Alaska, showing boundaries of sub-areas within the study area and the vessel- and land-based survey routes used during 2005-2012.

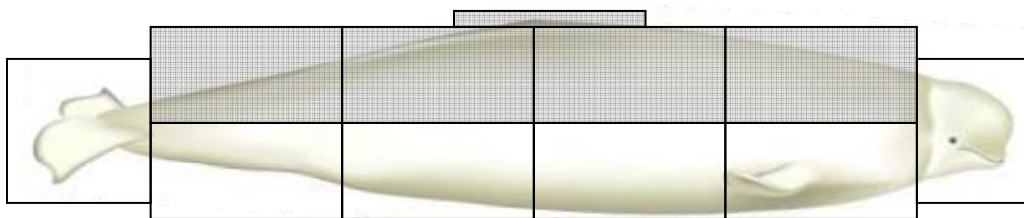


Figure 4. Diagram showing the various segments used when cataloging. The five shaded areas were the critical sections used in matching marks. Beluga illustration courtesy of Uko Gorter.

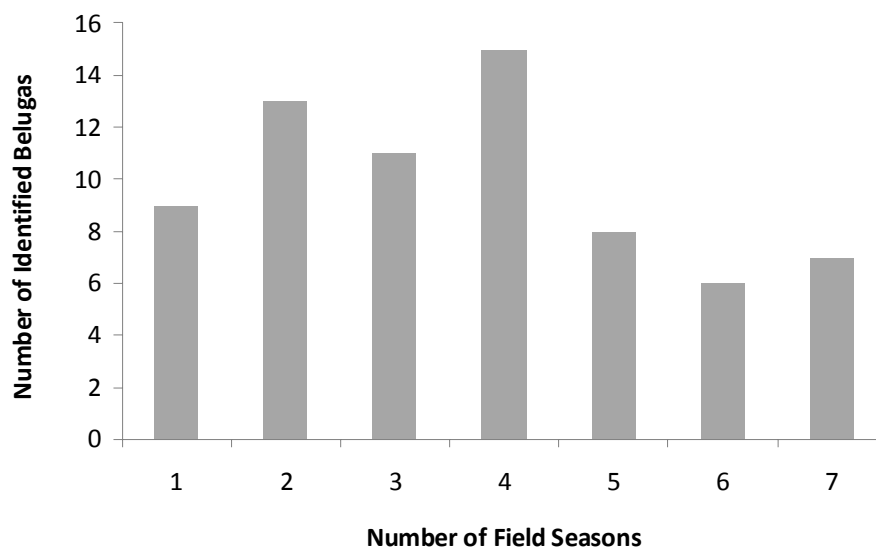


Figure 5. The number of field seasons in which whales identified in Eagle Bay in 2011 were re-sighted during the 2005-2011 study period ($n=69$ identified whales).

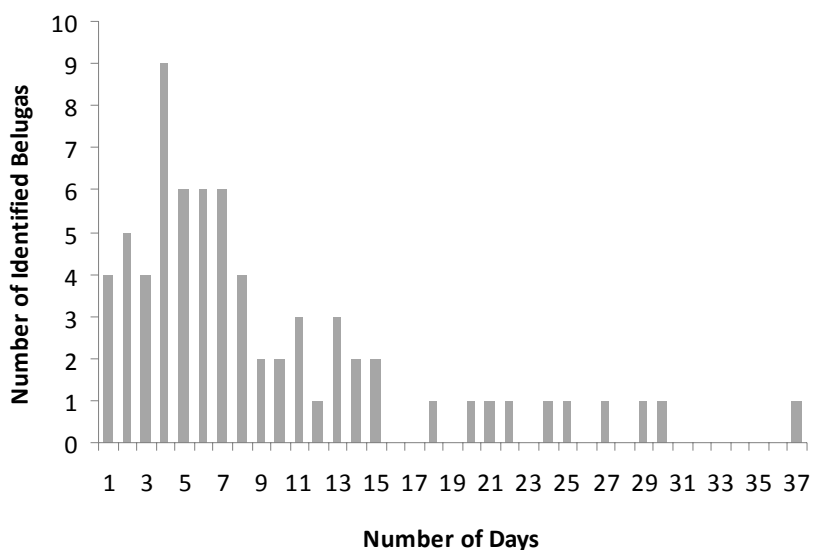


Figure 6. The number of days in which whales identified in Eagle Bay in 2011 were re-sighted during the 2005-2011 study period ($n=69$ identified whales).

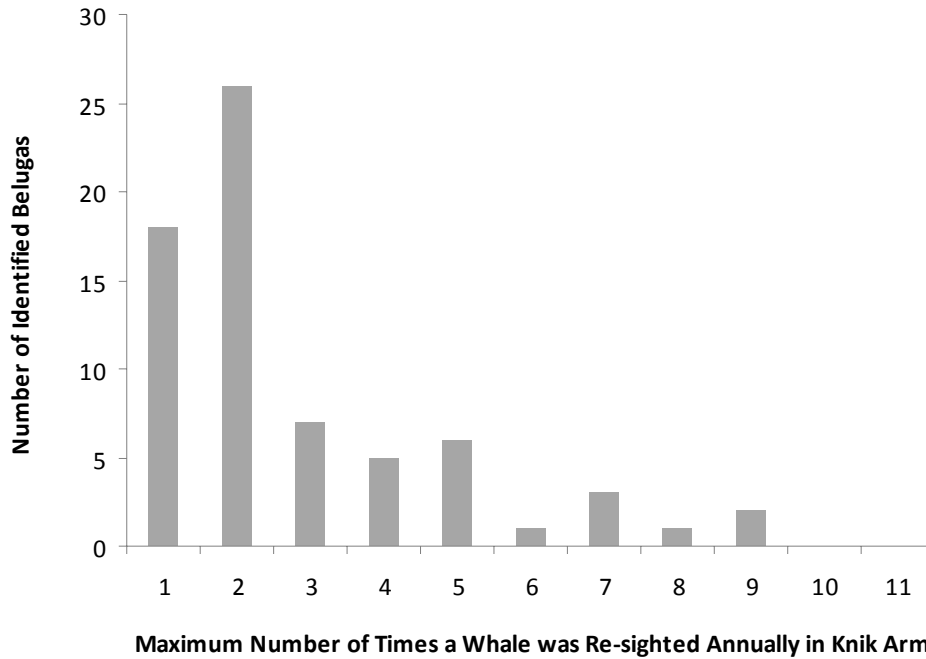


Figure 7. The maximum number of times per field season that whales identified in Eagle Bay in 2011 were re-sighted in Knik Arm during the 2005-2011 study period ($n=69$ identified whales).

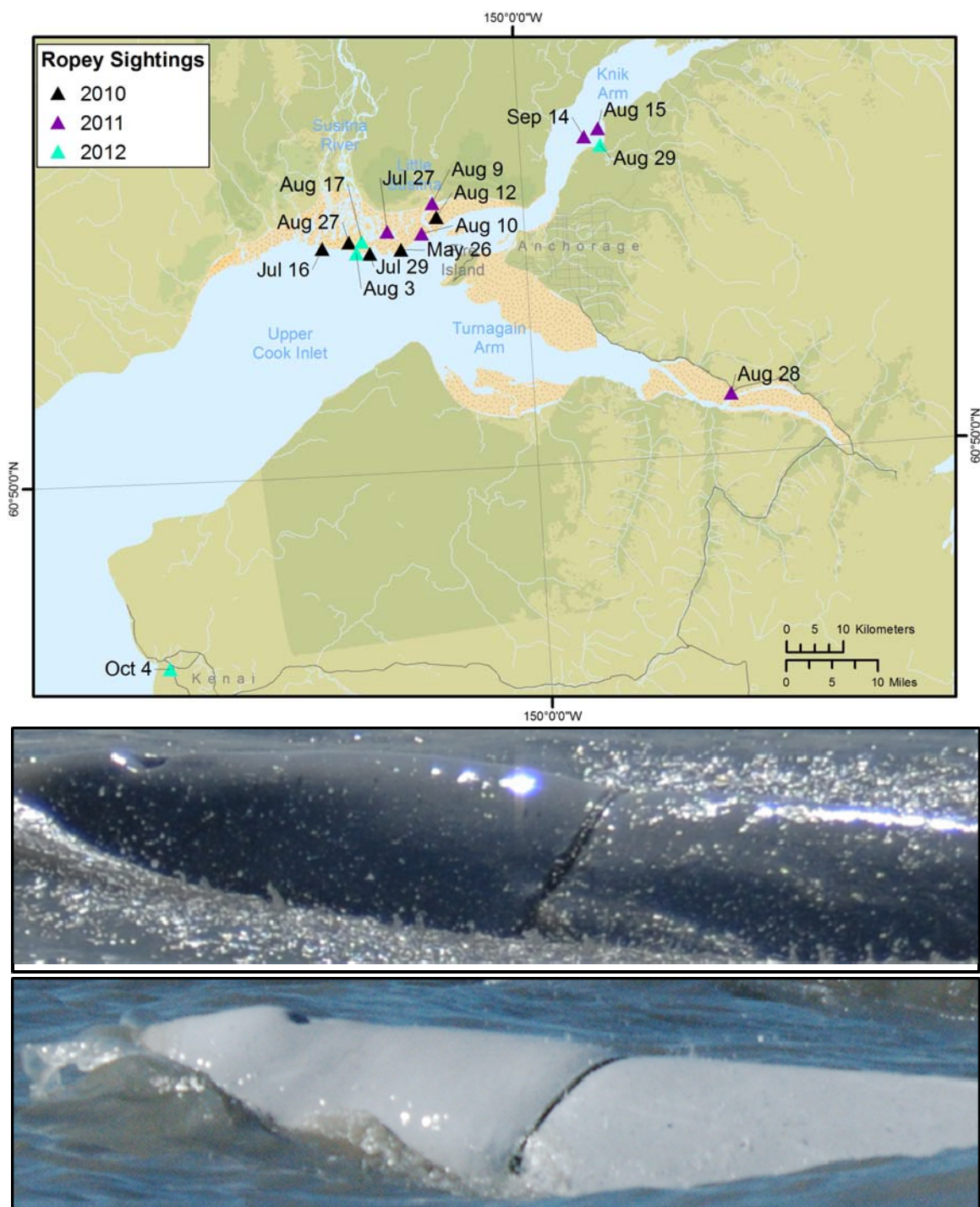


Figure 8. Sighting history and left-side photographs of an entangled beluga whale, R3846 Ropey, during the 2005-2012 field season in Cook Inlet, Alaska. Whale color differences are due to different ambient lighting conditions. The whale identification was confirmed by matching scars on the whale's body that are visible in the photo-processing program. This whale was not seen before 2010.



Figure 9. An unidentified entangled beluga whale seen in 2005 in Eagle Bay. This whale was only seen on one occasion, and the object causing the entanglement remains unknown. The top image is of the right side, and the bottom image is of the left side.

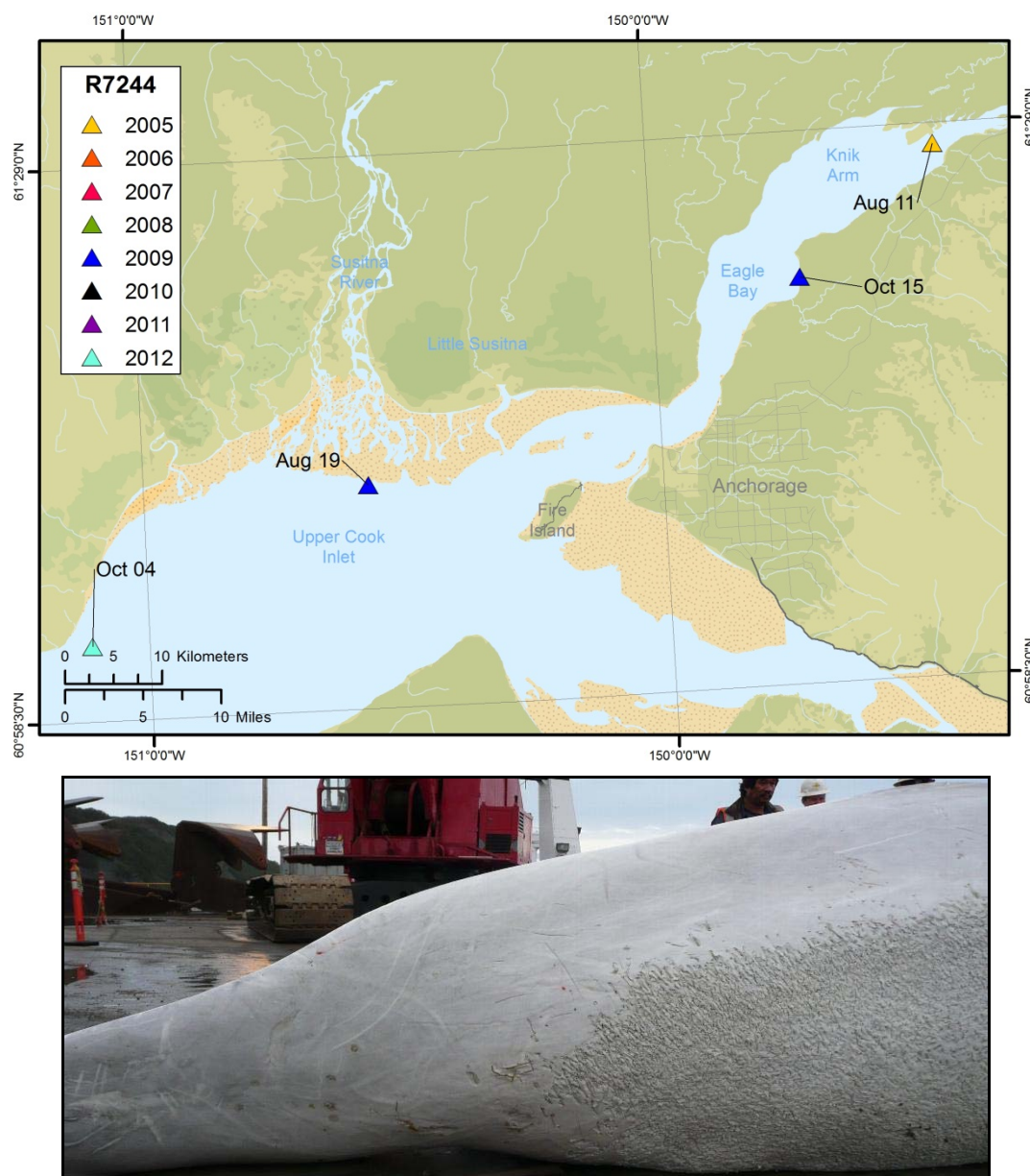


Figure 10. Sighting history and photograph of beluga R7244. This adult male was found dead in 2012, and photographed live in Knik Arm in 2005 and 2009.



Figure 11. This photograph demonstrates the difficulty in assigning maternity based on physical proximity and differences in relative color and size. The middle animal has been classified as the mother of the small calf; it is possible the white animal is the grandmother. It is also possible this is a photograph of a mother (white whale in background) and young calf (foreground) with an older sibling (middle).

APPENDIX A

**SIGHTING-HISTORY AND RIGHT-SIDE PHOTOGRAPHS OF 69
INDIVIDUALLY-IDENTIFIED BELUGA WHALES PHOTOGRAPHED IN
KNIK ARM IN 2011.**



WHALE ID	Encounter Date	Area
R875	September 12, 2008	Turnagain Arm
R875	August 3, 2009	Susitna River Delta
R875	August 22, 2009	Knik Arm
R875	September 8, 2009	Knik Arm
R875	October 1, 2009	Susitna River Delta
R875	July 27, 2011	Susitna River Delta
R875	August 14, 2011	Knik Arm

Figure A1. Photograph of the right side and sighting history of beluga R875.



WHALE ID	Encounter Date	Area
R86	September 14, 2005	Knik Arm
R86	September 19, 2005	Knik Arm
R86	May 27, 2006	Susitna River Delta
R86	August 7, 2006	Susitna River Delta
R86	September 5, 2006	Turnagain Arm
R86	September 11, 2006	Turnagain Arm
R86	July 13, 2007	Susitna River Delta
R86	July 24, 2008	Susitna River Delta
R86	July 29, 2008	Susitna River Delta
R86	September 2, 2008	Knik Arm
R86	August 25, 2011	Knik Arm

Figure A2. Photograph of the right side and sighting history of beluga R86.



WHALE ID	Encounter Date	Area
R85	September 14, 2005	Knik Arm
R85	September 15, 2005	Knik Arm
R85	September 16, 2005	Knik Arm
R85	September 20, 2005	Knik Arm
R85	September 29, 2005	Knik Arm
R85	September 30, 2005	Knik Arm
R85	September 15, 2006	Turnagain Arm
R85	July 22, 2008	Susitna River Delta
R85	August 5, 2009	Susitna River Delta
R85	September 8, 2009	Knik Arm
R85	June 29, 2011	Susitna River Delta
R85	August 17, 2011	Knik Arm
R85	August 22, 2011	Knik Arm
R85	August 24, 2011	Knik Arm
R85	August 25, 2011	Knik Arm

Figure A3. Photograph of the right side and sighting history of beluga R85.



WHALE ID	Encounter Date	Area
R84	June 17, 2006	Susitna River Delta
R84	July 29, 2008	Susitna River Delta
R84	August 6, 2008	Susitna River Delta
R84	August 27, 2008	Knik Arm
R84	September 12, 2008	Knik Arm
R84	October 1, 2009	Susitna River Delta
R84	October 6, 2009	Knik Arm
R84	May 17, 2011	Susitna River Delta
R84	August 15, 2011	Knik Arm
R84	August 16, 2011	Knik Arm
R84	August 18, 2011	Knik Arm

Figure A4. Photograph of the right side and sighting history of beluga R84.



WHALE ID	Encounter Date	Area
R75	September 7, 2005	Knik Arm
R75	September 16, 2006	Knik Arm
R75	September 26, 2008	Knik Arm
R75	September 4, 2009	Knik Arm
R75	September 8, 2009	Knik Arm
R75	August 30, 2010	Knik Arm
R75	August 16, 2011	Knik Arm
R75	August 18, 2011	Knik Arm

Figure A5. Photograph of the right side and sighting history of beluga R75.



WHALE ID	Encounter Date	Area
R67	June 6, 2005	Susitna River Delta
R67	October 7, 2005	Knik Arm
R67	July 27, 2007	Susitna River Delta
R67	July 24, 2008	Susitna River Delta
R67	August 6, 2008	Susitna River Delta
R67	August 27, 2008	Knik Arm
R67	August 16, 2011	Knik Arm
R67	August 18, 2011	Knik Arm
R67	August 22, 2011	Knik Arm
R67	September 4, 2011	Turnagain Arm

Figure A6. Photograph of the right side and sighting history of beluga R67.



WHALE ID	Encounter Date	Area
R6656	September 14, 2011	Knik Arm

Figure A7. Photograph of the right side and sighting history of beluga R6656.



WHALE ID	Encounter Date	Area
R66	September 15, 2005	Knik Arm
R66	October 7, 2005	Knik Arm
R66	September 27, 2006	Knik Arm
R66	September 27, 2007	Knik Arm
R66	July 29, 2008	Susitna River Delta
R66	August 18, 2008	Knik Arm
R66	August 22, 2008	Knik Arm
R66	August 19, 2009	Susitna River Delta
R66	August 16, 2011	Knik Arm
R66	August 18, 2011	Knik Arm

Figure A8. Photograph of the right side and sighting history of beluga R66.



WHALE ID	Encounter Date	Area
R6585	August 25, 2011	Knik Arm

Figure A9. Photograph of the right side and sighting history of beluga R6585.



WHALE ID	Encounter Date	Area
R6458	August 18, 2011	Knik Arm

Figure A10. Photograph of the right side and sighting history of beluga R6458 (foreground).



WHALE ID	Encounter Date	Area
R6436	August 18, 2011	Knik Arm

Figure A11. Photograph of the right side and sighting history of beluga R6436.



WHALE ID	Encounter Date	Area
R64	October 17, 2005	Knik Arm
R64	September 9, 2006	Knik Arm
R64	August 20, 2010	Susitna River Delta
R64	September 14, 2011	Knik Arm

Figure A12. Photograph of the right side and sighting history of beluga R64.



WHALE ID	Encounter Date	Area
R6386	August 18, 2011	Knik Arm
R6386	August 22, 2011	Knik Arm

Figure A13. Photograph of the right side and sighting history of beluga R6386.



WHALE ID	Encounter Date	Area
R6381	August 18, 2011	Knik Arm
R6381	August 22, 2011	Knik Arm

Figure A14. Photograph of the right side and sighting history of beluga R6381.



WHALE ID	Encounter Date	Area
R6380	August 17, 2011	Knik Arm
R6380	August 18, 2011	Knik Arm
R6380	September 7, 2011	Knik Arm
R6380	September 14, 2011	Knik Arm

Figure A15. Photograph of the right side and sighting history of beluga R6380.



WHALE ID	Encounter Date	Area
R6314	May 17, 2011	Susitna River Delta
R6314	August 15, 2011	Knik Arm
R6314	August 18, 2011	Knik Arm

Figure A16. Photograph of the right side and sighting history of beluga R6314.



WHALE ID	Encounter Date	Area
R6284	August 15, 2011	Knik Arm
R6284	August 18, 2011	Knik Arm

Figure A17. Photograph of the right side and sighting history of beluga R6284.



WHALE ID	Encounter Date	Area
R60	July 24, 2005	Knik Arm
R60	October 6, 2005	Knik Arm
R60	September 4, 2006	Turnagain Arm
R60	July 27, 2007	Susitna River Delta
R60	June 19, 2008	Susitna River Delta
R60	July 24, 2008	Susitna River Delta
R60	July 29, 2008	Susitna River Delta
R60	September 2, 2008	Knik Arm
R60	August 3, 2009	Susitna River Delta
R60	August 22, 2009	Knik Arm
R60	June 17, 2011	Susitna River Delta
R60	June 29, 2011	Susitna River Delta
R60	July 5, 2011	Susitna River Delta
R60	July 27, 2011	Susitna River Delta
R60	August 10, 2011	Susitna River Delta
R60	August 15, 2011	Knik Arm
R60	August 16, 2011	Knik Arm
R60	August 25, 2011	Knik Arm

Figure A18. Photograph of the right side and sighting history of beluga R60.



WHALE ID	Encounter Date	Area
R594	July 27, 2007	Susitna River Delta
R594	July 29, 2008	Susitna River Delta
R594	August 6, 2008	Susitna River Delta
R594	August 22, 2008	Knik Arm
R594	August 27, 2008	Knik Arm
R594	August 3, 2009	Susitna River Delta
R594	May 26, 2010	Susitna River Delta
R594	July 29, 2010	Susitna River Delta
R594	August 14, 2011	Knik Arm
R594	August 16, 2011	Knik Arm
R594	August 18, 2011	Knik Arm
R594	August 19, 2011	Knik Arm
R594	August 25, 2011	Knik Arm

Figure A19. Photograph of the right side and sighting history of beluga R594.



WHALE ID	Encounter Date	Area
R57	June 6, 2005	Susitna River Delta
R57	September 8, 2005	Knik Arm
R57	September 30, 2005	Knik Arm
R57	August 6, 2008	Susitna River Delta
R57	August 27, 2008	Knik Arm
R57	August 18, 2011	Knik Arm

Figure A20. Photograph of the right side and sighting history of beluga R57.



WHALE ID	Encounter Date	Area
R56	July 31, 2005	Susitna River Delta
R56	August 18, 2005	Knik Arm
R56	September 5, 2006	Turnagain Arm
R56	July 27, 2007	Susitna River Delta
R56	August 14, 2007	Knik Arm
R56	July 27, 2011	Susitna River Delta
R56	August 14, 2011	Knik Arm
R56	August 16, 2011	Knik Arm

Figure A21. Photograph of the right side and sighting history of beluga R56.



WHALE ID	Encounter Date	Area
R544	September 14, 2006	Knik Arm
R544	September 30, 2008	Chickaloon Bay/South Fire Island
R544	May 17, 2011	Susitna River Delta
R544	August 15, 2011	Knik Arm
R544	August 17, 2011	Knik Arm
R544	August 18, 2011	Knik Arm

Figure A22. Photograph of the right side and sighting history of beluga R544.



WHALE ID	Encounter Date	Area
R542	July 27, 2007	Susitna River Delta
R542	July 21, 2010	Susitna River Delta
R542	May 27, 2011	Susitna River Delta
R542	August 17, 2011	Knik Arm
R542	August 18, 2011	Knik Arm

Figure A23. Photograph of the right side and sighting history of beluga R542.



WHALE ID	Encounter Date	Area
R540	August 21, 2006	Susitna River Delta
R540	September 6, 2006	Knik Arm
R540	September 16, 2006	Knik Arm
R540	September 23, 2006	Knik Arm
R540	September 27, 2006	Knik Arm
R540	July 24, 2008	Susitna River Delta
R540	July 29, 2008	Susitna River Delta
R540	August 27, 2008	Knik Arm
R540	September 2, 2008	Knik Arm
R540	October 28, 2008	Knik Arm
R540	August 5, 2009	Susitna River Delta
R540	May 17, 2011	Susitna River Delta
R540	August 25, 2011	Knik Arm
R540	September 14, 2011	Knik Arm

Figure A24. Photograph of the right side and sighting history of beluga R540.



WHALE ID	Encounter Date	Area
R538	September 12, 2006	Turnagain Arm
R538	September 14, 2006	Knik Arm
R538	August 17, 2011	Knik Arm
R538	August 18, 2011	Knik Arm
R538	August 22, 2011	Knik Arm
R538	August 24, 2011	Knik Arm
R538	August 25, 2011	Knik Arm

Figure A25. Photograph of the right side and sighting history of beluga R538.



WHALE ID	Encounter Date	Area
R521	September 9, 2006	Knik Arm
R521	September 16, 2006	Knik Arm
R521	August 22, 2008	Knik Arm
R521	August 3, 2009	Susitna River Delta
R521	August 19, 2009	Susitna River Delta
R521	August 12, 2010	Susitna River Delta
R521	August 19, 2010	Knik Arm
R521	August 16, 2011	Knik Arm
R521	August 18, 2011	Knik Arm

Figure A26. Photograph of the right side and sighting history of beluga R521.



WHALE ID	Encounter Date	Area
R5198	August 12, 2010	Susitna River Delta
R5198	May 27, 2011	Susitna River Delta
R5198	July 5, 2011	Susitna River Delta
R5198	July 27, 2011	Susitna River Delta
R5198	August 10, 2011	Susitna River Delta
R5198	August 18, 2011	Knik Arm

Figure A27. Photograph of the right side and sighting history of beluga R5198.



WHALE ID	Encounter Date	Area
R517	September 7, 2006	Knik Arm
R517	August 15, 2011	Knik Arm
R517	August 16, 2011	Knik Arm
R517	August 18, 2011	Knik Arm
R517	August 22, 2011	Knik Arm

Figure A28. Photograph of the right side and sighting history of beluga R517.

Photo courtesy of Stacy DeRuiter.



WHALE ID	Encounter Date	Area
R49	June 6, 2005	Susitna River Delta
R49	September 7, 2005	Knik Arm
R49	September 8, 2005	Knik Arm
R49	September 27, 2006	Knik Arm
R49	July 29, 2008	Susitna River Delta
R49	August 6, 2008	Susitna River Delta
R49	August 29, 2008	Knik Arm
R49	August 29, 2008	Turnagain Arm
R49	July 21, 2010	Susitna River Delta
R49	August 10, 2011	Susitna River Delta
R49	August 15, 2011	Knik Arm
R49	August 18, 2011	Knik Arm
R49	August 19, 2011	Knik Arm
R49	August 25, 2011	Knik Arm

Figure A29. Photograph of the right side and sighting history of beluga R49.



WHALE ID	Encounter Date	Area
R4400	July 29, 2010	Susitna River Delta
R4400	September 14, 2011	Knik Arm

Figure A30. Photograph of the right side and sighting history of beluga R4400.



WHALE ID	Encounter Date	Area
R4236	September 5, 2010	Turnagain Arm
R4236	August 24, 2011	Knik Arm

Figure A31. Photograph of the right side and sighting history of beluga R4236.



WHALE ID	Encounter Date	Area
R4129	July 21, 2010	Susitna River Delta
R4129	May 17, 2011	Susitna River Delta
R4129	September 14, 2011	Knik Arm

Figure A32. Photograph of the right side and sighting history of beluga R4129.



WHALE ID	Encounter Date	Area
R4121	July 21, 2010	Susitna River Delta
R4121	July 13, 2011	Susitna River Delta
R4121	July 27, 2011	Susitna River Delta
R4121	September 14, 2011	Knik Arm

Figure A33. Photograph of the right side and sighting history of beluga R4121.



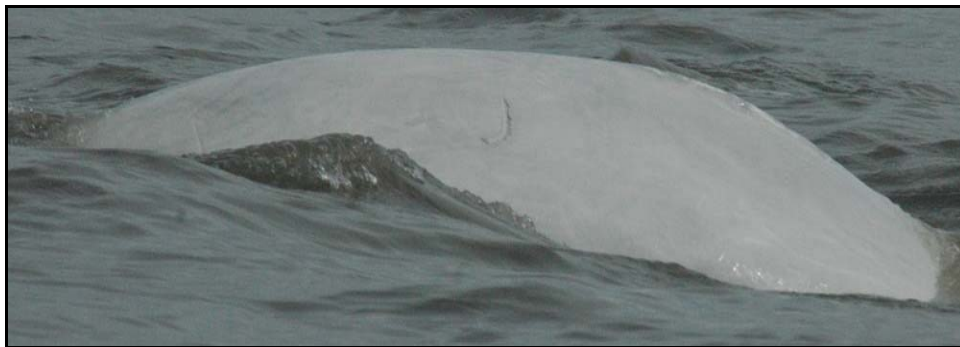
WHALE ID	Encounter Date	Area
R3846	August 12, 2010	Susitna River Delta
R3846	August 27, 2010	Susitna River Delta
R3846	August 10, 2011	Susitna River Delta
R3846	August 15, 2011	Knik Arm
R3846	August 28, 2011	Turnagain Arm
R3846	September 14, 2011	Knik Arm
R3846	October 4, 2012	Kenai River

Figure A34. Photograph of the right side and sighting history of beluga R3846.



WHALE ID	Encounter Date	Area
R3833	August 12, 2010	Susitna River Delta
R3833	July 27, 2011	Susitna River Delta
R3833	August 24, 2011	Knik Arm
R3833	August 25, 2011	Knik Arm

Figure A35. Photograph of the right side and sighting history of beluga R3833.



WHALE ID	Encounter Date	Area
R36	August 5, 2005	Knik Arm
R36	September 14, 2005	Knik Arm
R36	September 29, 2005	Knik Arm
R36	September 23, 2006	Knik Arm
R36	September 25, 2006	Knik Arm
R36	July 27, 2007	Susitna River Delta
R36	September 27, 2007	Knik Arm
R36	August 3, 2009	Susitna River Delta
R36	August 9, 2009	Susitna River Delta
R36	August 16, 2011	Knik Arm
R36	August 17, 2011	Knik Arm
R36	August 18, 2011	Knik Arm
R36	September 7, 2011	Knik Arm
R36	September 14, 2011	Knik Arm

Figure A36. Photograph of the right side and sighting history of beluga R36.



WHALE ID	Encounter Date	Area
R3470	September 27, 2007	Knik Arm
R3470	August 9, 2009	Susitna River Delta
R3470	September 8, 2009	Knik Arm
R3470	August 20, 2010	Knik Arm
R3470	August 25, 2011	Knik Arm

Figure A37. Photograph of the right side and sighting history of beluga R3470.
Photo courtesy of Department of Defense/JBER.



WHALE ID	Encounter Date	Area
R3203	August 9, 2009	Susitna River Delta
R3203	August 19, 2009	Susitna River Delta
R3203	May 26, 2010	Susitna River Delta
R3203	August 19, 2010	Susitna River Delta
R3203	June 29, 2011	Susitna River Delta
R3203	August 25, 2011	Knik Arm
R3203	September 27, 2011	Chickaloon Bay/South Fire Island

Figure A38. Photograph of the right side and sighting history of beluga R3203.



WHALE ID	Encounter Date	Area
R3121	July 22, 2008	Susitna River Delta
R3121	July 29, 2008	Susitna River Delta
R3121	August 3, 2009	Susitna River Delta
R3121	August 9, 2009	Knik Arm
R3121	October 15, 2009	Knik Arm
R3121	May 17, 2011	Susitna River Delta
R3121	August 16, 2011	Knik Arm
R3121	August 18, 2011	Knik Arm

Figure A39. Photograph of the right side and sighting history of beluga R3121.



WHALE ID	Encounter Date	Area
R3052	August 3, 2009	Susitna River Delta
R3052	August 6, 2010	Susitna River Delta
R3052	August 16, 2011	Knik Arm
R3052	August 18, 2011	Knik Arm
R3052	August 19, 2011	Knik Arm

Figure A40. Photograph of the right side and sighting history of beluga R3052.

Photo courtesy of Stacy DeRuiter.



WHALE ID	Encounter Date	Area
R2995	October 15, 2009	Knik Arm
R2995	August 10, 2011	Susitna River Delta
R2995	August 15, 2011	Knik Arm
R2995	August 18, 2011	Knik Arm

Figure A41. Photograph of the right side and sighting history of beluga R2995.
Photo courtesy of Stacy DeRuiter.



WHALE ID	Encounter Date	Area
R245	September 15, 2005	Knik Arm
R245	September 21, 2005	Knik Arm
R245	August 7, 2006	Susitna River Delta
R245	September 7, 2006	Knik Arm
R245	September 9, 2006	Knik Arm
R245	July 27, 2007	Susitna River Delta
R245	September 2, 2008	Knik Arm
R245	August 3, 2009	Susitna River Delta
R245	August 31, 2009	Knik Arm
R245	September 4, 2009	Knik Arm
R245	July 29, 2010	Susitna River Delta
R245	August 15, 2011	Knik Arm
R245	August 25, 2011	Knik Arm

Figure A42. Photograph of the right side and sighting history of beluga R245.



WHALE ID	Encounter Date	Area
R242	June 6, 2005	Susitna River Delta
R242	July 14, 2005	Susitna River Delta
R242	July 23, 2005	Susitna River Delta
R242	July 31, 2005	Susitna River Delta
R242	September 8, 2005	Knik Arm
R242	September 14, 2005	Knik Arm
R242	September 15, 2005	Knik Arm
R242	September 19, 2005	Knik Arm
R242	September 21, 2005	Knik Arm
R242	September 22, 2005	Knik Arm
R242	July 27, 2007	Susitna River Delta
R242	August 14, 2007	Knik Arm
R242	July 24, 2008	Susitna River Delta
R242	July 29, 2008	Susitna River Delta
R242	August 6, 2008	Susitna River Delta
R242	August 18, 2008	Knik Arm
R242	August 30, 2009	Turnagain Arm
R242	May 17, 2011	Susitna River Delta
R242	May 27, 2011	Susitna River Delta
R242	June 17, 2011	Susitna River Delta
R242	July 27, 2011	Susitna River Delta
R242	August 22, 2011	Knik Arm

Figure A43. Photograph of the right side and sighting history of beluga R242.



WHALE ID	Encounter Date	Area
R207	September 9, 2005	Knik Arm
R207	August 7, 2006	Susitna River Delta
R207	September 4, 2009	Knik Arm
R207	October 1, 2009	Susitna River Delta
R207	October 15, 2009	Knik Arm
R207	August 10, 2011	Susitna River Delta
R207	August 25, 2011	Knik Arm

Figure A44. Photograph of the right side and sighting history of beluga R207.



WHALE ID	Encounter Date	Area
R195	September 14, 2005	Knik Arm
R195	September 30, 2005	Knik Arm
R195	July 15, 2008	Susitna River Delta
R195	July 22, 2008	Susitna River Delta
R195	July 24, 2008	Susitna River Delta
R195	July 29, 2008	Susitna River Delta
R195	August 6, 2008	Susitna River Delta
R195	August 27, 2008	Knik Arm
R195	September 2, 2008	Knik Arm
R195	August 9, 2009	Susitna River Delta
R195	May 17, 2011	Susitna River Delta
R195	July 27, 2011	Susitna River Delta
R195	August 14, 2011	Knik Arm
R195	August 15, 2011	Knik Arm
R195	August 16, 2011	Knik Arm
R195	August 17, 2011	Knik Arm
R195	August 18, 2011	Knik Arm
R195	August 22, 2011	Knik Arm
R195	August 24, 2011	Knik Arm
R195	August 25, 2011	Knik Arm

Figure A45. Photograph of the right side and sighting history of beluga R195.



WHALE ID	Encounter Date	Area
R165	June 13, 2005	Knik Arm
R165	August 5, 2005	Knik Arm
R165	September 8, 2005	Knik Arm
R165	September 14, 2005	Knik Arm
R165	September 15, 2005	Knik Arm
R165	September 19, 2005	Knik Arm
R165	September 22, 2005	Knik Arm
R165	May 27, 2006	Susitna River Delta
R165	June 17, 2006	Susitna River Delta
R165	July 17, 2007	Susitna River Delta
R165	June 19, 2008	Susitna River Delta
R165	July 24, 2008	Susitna River Delta
R165	July 29, 2008	Susitna River Delta
R165	August 22, 2008	Knik Arm
R165	August 9, 2009	Susitna River Delta
R165	July 21, 2010	Susitna River Delta
R165	August 12, 2010	Susitna River Delta
R165	July 13, 2011	Susitna River Delta
R165	August 25, 2011	Knik Arm
R165	September 7, 2011	Knik Arm
R165	September 14, 2011	Knik Arm

Figure A46. Photograph of the right side and sighting history of beluga R165.



WHALE ID	Encounter Date	Area
R160	August 5, 2005	Knik Arm
R160	October 6, 2005	Knik Arm
R160	October 7, 2005	Knik Arm
R160	August 7, 2006	Susitna River Delta
R160	September 16, 2006	Knik Arm
R160	September 27, 2006	Knik Arm
R160	July 24, 2008	Susitna River Delta
R160	August 27, 2008	Knik Arm
R160	September 4, 2009	Knik Arm
R160	September 8, 2009	Knik Arm
R160	October 6, 2009	Knik Arm
R160	June 21, 2010	Susitna River Delta
R160	August 20, 2010	Susitna River Delta
R160	August 25, 2011	Knik Arm
R160	September 14, 2011	Knik Arm

Figure A47. Photograph of the right side and sighting history of beluga R160.



WHALE ID	Encounter Date	Area
R145	July 24, 2005	Knik Arm
R145	August 5, 2005	Knik Arm
R145	August 18, 2005	Knik Arm
R145	September 29, 2005	Knik Arm
R145	September 30, 2005	Knik Arm
R145	August 7, 2006	Susitna River Delta
R145	September 14, 2011	Knik Arm

Figure A48. Photograph of the right side and sighting history of beluga R145.



WHALE ID	Encounter Date	Area
R1416	September 16, 2006	Knik Arm
R1416	September 27, 2006	Knik Arm
R1416	August 14, 2007	Knik Arm
R1416	August 22, 2009	Knik Arm
R1416	August 25, 2011	Knik Arm

Figure A49. Photograph of the right side and sighting history of beluga R1416.



WHALE ID	Encounter Date	Area
R1314	August 22, 2008	Knik Arm
R1314	October 1, 2009	Susitna River Delta
R1314	October 15, 2009	Knik Arm
R1314	August 12, 2010	Susitna River Delta
R1314	August 24, 2011	Knik Arm
R1314	September 27, 2011	Chickaloon Bay/South Fire Island

Figure A50. Photograph of the right side and sighting history of beluga R1314.



WHALE ID	Encounter Date	Area
R125	June 6, 2005	Susitna River Delta
R125	July 7, 2005	Chickaloon Bay/South Fire Island
R125	July 23, 2005	Susitna River Delta
R125	July 31, 2005	Susitna River Delta
R125	September 14, 2005	Knik Arm
R125	September 15, 2005	Knik Arm
R125	September 30, 2005	Knik Arm
R125	September 23, 2006	Knik Arm
R125	September 27, 2006	Knik Arm
R125	August 31, 2009	Knik Arm
R125	August 20, 2010	Susitna River Delta
R125	August 25, 2011	Knik Arm

Figure A51. Photograph of the right side and sighting history of beluga R125.



WHALE ID	Encounter Date	Area
R118	June 6, 2005	Susitna River Delta
R118	July 7, 2005	Susitna River Delta
R118	July 23, 2005	Susitna River Delta
R118	July 31, 2005	Susitna River Delta
R118	June 17, 2006	Susitna River Delta
R118	August 8, 2006	Susitna River Delta
R118	September 7, 2006	Knik Arm
R118	September 9, 2006	Knik Arm
R118	September 25, 2006	Knik Arm
R118	September 26, 2006	Knik Arm
R118	September 27, 2006	Knik Arm
R118	July 27, 2007	Susitna River Delta
R118	July 22, 2008	Susitna River Delta
R118	July 24, 2008	Susitna River Delta
R118	July 29, 2008	Susitna River Delta
R118	August 6, 2008	Susitna River Delta
R118	August 27, 2008	Knik Arm
R118	August 9, 2009	Susitna River Delta
R118	August 10, 2009	Susitna River Delta
R118	August 13, 2009	Susitna River Delta
R118	July 29, 2010	Susitna River Delta
R118	August 15, 2011	Knik Arm
R118	August 18, 2011	Knik Arm
R118	August 22, 2011	Knik Arm

Figure A52. Photograph of the right side and sighting history of beluga R118.



WHALE ID	Encounter Date	Area
R1168	September 8, 2009	Knik Arm
R1168	October 15, 2009	Knik Arm
R1168	August 16, 2011	Knik Arm
R1168	August 18, 2011	Knik Arm

Figure A53. Photograph of the right side and sighting history of beluga R1168.
Photo courtesy of Stacy DeRuiter.



WHALE ID	Encounter Date	Area
R1159	July 24, 2008	Susitna River Delta
R1159	July 29, 2008	Susitna River Delta
R1159	September 4, 2009	Knik Arm
R1159	August 20, 2010	Knik Arm
R1159	August 30, 2010	Knik Arm
R1159	September 14, 2011	Knik Arm

Figure A54. Photograph of the right side and sighting history of beluga R1159.



WHALE ID	Encounter Date	Area
R1156	July 24, 2008	Susitna River Delta
R1156	July 29, 2008	Susitna River Delta
R1156	August 6, 2008	Susitna River Delta
R1156	August 22, 2011	Knik Arm

Figure A55. Photograph of the right side and sighting history of beluga R1156.



WHALE ID	Encounter Date	Area
R115	May 31, 2005	Susitna River Delta
R115	June 13, 2005	Knik Arm
R115	September 5, 2006	Turnagain Arm
R115	July 27, 2007	Susitna River Delta
R115	August 14, 2007	Knik Arm
R115	August 21, 2007	Knik Arm
R115	July 24, 2008	Susitna River Delta
R115	July 29, 2008	Susitna River Delta
R115	August 6, 2008	Susitna River Delta
R115	August 22, 2008	Knik Arm
R115	August 27, 2008	Knik Arm
R115	August 3, 2009	Susitna River Delta
R115	August 5, 2009	Susitna River Delta
R115	August 9, 2009	Susitna River Delta
R115	August 10, 2009	Susitna River Delta
R115	September 4, 2009	Knik Arm
R115	June 21, 2010	Susitna River Delta
R115	July 21, 2010	Susitna River Delta
R115	July 29, 2010	Susitna River Delta
R115	August 6, 2010	Susitna River Delta
R115	August 28, 2010	Turnagain Arm
R115	September 4, 2010	Turnagain Arm
R115	May 17, 2011	Susitna River Delta
R115	June 17, 2011	Susitna River Delta
R115	August 16, 2011	Knik Arm

Figure A56. Photograph of the right side and sighting history of beluga R115.



WHALE ID	Encounter Date	Area
R1145	July 24, 2008	Susitna River Delta
R1145	July 29, 2008	Susitna River Delta
R1145	August 30, 2008	Knik Arm
R1145	August 9, 2009	Susitna River Delta
R1145	August 19, 2009	Susitna River Delta
R1145	July 29, 2010	Susitna River Delta
R1145	August 18, 2011	Knik Arm
R1145	August 22, 2011	Knik Arm
R1145	August 26, 2011	Susitna River Delta

Figure A57. Photograph of the right side and sighting history of beluga R1145.



WHALE ID	Encounter Date	Area
R113	September 8, 2005	Knik Arm
R113	September 15, 2005	Knik Arm
R113	August 7, 2006	Susitna River Delta
R113	September 5, 2006	Turnagain Arm
R113	July 24, 2008	Susitna River Delta
R113	August 3, 2009	Susitna River Delta
R113	September 8, 2009	Knik Arm
R113	October 1, 2009	Susitna River Delta
R113	October 6, 2009	Knik Arm
R113	August 28, 2010	Turnagain Arm
R113	August 29, 2011	Susitna River Delta

Figure A58. Photograph of the right side and sighting history of beluga R113.



WHALE ID	Encounter Date	Area
R112	June 6, 2005	Susitna River Delta
R112	June 13, 2005	Knik Arm
R112	June 15, 2005	Knik Arm
R112	July 14, 2005	Susitna River Delta
R112	July 31, 2005	Susitna River Delta
R112	September 15, 2005	Knik Arm
R112	September 20, 2005	Knik Arm
R112	October 7, 2005	Knik Arm
R112	September 9, 2006	Knik Arm
R112	September 16, 2006	Knik Arm
R112	August 30, 2007	Knik Arm
R112	September 27, 2007	Knik Arm
R112	June 19, 2008	Susitna River Delta
R112	July 24, 2008	Susitna River Delta
R112	August 22, 2008	Knik Arm
R112	September 2, 2008	Knik Arm
R112	September 15, 2008	Knik Arm
R112	September 29, 2008	Turnagain Arm
R112	June 24, 2009	Susitna River Delta
R112	August 3, 2009	Susitna River Delta
R112	August 5, 2009	Susitna River Delta
R112	August 31, 2009	Knik Arm
R112	September 4, 2009	Knik Arm
R112	September 8, 2009	Knik Arm
R112	October 6, 2009	Knik Arm
R112	July 29, 2010	Susitna River Delta
R112	August 26, 2010	Knik Arm
R112	September 10, 2010	Knik Arm
R112	July 5, 2011	Susitna River Delta
R112	July 13, 2011	Susitna River Delta
R112	August 14, 2011	Knik Arm
R112	August 16, 2011	Knik Arm
R112	August 17, 2011	Knik Arm
R112	August 18, 2011	Knik Arm
R112	August 22, 2011	Knik Arm
R112	August 25, 2011	Knik Arm
R112	September 14, 2011	Knik Arm

Figure A59. Photograph of the right side and sighting history of beluga R112.



WHALE ID	Encounter Date	Area
R111	June 13, 2005	Knik Arm
R111	June 15, 2005	Knik Arm
R111	July 23, 2005	Susitna River Delta
R111	July 31, 2005	Susitna River Delta
R111	September 8, 2005	Knik Arm
R111	September 9, 2005	Knik Arm
R111	September 14, 2005	Knik Arm
R111	September 15, 2005	Knik Arm
R111	September 19, 2005	Knik Arm
R111	September 30, 2005	Knik Arm
R111	October 21, 2005	Knik Arm
R111	July 27, 2007	Susitna River Delta
R111	July 15, 2008	Susitna River Delta
R111	July 24, 2008	Susitna River Delta
R111	July 29, 2008	Susitna River Delta
R111	August 6, 2008	Susitna River Delta
R111	August 13, 2009	Susitna River Delta
R111	August 19, 2009	Susitna River Delta
R111	September 4, 2009	Knik Arm
R111	October 1, 2009	Susitna River Delta
R111	October 6, 2009	Knik Arm
R111	May 26, 2010	Susitna River Delta
R111	July 21, 2010	Susitna River Delta
R111	August 12, 2010	Susitna River Delta
R111	June 29, 2011	Susitna River Delta
R111	August 24, 2011	Knik Arm
R111	August 25, 2011	Knik Arm

Figure A60. Photograph of the right side and sighting history of beluga R111.



WHALE ID	Encounter Date	Area
R1103	August 22, 2008	Knik Arm
R1103	September 30, 2008	Chickaloon Bay/South Fire Island
R1103	August 19, 2011	Knik Arm

Figure A61. Photograph of the right side and sighting history of beluga R1103.



WHALE ID	Encounter Date	Area
R1092	July 24, 2008	Susitna River Delta
R1092	September 4, 2009	Knik Arm
R1092	August 30, 2010	Knik Arm
R1092	May 17, 2011	Susitna River Delta
R1092	August 18, 2011	Knik Arm
R1092	August 25, 2011	Knik Arm

Figure A62. Photograph of the right side and sighting history of beluga R1092.



WHALE ID	Encounter Date	Area
R109	August 18, 2005	Knik Arm
R109	September 7, 2005	Knik Arm
R109	September 8, 2005	Knik Arm
R109	September 9, 2005	Knik Arm
R109	September 14, 2005	Knik Arm
R109	September 15, 2005	Knik Arm
R109	September 19, 2005	Knik Arm
R109	September 21, 2005	Knik Arm
R109	September 7, 2006	Knik Arm
R109	September 9, 2006	Knik Arm
R109	September 16, 2006	Knik Arm
R109	September 23, 2006	Knik Arm
R109	September 25, 2006	Knik Arm
R109	October 3, 2006	Knik Arm
R109	July 27, 2007	Susitna River Delta
R109	August 14, 2007	Knik Arm
R109	July 24, 2008	Susitna River Delta
R109	July 29, 2008	Susitna River Delta
R109	August 6, 2008	Susitna River Delta
R109	August 3, 2009	Susitna River Delta
R109	August 5, 2009	Susitna River Delta
R109	August 9, 2009	Susitna River Delta
R109	August 19, 2009	Susitna River Delta
R109	July 21, 2010	Susitna River Delta
R109	July 29, 2010	Susitna River Delta
R109	July 13, 2011	Susitna River Delta
R109	August 14, 2011	Knik Arm
R109	August 16, 2011	Knik Arm
R109	August 18, 2011	Knik Arm
R109	August 19, 2011	Knik Arm

Figure A63. Photograph of the right side and sighting history of beluga R109.



WHALE ID	Encounter Date	Area
R1086	September 12, 2006	Turnagain Arm
R1086	July 15, 2008	Susitna River Delta
R1086	August 3, 2009	Susitna River Delta
R1086	August 25, 2011	Knik Arm

Figure A64. Photograph of the right side and sighting history of beluga R1086.



WHALE ID	Encounter Date	Area
R1080	July 24, 2008	Susitna River Delta
R1080	August 9, 2009	Susitna River Delta
R1080	August 18, 2011	Knik Arm

Figure A65. Photograph of the right side and sighting history of beluga R1080.



WHALE ID	Encounter Date	Area
R1048	July 29, 2008	Susitna River Delta
R1048	September 2, 2008	Knik Arm
R1048	September 4, 2009	Knik Arm
R1048	September 7, 2011	Knik Arm

Figure A66. Photograph of the right side and sighting history of beluga R1048.



WHALE ID	Encounter Date	Area
R103	June 6, 2005	Susitna River Delta
R103	July 31, 2005	Susitna River Delta
R103	August 18, 2005	Knik Arm
R103	September 7, 2005	Knik Arm
R103	September 9, 2005	Knik Arm
R103	September 15, 2005	Knik Arm
R103	October 5, 2005	Knik Arm
R103	June 17, 2006	Susitna River Delta
R103	August 7, 2006	Susitna River Delta
R103	September 9, 2006	Knik Arm
R103	September 16, 2006	Knik Arm
R103	September 23, 2006	Knik Arm
R103	September 25, 2006	Knik Arm
R103	September 27, 2006	Knik Arm
R103	July 27, 2007	Susitna River Delta
R103	August 16, 2007	Knik Arm
R103	September 27, 2007	Knik Arm
R103	July 15, 2008	Susitna River Delta
R103	July 22, 2008	Susitna River Delta
R103	July 24, 2008	Susitna River Delta
R103	July 29, 2008	Susitna River Delta
R103	August 18, 2008	Knik Arm
R103	August 22, 2008	Knik Arm
R103	September 27, 2008	Turnagain Arm
R103	August 19, 2009	Susitna River Delta
R103	July 21, 2010	Susitna River Delta
R103	August 20, 2010	Susitna River Delta
R103	August 30, 2010	Knik Arm
R103	August 18, 2011	Knik Arm

Figure A67. Photograph of the right side and sighting history of beluga R103.



WHALE ID	Encounter Date	Area
R1008	September 26, 2008	Knik Arm
R1008	August 15, 2011	Knik Arm
R1008	August 16, 2011	Knik Arm
R1008	August 17, 2011	Knik Arm
R1008	August 18, 2011	Knik Arm

Figure A68. Photograph of the right side and sighting history of beluga R1008.
Photo courtesy of Stacy DeRuiter.



WHALE ID	Encounter Date	Area
R1004	July 22, 2008	Susitna River Delta
R1004	July 29, 2008	Susitna River Delta
R1004	August 5, 2009	Susitna River Delta
R1004	August 19, 2009	Susitna River Delta
R1004	July 21, 2010	Susitna River Delta
R1004	August 6, 2010	Susitna River Delta
R1004	September 7, 2011	Knik Arm
R1004	September 14, 2011	Knik Arm

Figure A69. Photograph of the right side and sighting history of beluga R1004.

APPENDIX B

**INDIVIDUAL SIGHTING-HISTORY MAPS AND RIGHT-SIDE
PHOTOGRAPHS OF CATALOGED WHALES IDENTIFIED IN 2011 IN KNIK
ARM THAT WERE ALSO SEEN IN EVERY PREVIOUS YEAR OF THE STUDY
(2005-2011).**

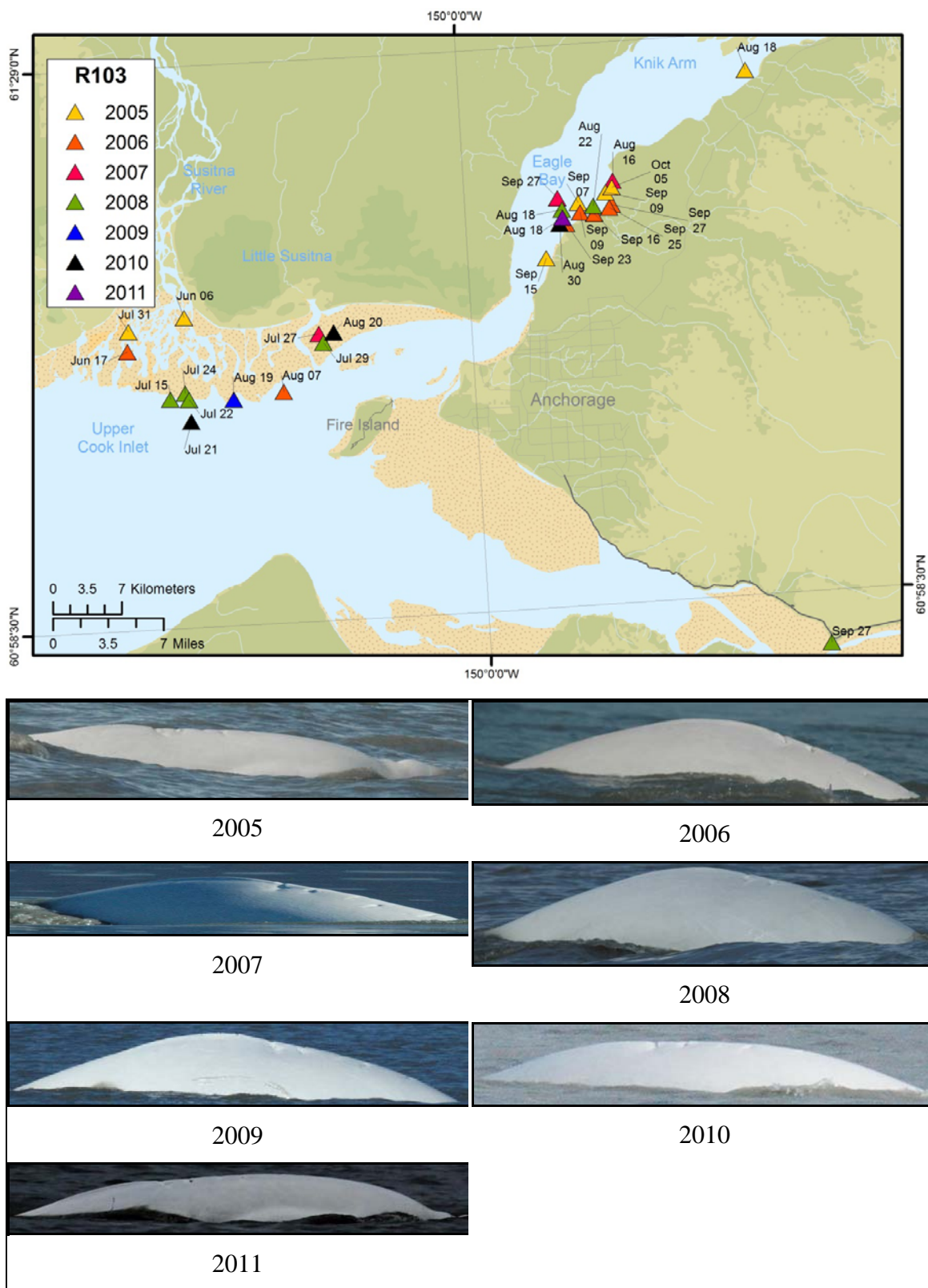


Figure B1. Sighting history and yearly photographs of beluga R103. This beluga was seen every year of the 2005-2011 study period.

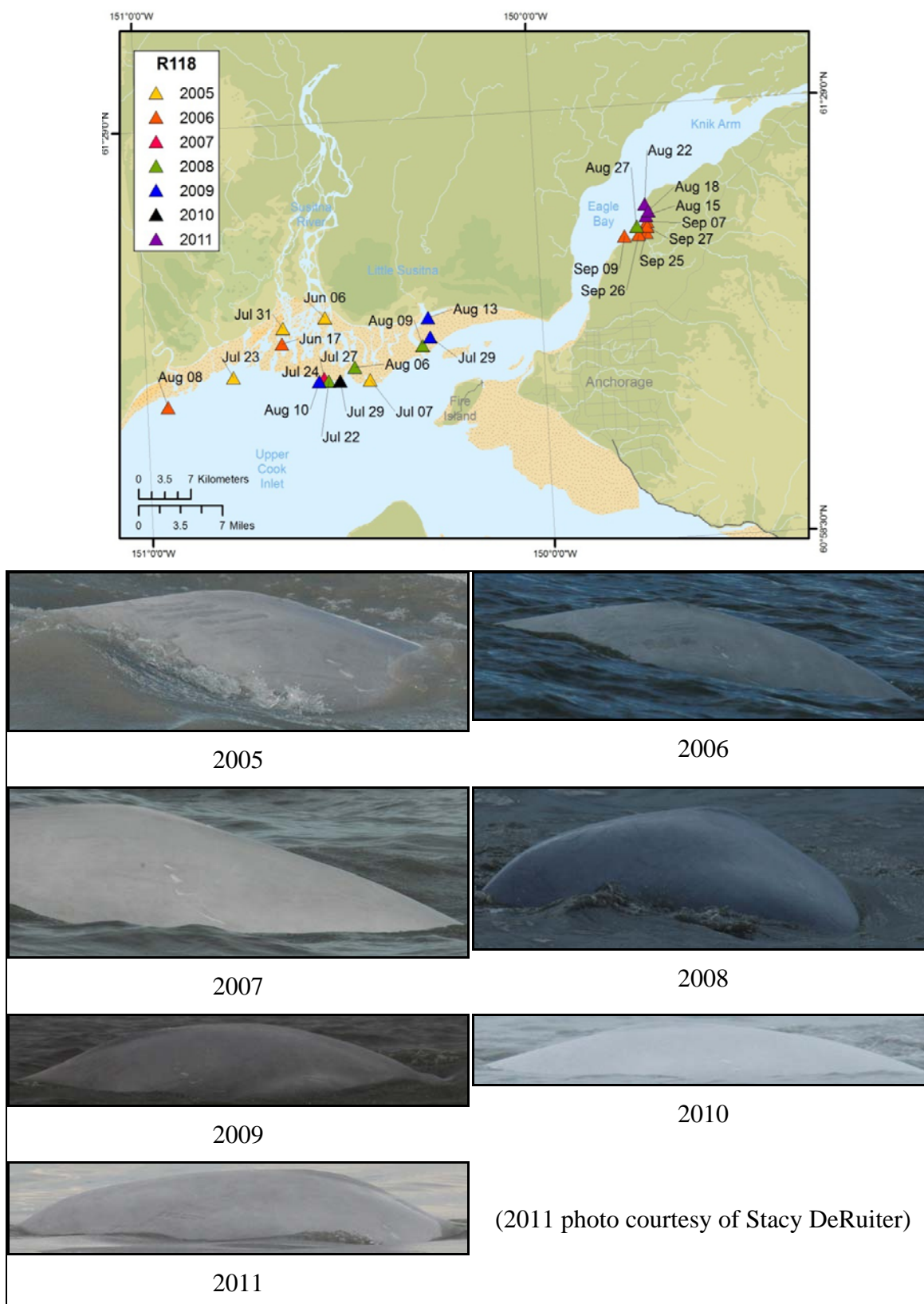


Figure B3. Sighting history and yearly photographs of beluga R118. This beluga was seen every year of the 2005-2011 study period.

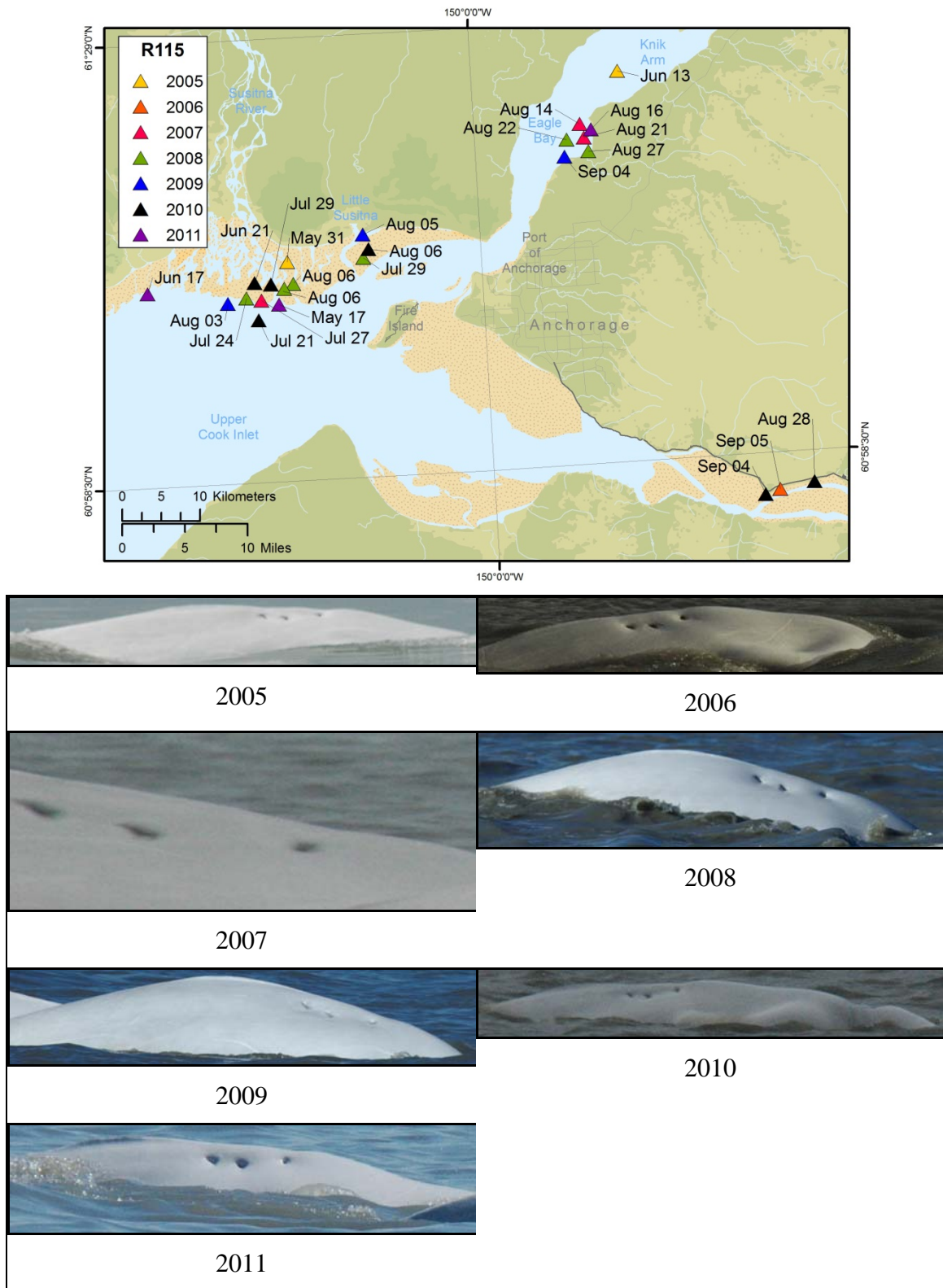


Figure B4. Sighting history and yearly photographs of beluga R115. This beluga was seen every year of the 2005-2011 study period.

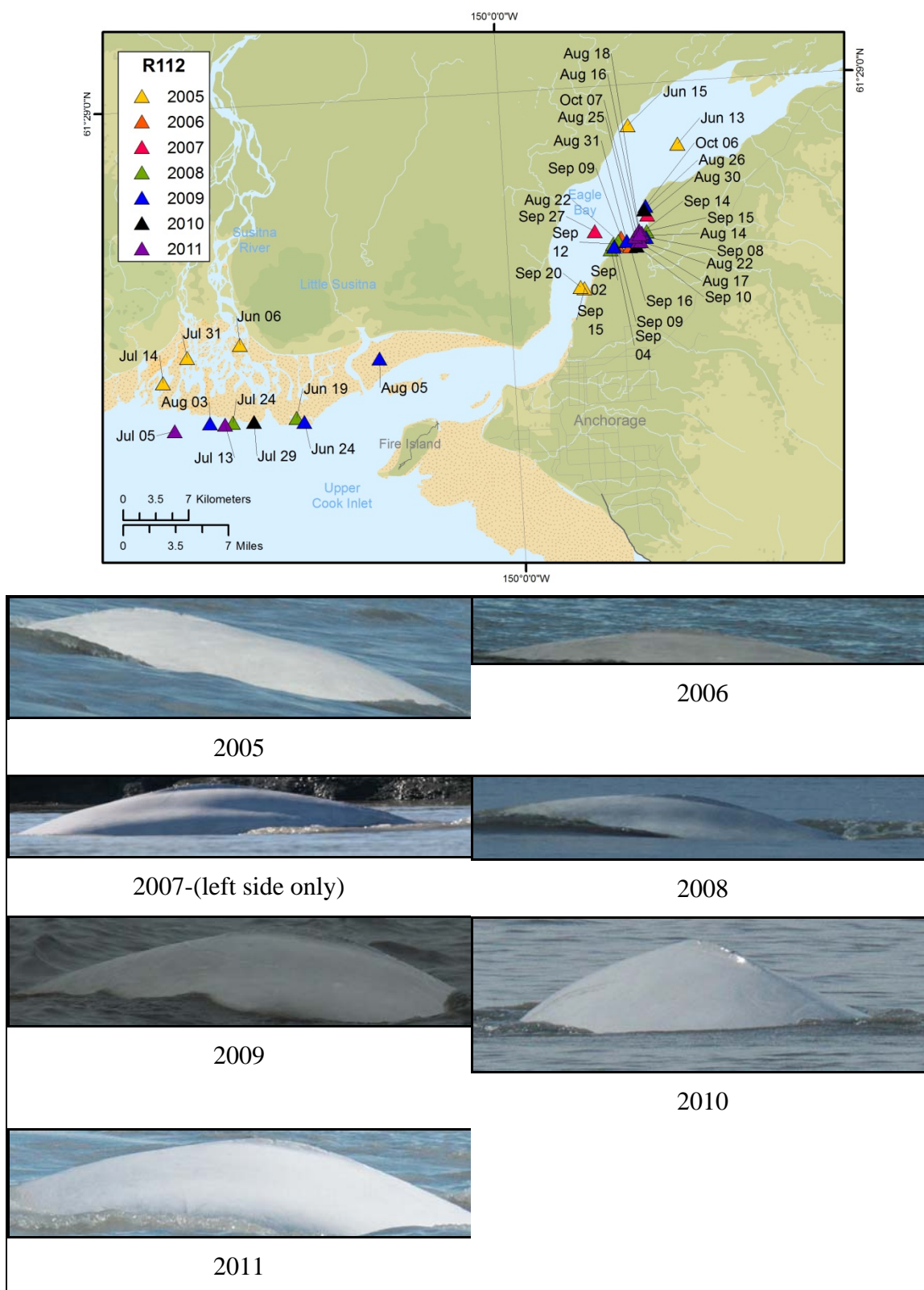


Figure B5. Sighting history and yearly photographs of beluga R112. This beluga was seen every year of the 2005-2011 study period.

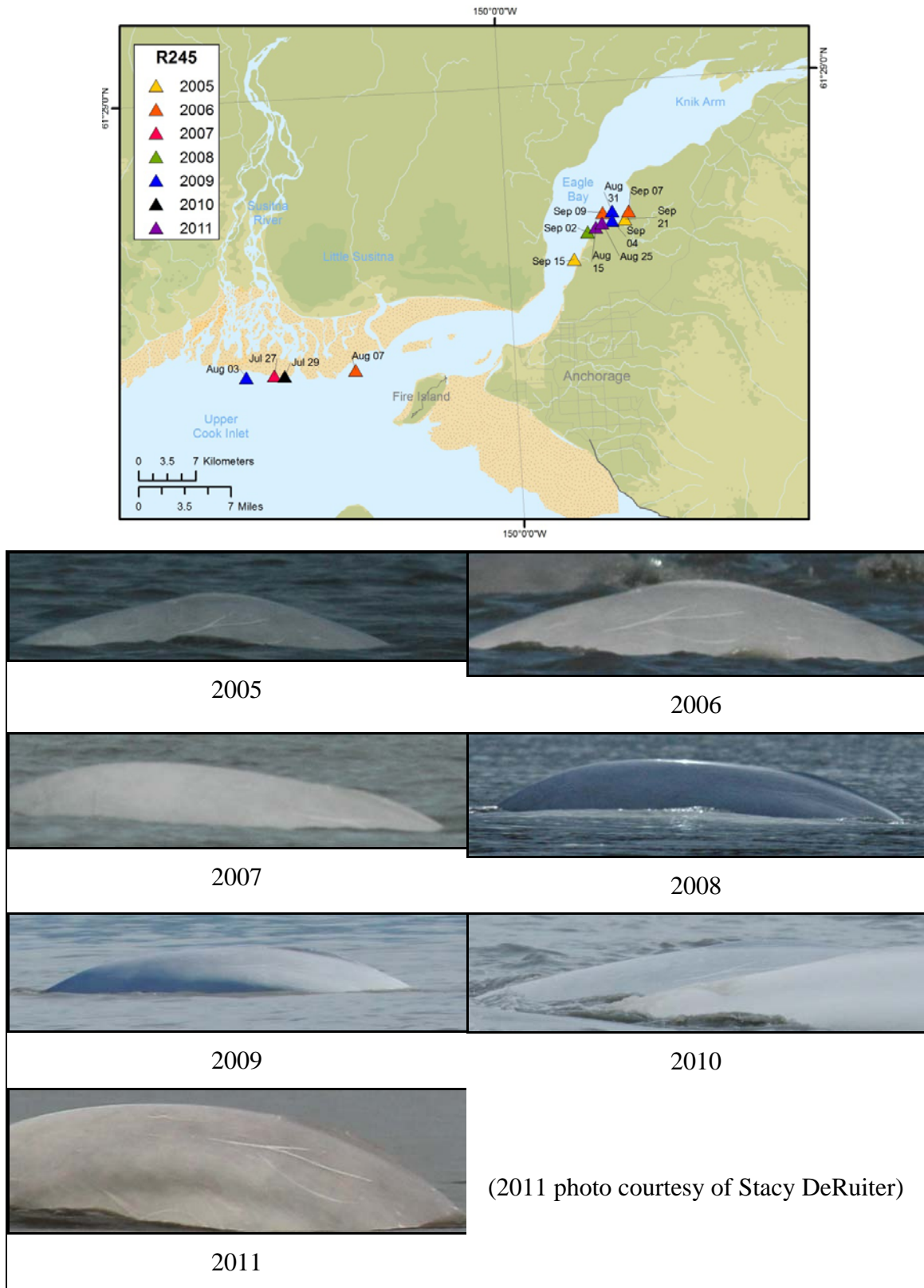


Figure B6. Sighting history and yearly photographs of beluga R245. This beluga was seen every year of the 2005-2011 study period.

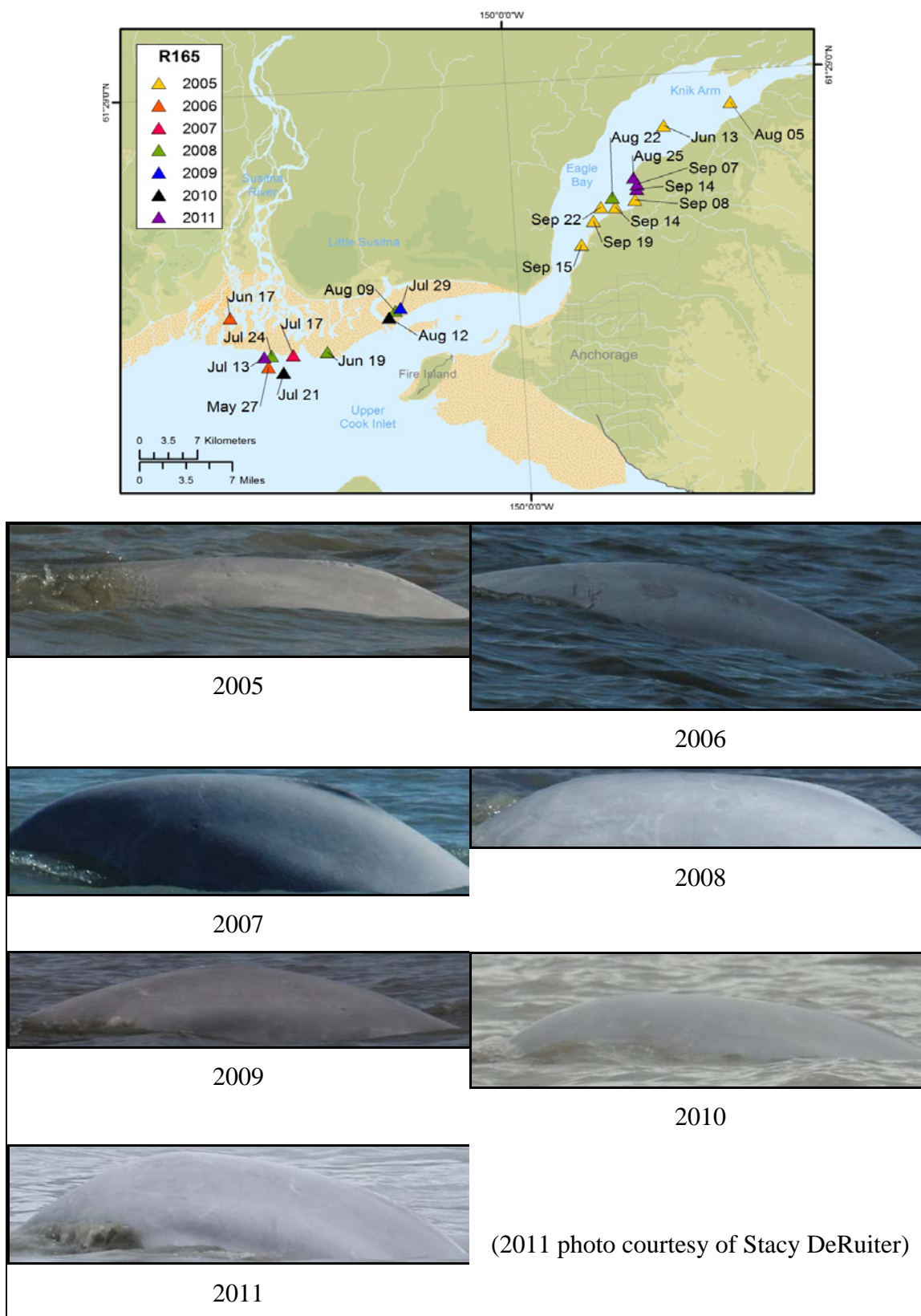


Figure B7. Sighting history and yearly photographs of beluga R165. This beluga was seen every year of the 2005-2011 study period.

APPENDIX C

**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.**

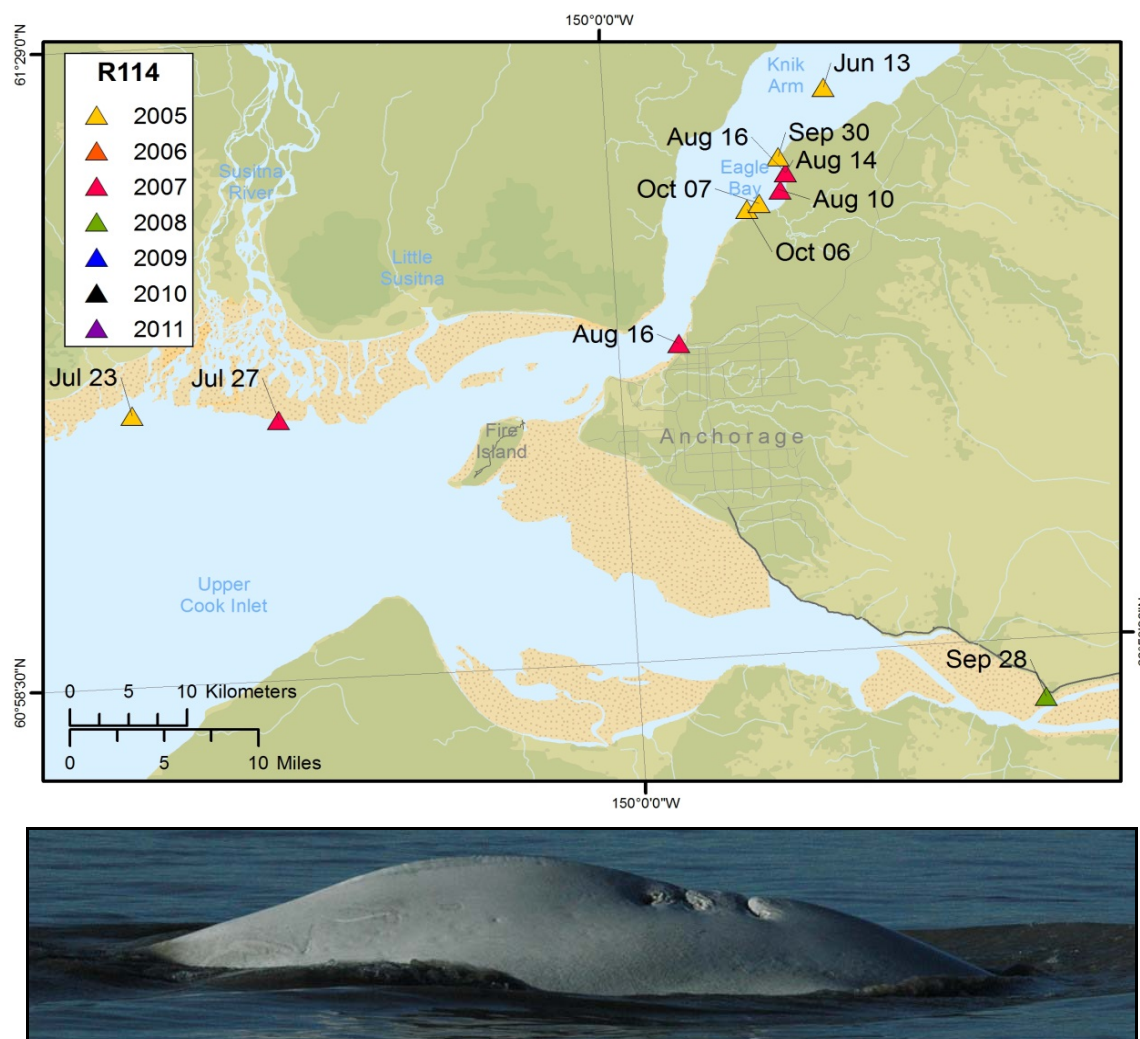


Figure C1. Sighting history and photograph of beluga R114. This beluga was tagged by NMFS sometime between 1999 and 2002.

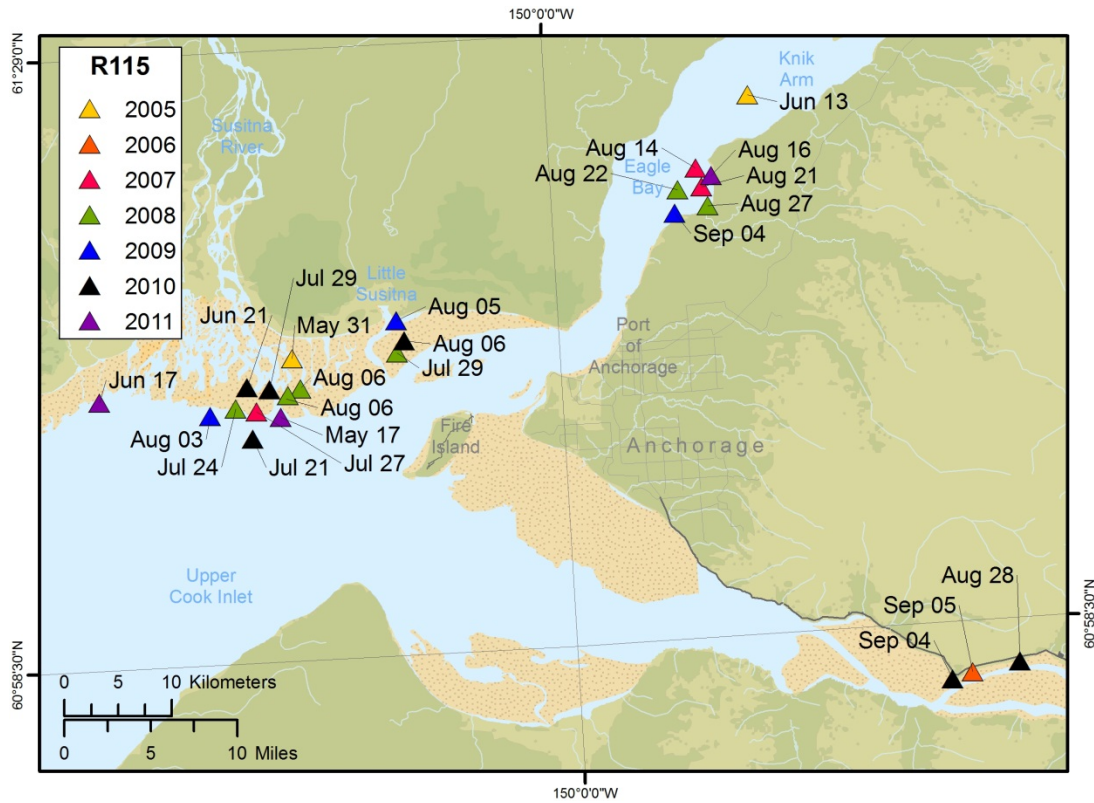


Figure C2. Sighting history and photograph of beluga R115. This beluga was tagged by NMFS sometime between 1999 and 2002. This beluga is a presumed mother based on photographs with an accompanying calf.

LGL Alaska Research Associates, Inc.

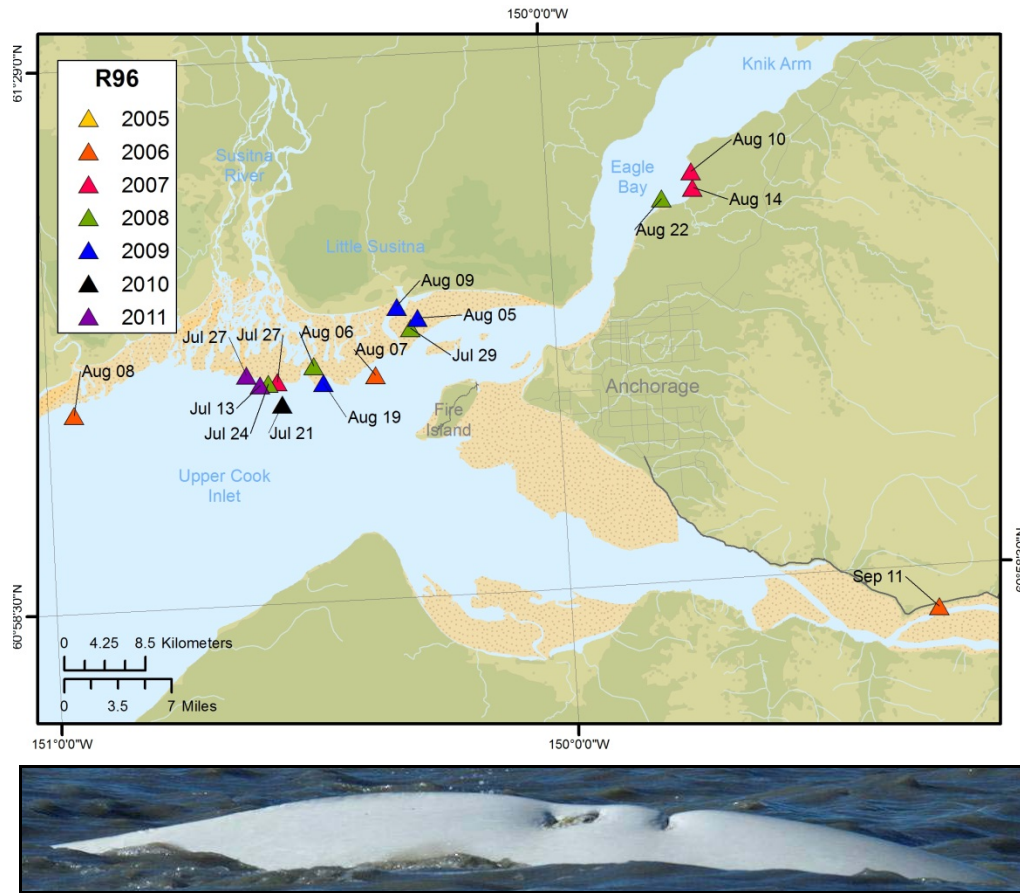


Figure C4. Sighting history and photograph of beluga R96. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf.

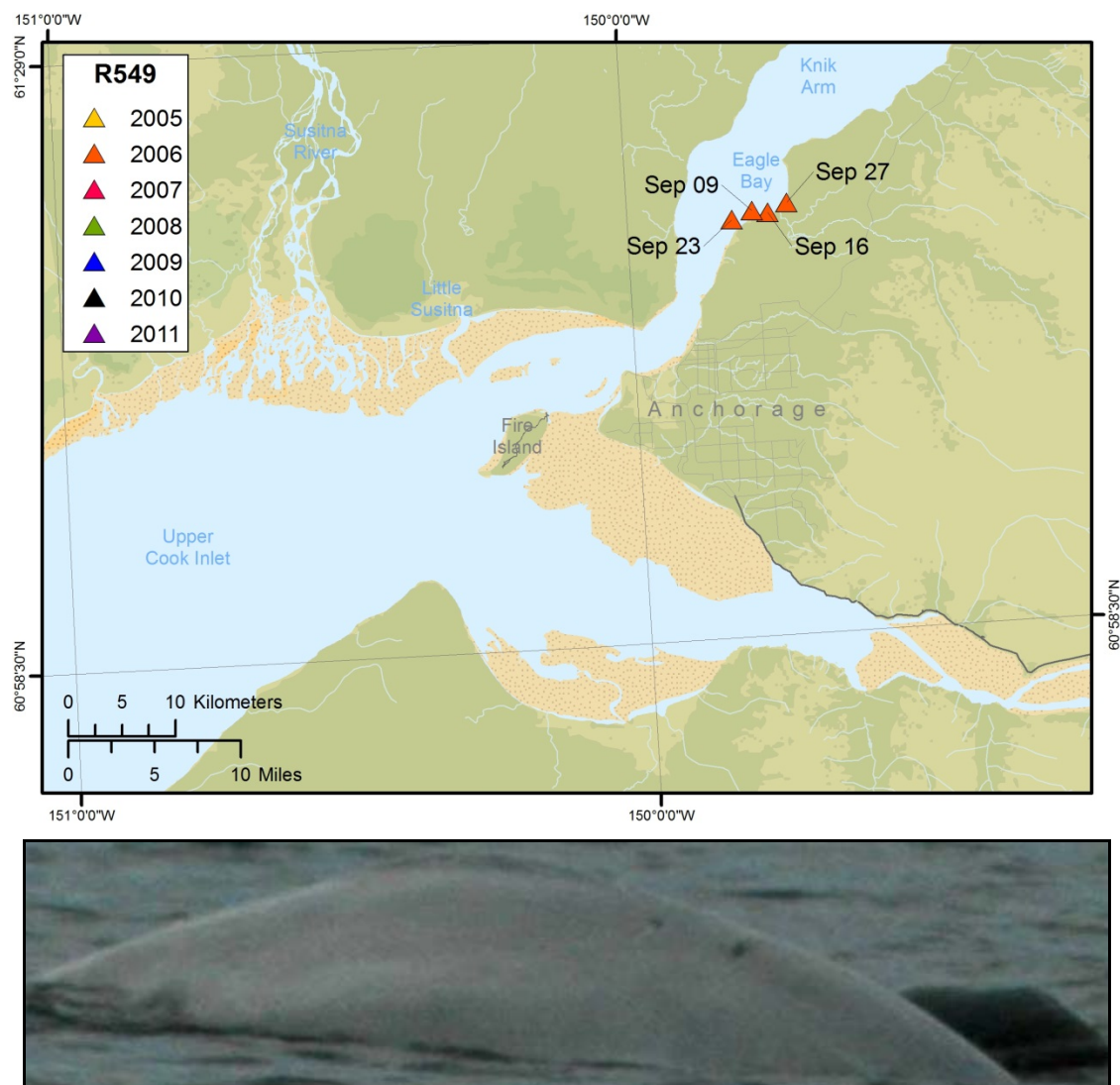


Figure C5. Sighting and photograph of beluga R549. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf.

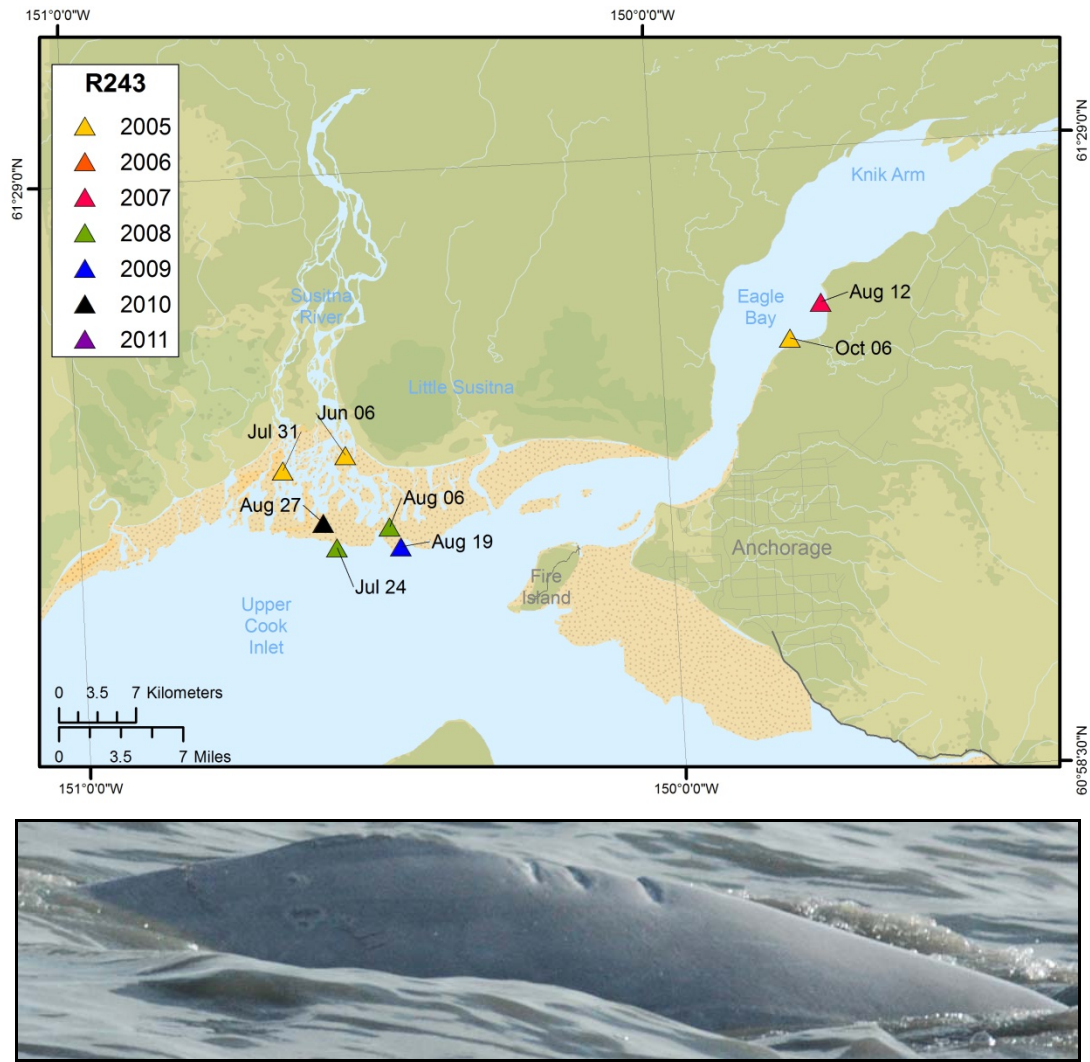


Figure C6. Sighting and photograph of beluga R243. This beluga was tagged by NMFS sometime between 1999 and 2002.

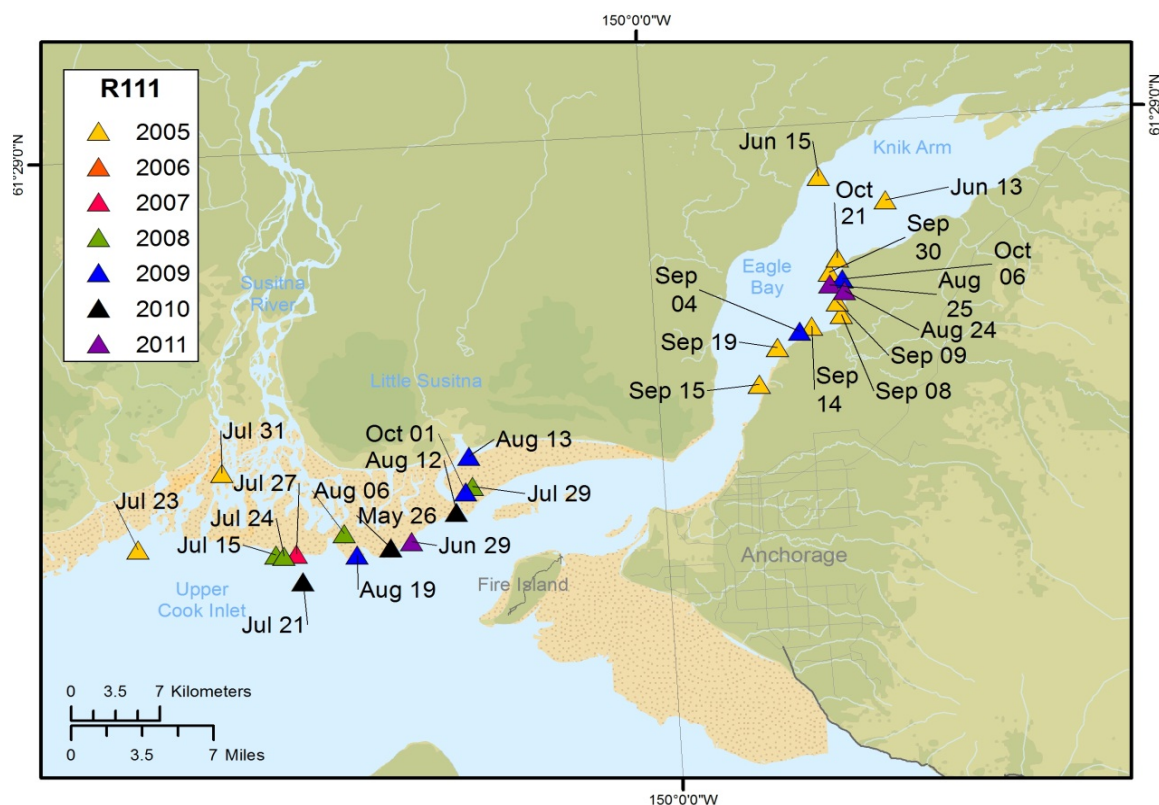


Figure C7. Sighting and photograph of beluga R111. This beluga was tagged by NMFS sometime between 1999 and 2002, and is a presumed mother based on photographs with an accompanying calf.

APPENDIX D

**EXAMPLES OF MARK TYPES IDENTIFIED FOR BELUGA WHALES
PHOTOGRAPHED IN KNIK ARM IN 2011.**

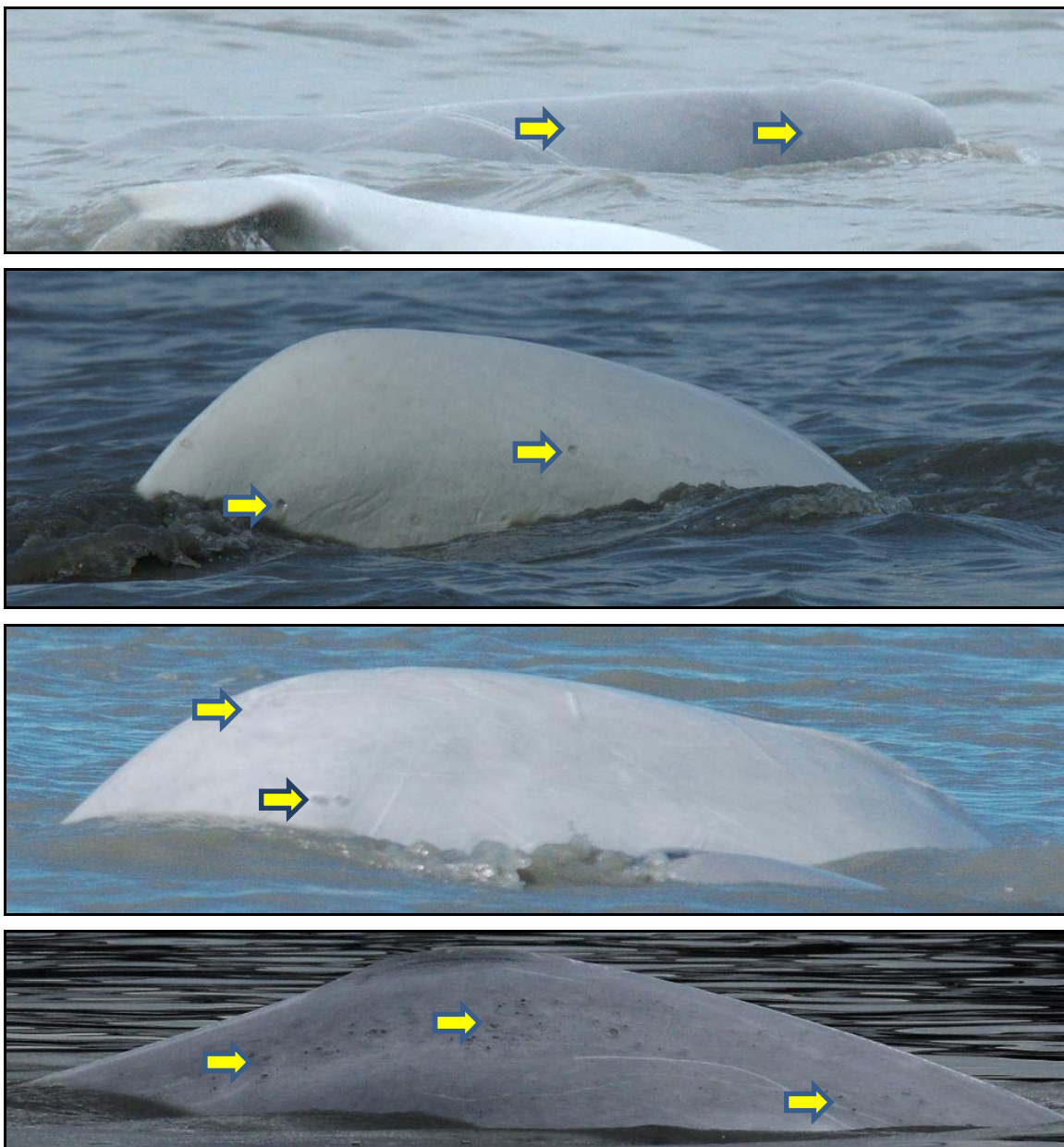


Figure D1. Examples of marks classified as “Infection”. (Final photo courtesy of 2011 Stacy DeRuiter).

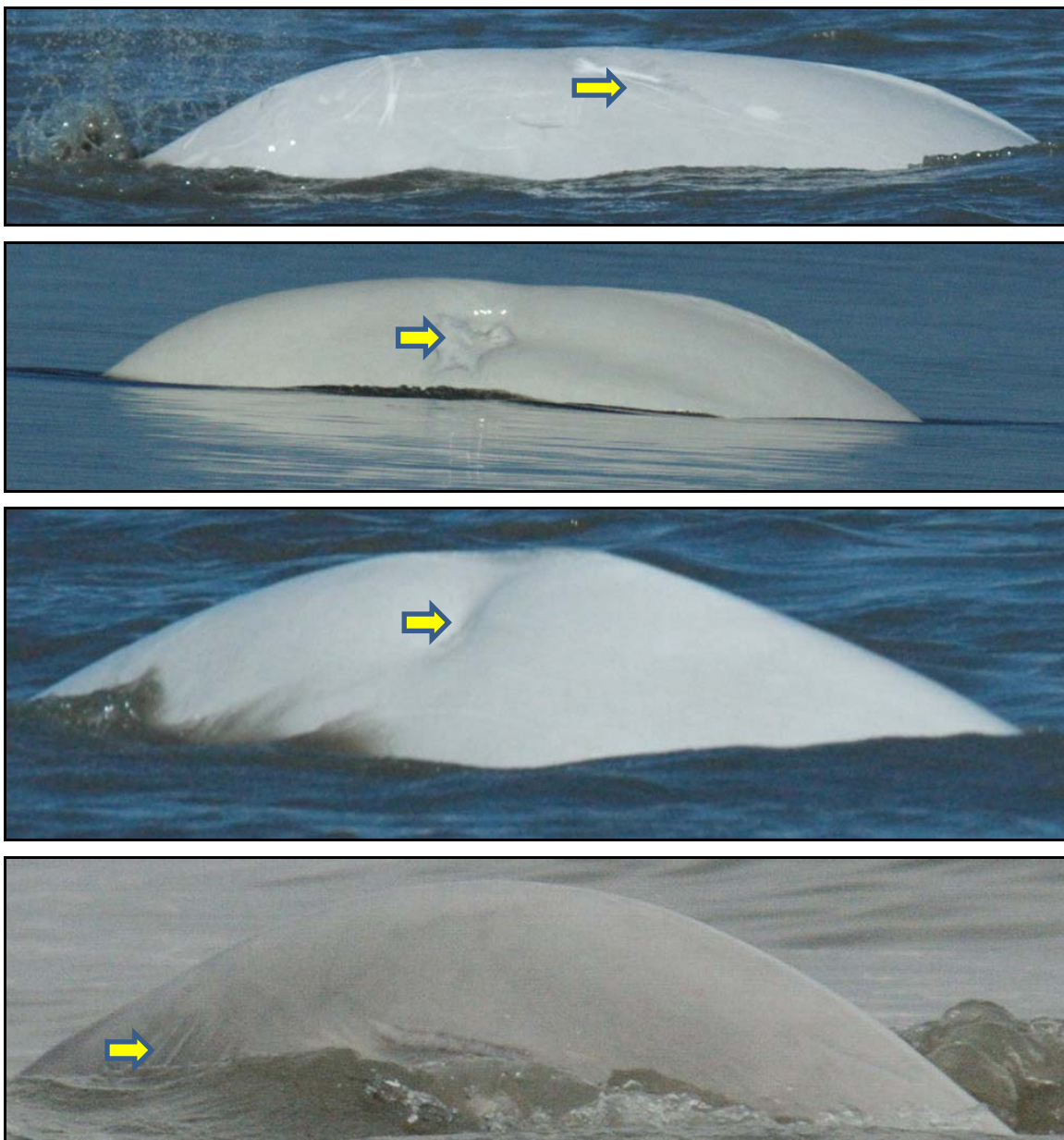


Figure D2. Examples of marks classified as “Trauma”. These marks could be caused by vessel strikes (bow or propeller), guns, harpoons, or unknown sources.

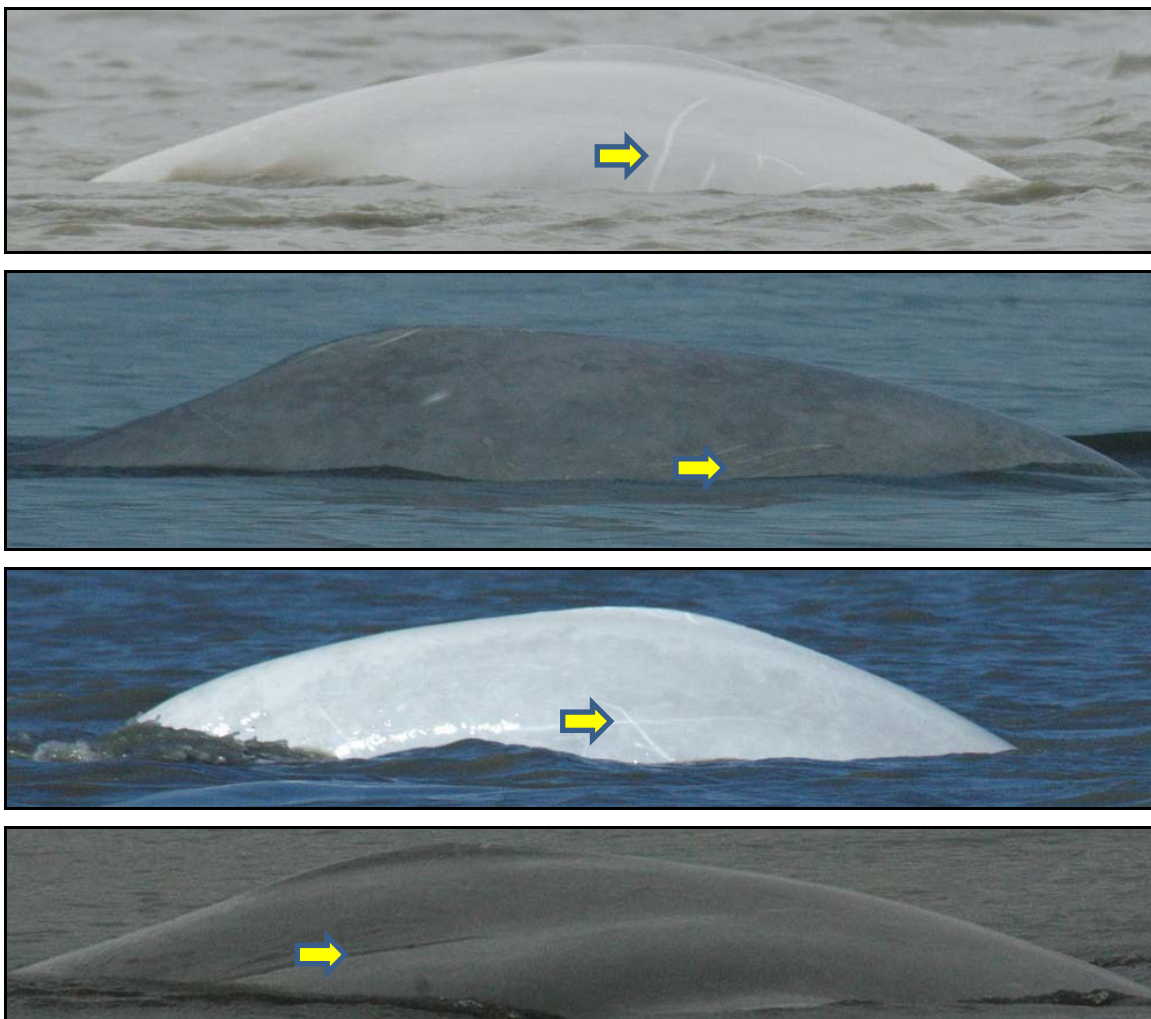


Figure D3. Examples of marks classified as “Rake Marks”. Rake marks may be caused by teeth (of other belugas, orcas, or seals) or claws (harbor seals).

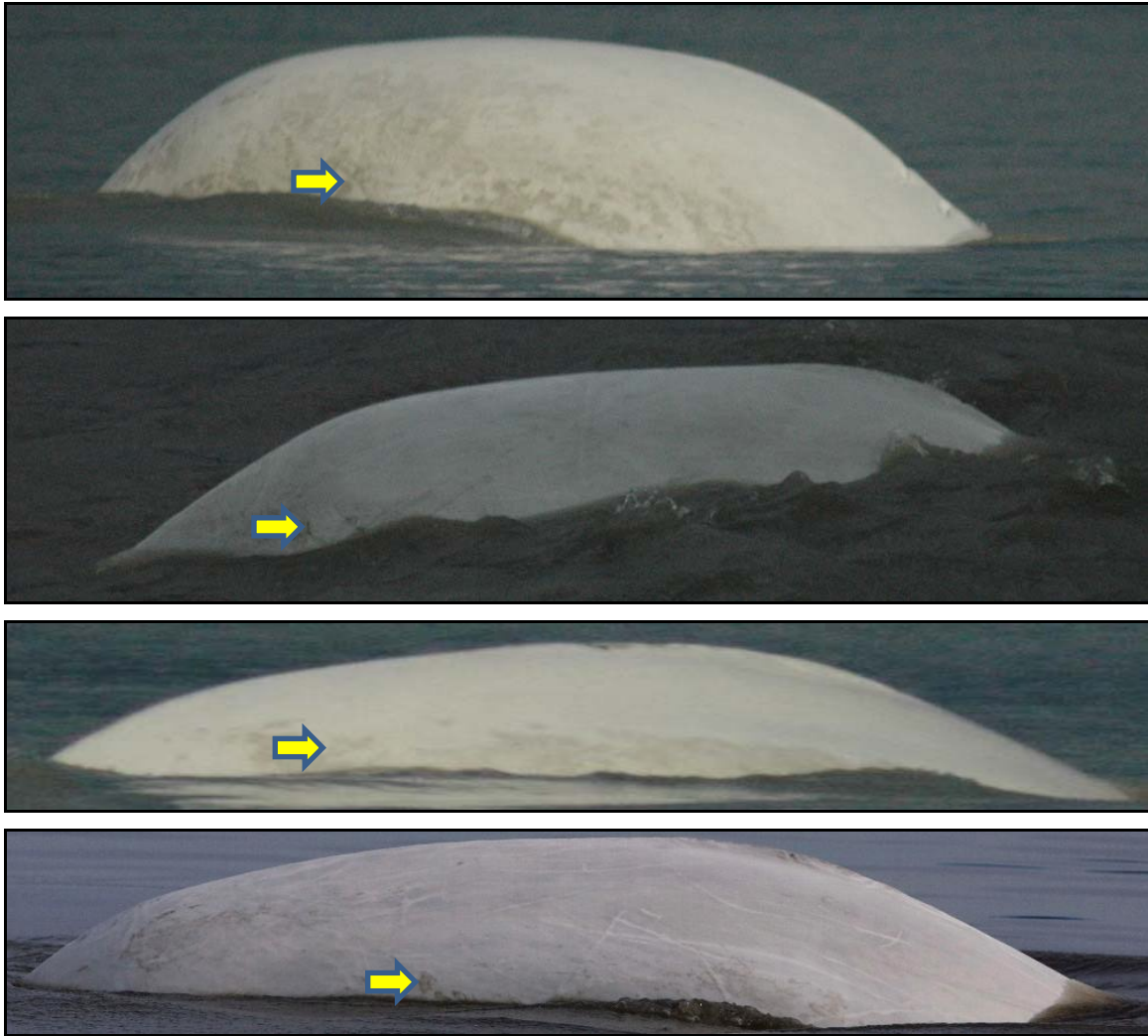


Figure D4. Examples of marks classified as “Possible Molting”. These marks may also be from mud/silt and/or disease. (Final photo courtesy of Department of Defense/JBER)



Figure D5. Example of marks classified as “Satellite Tag Scars”. This scar also appears to be infected in this photograph. See Appendix C for more examples of whales with scars from satellite tags.

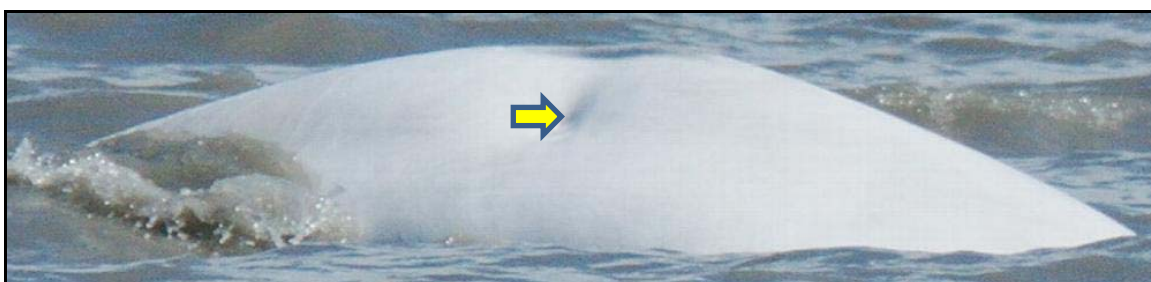


Figure D6. Examples of marks classified as “Puncture Wounds”. Wounds may be caused by gunshots, harpoons, or unknown sources. These wounds are also classified as “Trauma”. Wounds caused by satellite tags are not classified as puncture wounds or trauma.



Figure D7. Examples of mark classified as “Entanglement”.

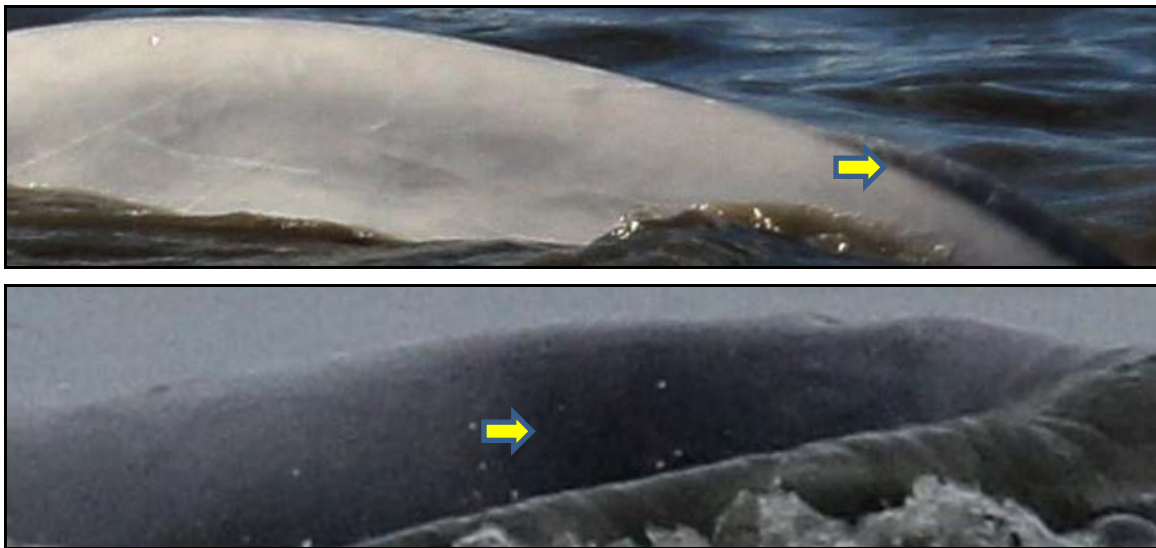


Figure D8. Examples of mark classified as “Pigment”. Both photos courtesy of Stacy DeRuiter.



Figure D9. Examples of mark classified as “Mud/Silt”. These marks could also be from molting and/or disease. The bottom photo is courtesy of the Department of Defense/JBER.