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AERIAL SURVEYS OF BELUGA WHALES (*DELPHINAPTERUS LEUCAS*) IN COOK INLET, ALASKA, JUNE 2014

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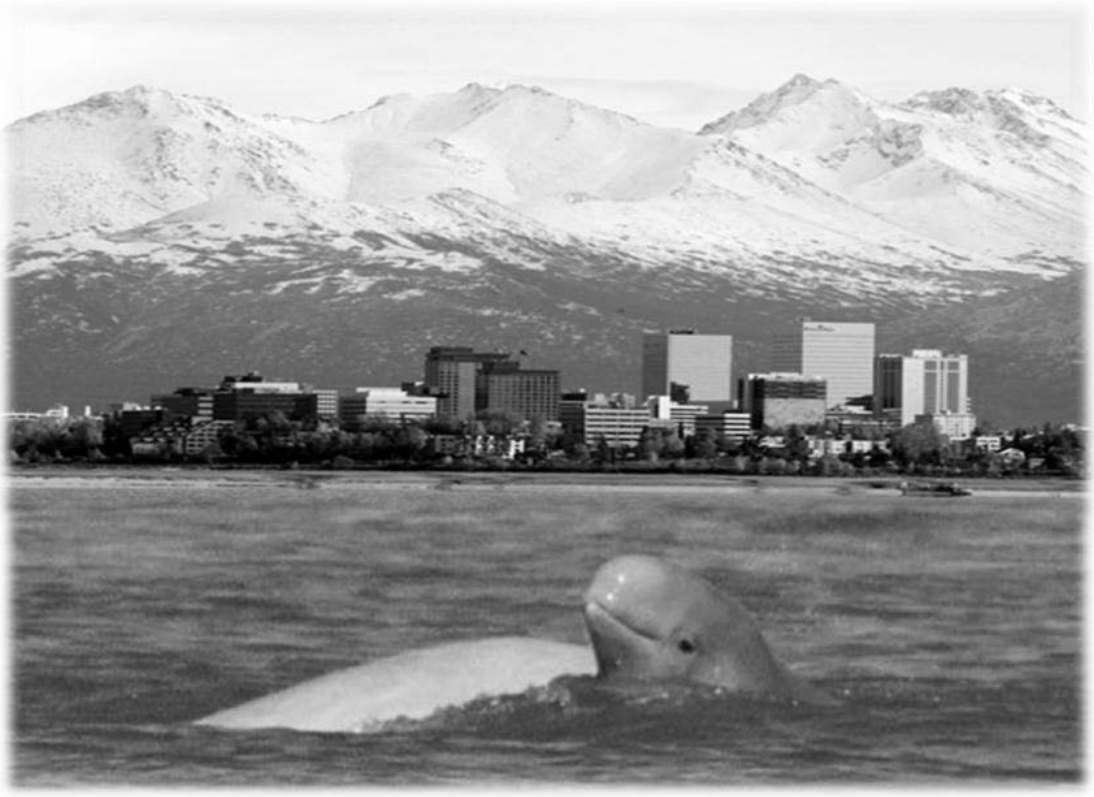

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ABSTRACT

The National Marine Fisheries Service (NMFS) has conducted aerial surveys of the beluga population in Cook Inlet, Alaska, each June, July, or both from 1993 to 2012, after which biennial surveys began in 2014. The current document presents survey results and subsequent analyses yielding an abundance estimate and population trend based on data collected during June 2014. Surveys occurred 3-12 June 2014 (52 flight hours). All surveys were flown in twin-engine, high-wing aircraft (i.e., an Aero Commander) at a target altitude of 244 m (800 ft) and speed of 185 km/hour (100-120 knots), consistent with NMFS' surveys of Cook Inlet conducted in previous years. Tracklines were flown 1.4 km from the shoreline, along the entire Cook Inlet coast, including islands. Additionally, sawtooth pattern tracklines were flown across the inlet. These aerial surveys effectively covered 32% of the total surface area of Cook Inlet and 100% of the coastline. In particular, most of the upper inlet, north of the Forelands where beluga whales are consistently found, was surveyed six times (out of eight attempts). Paired, independent observers searched on the coastal side of the plane, where virtually all beluga sightings occur, while a single observer searched on the inlet side. A computer operator/data recorder periodically monitored distance from the shoreline (1.4 km) with a clinometer (angle 10°). After finding beluga groups, a series of aerial passes allowed all observers to each make four or more independent counts of every group (i.e., typically 16 counts of each group conducted during eight passes). In addition, whale groups were video recorded for later analysis and more precise counts in the laboratory.

Belugas were not seen in lower Cook Inlet (south of East and West Foreland) nor in the upper inlet south of North Foreland and Moose Point. Much of the survey period occurred during low tides that were 5 to 7 ft versus negative low tides, which expose vast expanses of mudflats and typically line up whales within the deeper channels. Because of this, whale groups tended to be more dispersed over the unexposed mudflats in the Susitna delta and Chickaloon Bay. Beluga groups were found from Chuitna River to the Little Susitna River in the Susitna delta, scattered from the Susitna delta to Point Possession, and from Chickaloon River to the bluffs approaching Point Possession. The annual sums of medians from aerial counts provide an index of relative abundance, not corrected for estimates of whales missed. Daily overall medians ranged from 231

to 352 whales. The annual median index count of 352 whales represents the highest median count to date for this project. Corrected group sizes ranged from 2 to 168 whales (SD = 53). Similar to the past five survey years, whales were not found in Knik Arm. The greatest numbers were found in the Susitna delta (average group size = 71, range: 2 - 168) compared to Chickaloon Bay (average groups size = 22, range: 2 - 79). The abundance estimate was based on 3 days of surveys (9-11 June) where coverage of the upper inlet was complete and observer counts with (11 groups) and without (4 groups) video recordings were obtained for every beluga whale group observed. The abundance estimate of 340 (*CV* = 0.08, 95% CI = [291,398], N_{min} = 318) falls within the range of abundance estimates from the last 10 survey years (312 - 375 whales). The 10-year trend (2004-2014) was -0.4% /year with a SE of 1.3% (i.e., a declining trend: *P* (< 0.0) = 62%). During the period since management of the hunt began (1999-2014), the trend was -1.3% /year with a SE of 0.7% (i.e., a declining trend: *P* (< 0.0) = 97%).

CONTENTS

INTRODUCTION

Beluga whales (*Delphinapterus leucas*) inhabit waters surrounding Alaska from Yakutat Bay to the Alaska/Yukon Territory boundary (Hazard 1988). Five stocks are recognized in this region: Cook Inlet, Bristol Bay, Eastern Bering Sea, Eastern Chukchi Sea, and Beaufort Sea (O'Corry-Crowe et al. 1997, Allen and Angliss 2013). The most isolated of these is the Cook Inlet stock, separated from the others by the Alaska Peninsula (Laidre et al. 2000). Beluga whales in Cook Inlet gather in river mouths and bays during the summer months (Rugh et al. 2000a, 2005a, 2010). The small population size (fewer than 400 whales; Hobbs et al. 2000a, in press) and geographic and genetic isolation of the whales in Cook Inlet (O'Corry-Crowe et al. 1997, Laidre et al. 2000, Rugh et al. 2000a), in combination with their strong site fidelity, has made this stock vulnerable to anthropogenic impacts. Until 1999, these whales were subject to an unregulated Native subsistence hunt (Mahoney and Shelden 2000), but on 31 May 2000, the stock of belugas in Cook Inlet was designated as depleted under the U.S. Marine Mammal Protection Act (65 Fed. Reg. 34590) and is now managed with a small, regulated, subsistence hunt by Alaska Natives (65 Fed. Reg. 59164). The Cook Inlet population was designated a Distinct Population Segment and listed as endangered under the U.S. Endangered Species Act (73 Fed. Reg. 62919) in October 2008.

Each June, July, or both from 1993 to 2012, the National Marine Fisheries Service (NMFS) conducted annual aerial surveys to study the distribution and abundance of beluga whales in Cook Inlet (Withrow et al. 1994; Rugh et al. 1995, 1996, 1997a, 1997b, 1999, 2000a, 2001, 2002, 2003, 2004; 2005a, 2006, 2007; Shelden et al. 2008, 2009, 2010, 2011, 2012)[1]. Results from 1993 to 2000, 2001 to 2004, and 2005 to 2012 were published in Rugh et al. (2000b, 2005b) and Shelden et al. (2013), respectively. After 2012, NMFS adopted a biennial survey schedule (Hobbs 2013) resuming abundance estimates with the June 2014 survey. Surveys were conducted in cooperation with the Cook Inlet Marine Mammal Council (CIMMC) and the Alaska Beluga Whale Commission (ABWC). Aerial surveys have proven to be an

[1] These field reports contained data considered provisional and have subsequently been revised and published in the peer-review literature as Rugh et al. (2000b, 2005b) and Shelden et al. (2013).

efficient method for collecting distribution and abundance data for beluga whales in Cook Inlet and were used for many years prior to the start of the NMFS surveys, though no complete systematic census had been conducted (e.g., Klinkhart 1966, Murray and Fay 1979, Calkins 1984, Shelden et al. in review). The NMFS studies have been the most thorough and intensive in terms of coverage and effort (Shelden et al. in review). The primary objectives for the current study were to document sighting locations and count beluga whales in Cook Inlet while maintaining continuity with preceding studies to allow for inter-year trend analyses. This document presents data collected in June 2014, the first year of surveys after adopting a biennial survey schedule for this project (Hobbs 2013).

Study Area

Cook Inlet is a major inland sea in south-central Alaska covering approximately 20,000 km^2 (Fig. 1). The southern boundary, which opens to the Gulf of Alaska, is approximately 85 km across from Cape Douglas to Elizabeth Island. The northern limit, at the Susitna River, is 315 km north of Cape Douglas. From there two substantial tidal estuaries extend to the northeast (Knik Arm, roughly 55 km long) and southeast (Turnagain Arm, 75 km long). The shoreline of Cook Inlet (1,810 km) is highly irregular and interrupted by many rivers and creeks which contribute considerable freshwater input and glacial melt into the inlet. Detritus from glacial erosion and strong tidal fluxes keep the waters of upper Cook Inlet (north of East Foreland and West Foreland) extremely turbid and nearly opaque with silt. A description of beluga habitat in Cook Inlet can be found in Moore et al. (2000) and Goetz et al. (2007, 2012a). Anchorage, the largest city in Alaska, served as the base of operations for these aerial surveys.

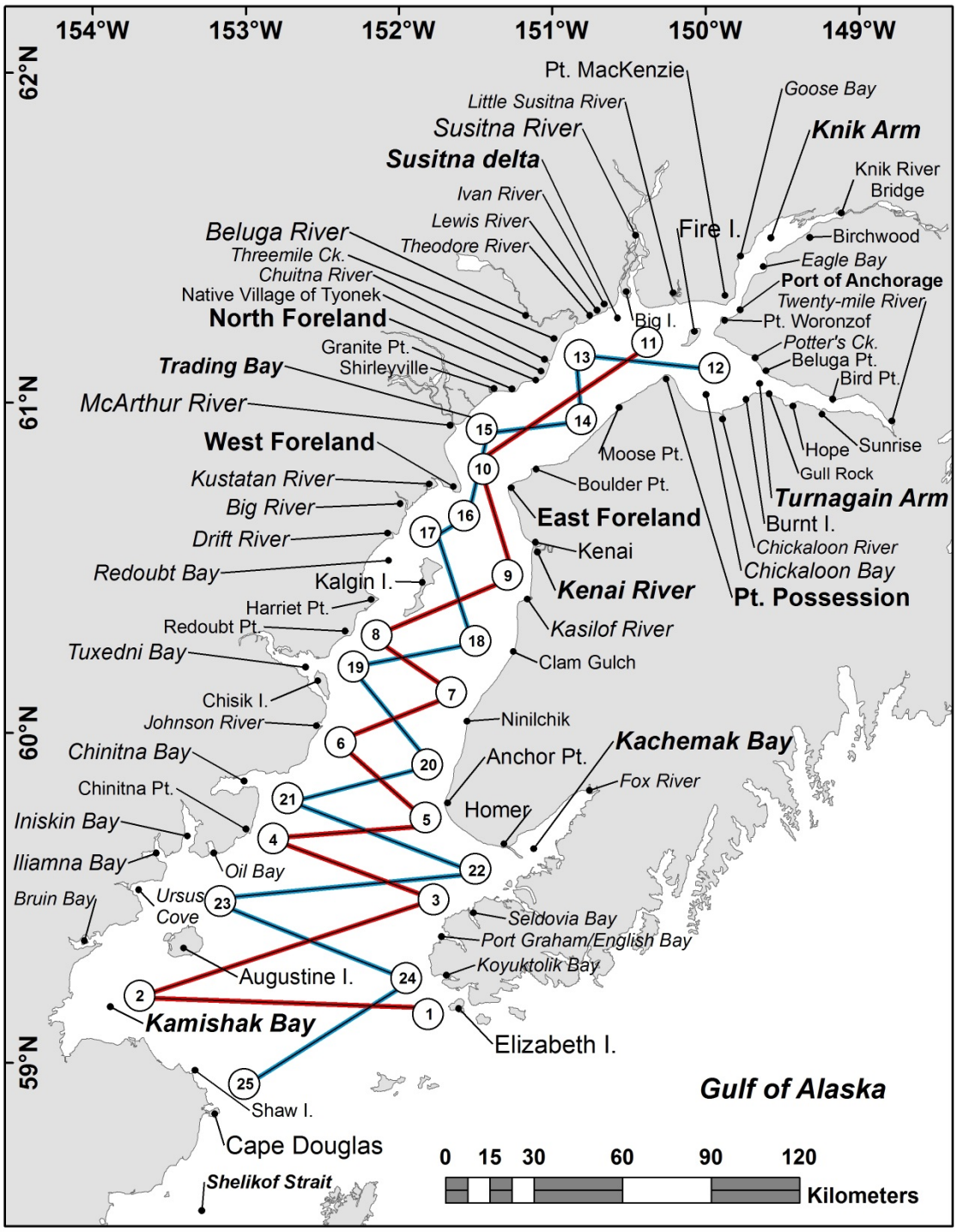

Figure 1. -- Cook Inlet, Alaska, with place names mentioned in text, and mid-inlet sawtooth tracklines flown during beluga whale surveys in June 2014.

METHODS

Aircraft and Data Entry

In June 2014, the survey aircraft was a twin engine, high wing Aero Commander 690 (tail number: *N690AX*) with 6 to 8-hour flying capability. Bubble windows were inserted at the forward observer positions to maximize the search area. The left-rear observer window was flat (Fig. 2). An opening window allowed for video recording and photography. Two observers were positioned on the coastal side of the aircraft providing independent search effort on the side where virtually all beluga whales were seen. A single observer searched on the mid-inlet side of the aircraft because of the paucity of beluga sightings more than 3 km from the coast. A data recorder sat at a computer desk in the rear portion of the aircraft. The data recorder and pilots also searched for belugas but were instructed not to alert observers until a sighting was beyond view.

Figure 2. --Twin engine, high wing Aero Commander 690 survey platform used during Cook Inlet beluga whale aerial surveys, June 2014 (photo courtesy of Clearwater Air, Inc.).

An intercom system provided communication among the observers, data recorder, and pilots. Seating positions were noted each time the survey team changed positions and tasks (i.e., video recording, data recording, observing/counting). Location data were collected from a portable global positioning system (GPS) interfaced with the laptop computer used to enter sighting data. Data entries included routine updates of time, location (latitude/longitude), beginning and end of search effort, percent cloud cover, sea state (Beaufort scale as a function of the wind on the water surface), glare (on the coastal and mid-inlet sides of the plane), and visibility (on the coastal and mid-inlet sides of the plane).

Visibility was documented in five subjective categories from excellent to useless. Best counting conditions (excellent visibility) were when Beaufort sea state was less than 3 (no white caps), there was a light overcast (reduced glare), the sun was well above the horizon (good lighting), windows were clean (no dust particles or smears to distract from sighting effort), and the observer was comfortable (no back pain, air sickness, etc., which can reduce search effort). Areas where visibility was considered poor or useless (as determined by the left-forward observer) were treated in the analysis as unsampled. Only the typical search area (e.g., > 10° below the horizon and 10° to 60° to the side) was considered when selecting a visibility category.

Tracklines

Coastal surveys were conducted approximately 1.4 km from the shoreline or exposed mudflat edge. The objective was to search all nearshore, shallow waters where belugas are typically seen in late spring/early summer (Rugh et al. 2000b, 2005b; Shelden et al. 2013). The trackline distance from shore was monitored with a clinometer to keep the shoreline 10° below horizontal while the aircraft was at the standard altitude of 244 m (800 ft). Ground speed was approximately 185 km/hour (100 knots). This coastal survey included searches up rivers until the water appeared to be less than 1 m deep, based on the appearance of rapids or riffles or as recommended by Alaska Native hunters who have flown with us in the past.

In addition to the coastal surveys, systematic transects were flown across the inlet (Fig. 1). As during past surveys, mid-inlet tracklines were designed to run the length of Cook

Inlet or in a sawtooth pattern across it, minimizing overlap. Each year there has been an attempt to alter the mid-inlet sampling effort to conduct as broad an array of searches as is practical.

Tides and Light

The broad geographical range of these surveys in conjunction with rapidly changing tide heights – as much as 9.5 m (30 ft) – made it impractical to survey at specific tidal conditions (such as at low tide) throughout Cook Inlet. However, there was an attempt to synchronize flights with low tides in the Susitna delta and Knik Arm. Lower tides kept beluga groups confined along the mudflat edge in more compact groups, rather than dispersing across the flats, and reduced the area that would need to be searched, as a large proportion of upper Cook Inlet has exposed mudflats only at low tide that would otherwise have to be surveyed. Increased emphasis on surveying during preferred tidal conditions is thought to improve the efficiency of the aerial surveys but probably does not significantly affect the visibility of whales, as long as the whales are still over shallow waters. When beluga groups are in deeper water, they tend to be more scattered making counting and video recording more difficult.

Whales seen near Anchorage usually could not be circled (see Counting Protocol) due to aircraft traffic in the vicinity of the Ted Stevens Anchorage International Airport. Turnagain Arm was usually surveyed in the morning when wind speeds were often slower allowing for better survey conditions and smoother flights. The timing of aerial surveys in areas south of Point Possession and North Foreland was a function of weather, not tides.

Daylight hours in the Cook Inlet area during early June (just prior to the summer solstice) cover about 19 hours between sunrise and sunset, though light levels become low enough to limit our survey to hours between 07:30 and 20:30, local time. The flight schedule for every survey day was designed to take advantage of tidal patterns, as described above, relative to workable daylight hours.

Counting Protocol

Immediately upon seeing a beluga group, an observer independently reported the sighting to the data recorder. As the aircraft passed abeam of the whales, the observer informed the data recorder of the clinometer angle, whale travel direction, and notable behaviors when possible, but not group size. With each sighting, the observer's position (left-forward, left-rear, or right-forward) was also recorded. An important component of the survey protocol was the independence of the paired observers (i.e., observers do not cue each other to their sightings). After a group of whales was reported, the trackline was maintained until the group was well behind the wing; then the aircraft returned to the group to mark its location and begin a circling routine. This allowed each observer an opportunity to independently sight and report whale groups. The pilots and data recorder did not cue the observers to the presence of a whale group until the whale group was behind the plane and it was clear as to whether an observer had seen the group.

The location of each whale group was established at the onset of the aerial counting passes by flying directly over the group, then recording (i.e., marking) the group perimeters. The flight pattern used to count a whale group involved an extended oval around the longitudinal axis of the group with turns made well beyond the ends of the group (Fig. 3). Counts of whales were usually made on each pass down the long axis of the oval unless poor visibility (usually due to glare) limited counts to only one side of the long axis of the oval. There were typically eight or more separate counting opportunities per whale group, with two observers counting during each pass then rotating positions after four good counts to allow another pair of observers to count. Counts began and ended on a cue from the front observer, starting when the leading edge of the group was close enough to be counted and ending when the trailing edge went behind the wing of the aircraft. This provided a precise record of the duration of each counting pass. The paired observers each made independent counts and wrote down their results along with date, time, pass number, and quality of the count.

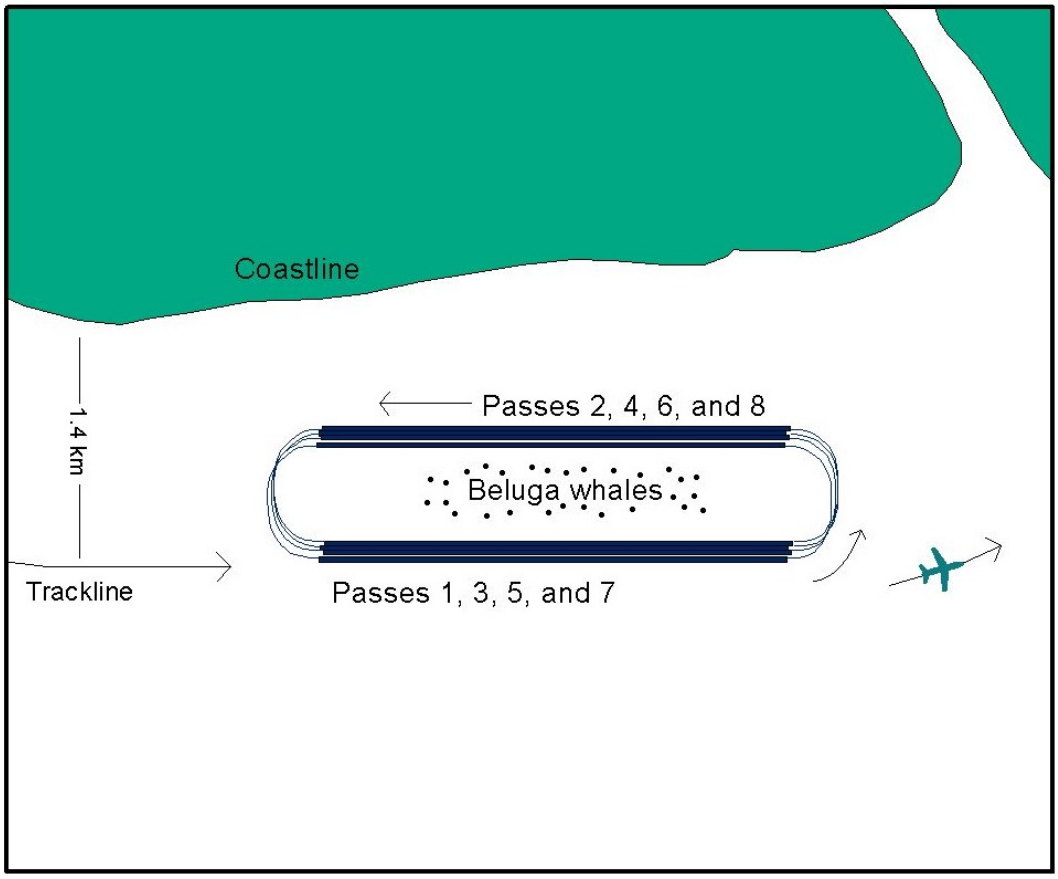

Figure 3. -- Racetrack pattern flown during counting passes of Cook Inlet beluga whales.

The quality of a count was not dependent on whales being present at the surface during a pass (i.e., a count could be zero and still used if other factors did not compromise visibility). Ratings were A (if glare, whitecaps, or distance did not compromise the counting effort) through F (if it was not practical to count whales on the respective pass). Only quality A and B estimates were used in the median count calculations and abundance estimate analysis. Only whales that were at the surface during a pass were counted; mud plumes or ripples from subsurface whales were not counted. Count records were not shared among aerial team members until each season's surveys were complete in order to maintain the independence of each observer's counts.

Because most whale groups were counted on eight different aerial passes, and because two observers were counting during each pass, there were usually 16 counts made per group per day, not including counts made later from video recordings (Hobbs et al. 2000b, in press). The

daily aerial counts were represented by medians of each of the four observers' median counts on multiple passes over a group. The process of using medians instead of maximums or means reduces the effect of outliers (extremes in high or low counts) and makes the results more comparable to other surveys which lack multiple passes over whale groups. Medians were also more appropriate than maximums when counts were corrected for missed whales (see Abundance and Trend Analyses section).

After median counts were calculated for each location (e.g., Chickaloon Bay, Susitna delta) on each day, the annual index count for the survey was taken from the highest daily sum. This procedure of using the highest daily median sum for the index ameliorates problems with partially or totally missing whale groups in certain areas on some days (Rugh et al. 2005b). Previously, the highest median count for each area (e.g., Susitna delta, Knik Arm, Turnagain Arm, Chickaloon Bay, Trading Bay, lower inlet) was used as the annual index count irrespective of survey day (Rugh et al. 2000b). However, because of the evident movement of whales between these areas in upper Cook Inlet on some days, over-counting was avoided by not adding counts from different days (with the exception of sightings made in the lower inlet since it takes two days to complete a lower inlet survey).

Cameras

Two digital video cameras mounted on a board were operated together on most counting passes (Fig. 4). The "standard" camera was adjusted to keep the entire group of belugas in view (generally at maximum wide angle). Magnification was kept constant throughout a pass. The second "zoomed" camera was kept at maximum optical zoom (12×). The zoomed video was used to determine correction factors for missed animals (Hobbs et al. 2000b, in press) and to examine color ratios of white adults relative to dark juveniles (Litzky 2001, Sims et al. 2003). Paired Sony HXR-NX5U HD digital video cameras with 1920 × 1080 pixel resolution were used during the June 2014 survey.

A.

B.

Figure 4. -- Video and counting passes of Cook Inlet beluga whales. Observers counted from the left-forward position (A. hidden behind the camera operator) and left-rear position (B. opposite the computer display) while pass number and flight path were recorded by the computer operator.

Each video counting pass was reviewed for quality and rated on a scale (excellent, good, fair, poor, and unacceptable). Video passes rated excellent and good were analyzed using a computer-aided system (introduced in 2004). With this program (called "Beluga Dots"), analysts were able to count and catalog the individual whale images found in the survey video, track the images across the computer screen, and measure image size and color. All of these data were stored in a text file used by the program (Fig. 5). Video counts were then used to calculate abundance estimates[2] (Hobbs et al. in press). Images from the camera kept at maximal zoom were examined for whale surfacings that did not show up in the standard video, and for color ratios (white adults vs. dark juveniles) within the respective groups (as described in Litzky 2001).

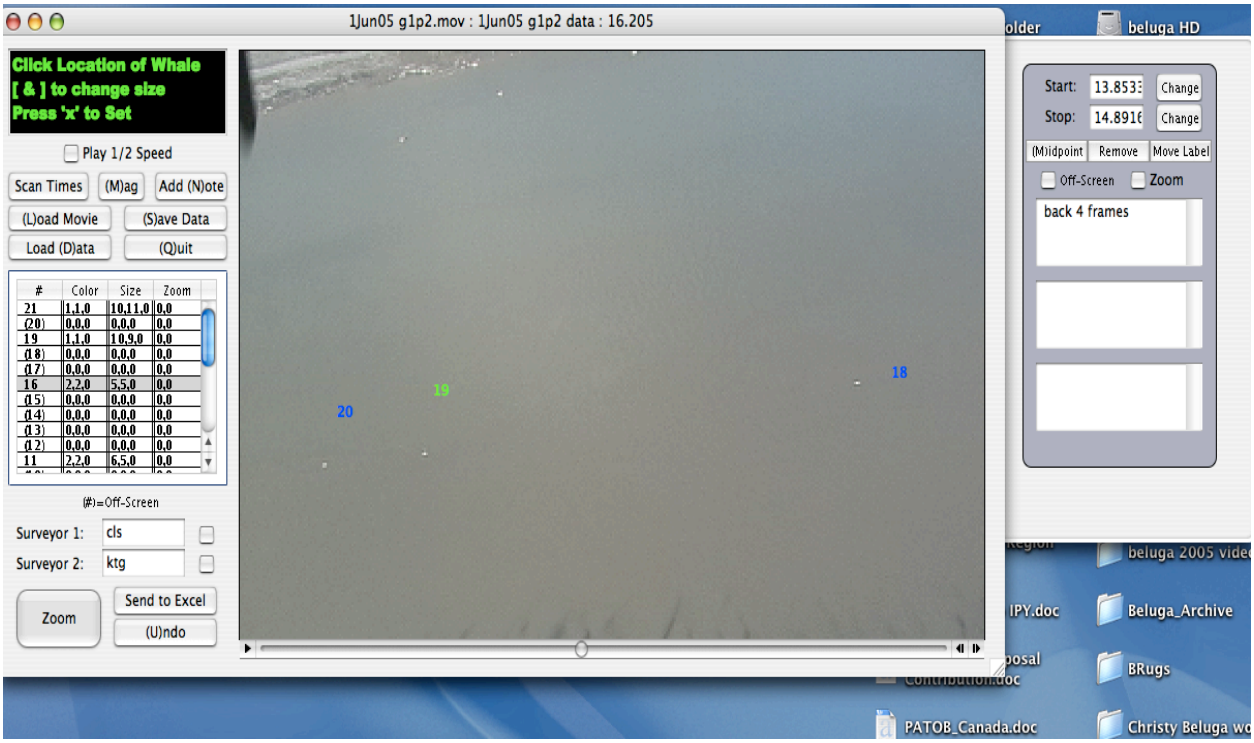

Figure 5. -- Computer screen shot of "Beluga Dots" program used to catalog individual beluga whale images found in the Cook Inlet survey video.

[2]Although whale counts made from video were used in abundance estimates, the median counts made by observers in the aircraft provided a quick, efficient approximation of relative abundance. Aerial counts could also be used as a proxy (with appropriate corrections relative to each observer and group density) for video counts when video was inadequate for a particular group.

Abundance and Trend Analyses

Analysis of both the aerial counts and counts from the video recordings are described in Hobbs et al. (2000b) for data from 1994 to 2000, and Hobbs et al. (in press) for all years through 2012. The following excerpt from Hobbs et al. (in press) explains changes made to the analyses presented in Hobbs et al. (2000b):

"Beginning in 2004, the number of survey days was increased [from one week to two weeks] and the northeast and northwest sectors in the upper inlet [bisecting Trading Bay/Susitna delta/Knik Arm from Chickaloon Bay/Turnagain Arm/Point Possession] were combined so that the inlet was divided into two sectors (upper and lower [separated by East and West Foreland]) [rather than three sectors. The revised formula is now]:

$$\hat{N}_{s,y} = \sum_{i=1}^{G_{s,y}} \hat{n}_{i,s}\,, \quad Var(\hat{N}_{s,y}) = \sum_{i=1}^{G_{s,y}} Var(\hat{n}_{i,s})$$

$$\hat{N}_{y} = \frac{\hat{K}_{y}}{J_{y}} \sum_{s=1}^{J_{y}} \hat{N}_{s,y}\,,$$

$$Var(\hat{N}_{y}) = \frac{1}{J_{y}-1} \sum_{s=1}^{J_{y}} (\hat{N}_{y} - \hat{K}_{y}\hat{N}_{s,y})^{2} + \frac{\hat{K}_{y}^{2}}{J_{y}^{2}} \sum_{s=1}^{J_{y}} Var(\hat{N}_{s,y}) + CV^{2}(\hat{K}_{y})\hat{N}_{y}^{2} \quad ,$$

where

$\hat{N}_{J,y}$ = the estimated number of beluga in groups found in survey J of year y,

$G_{J,y}$ = the number of groups found in survey J of year y,

$\hat{n}_{i,j}$ = the estimated number of beluga in the ith group found in survey J,

$\hat{N}_{y}$ = the estimated number of belugas in year y,

$\hat{K}_{y}$ = the multiplicative correction for belugas in groups that were missed,

J_{y} = the number of usable surveys in year y.

Estimates from each survey day were summed, and only survey days with complete surveys of the upper inlet were used to estimate abundance in the upper inlet. This addressed the concern that groups of whales might move from one sector to another in the upper inlet between days during the 2-week period of the surveys, but it required more survey days and flight hours to complete.

For survey days with unusually low estimates (e.g., less than about 60% of the highest daily estimate), the flight paths were reviewed to determine if a group seen on other survey days could have been missed either because the area was unavailable due to weather or air traffic, or if the group could have moved to an adjacent area that was not surveyed. If this was the case, these survey days were not included in the abundance estimate to reduce the possibility of biasing the estimate downward.

The estimate of the variance of the abundance in each sector equation in Hobbs et al. (2000b) under the heading Abundance Estimate was revised to use the squared standard error of the average for the sector in place of the variance of the abundance estimate (*CV*) and the measurement error. In Hobbs et al. (2000b), both measurement error and the standard deviation were included to avoid underestimation of the variance; at that time it was thought that there were significant variations in behavior from year to year that could not be corrected for with existing methods.

With the recent trend results it is clear that the variance is overestimated by the method of Hobbs et al. (2000b). Examining the standard deviation of the residuals of abundance estimates from 1999 to 2011 around the trend line, we have an upper bound for the average *CV* of 11%. The residuals include both the variation resulting from the estimation and any variation in the dynamics of the population from year to year. Using the equation in Hobbs et al. (2000b), the average *CV* (square root of the mean of CV^2) for 1999-2011 was 17%, indicating that *CV* had been overestimated by this equation. The revised estimate of variance (shown below) accounts for the variation in behavior explicitly and uses the standard error which takes advantage of the increased sampling effort of the recent surveys.

Using the notation of Hobbs et al. (2000b), the variance is now [as follows]:

$$Var\left(\hat{N}_{s,y}\right)=\frac{1}{\left(J_{s,y}-1\right)J_{s,y}}\sum_{j=1}^{J_{s,y}}\left(\hat{N}_{s,y}-\hat{K}_{y}\sum_{i=1}^{G_{j,s,y}}\hat{n}_{i,j}\right)^{2}+\left(CV^{2}(T_{I,y})+CV^{2}(\hat{K}_{y})\right)\hat{N}_{s,y}^{2} \quad ,$$

where,

$\hat{N}_{s,y}$ = the estimated number of beluga whales in groups found in sector *s* (northwest, northeast or south 1994-2003, and upper or lower 2004-2011) of year *y*,

$J_{s,y}$ = the number of surveys of sector *s* during year *y*.

$\hat{K}_{y}$ = the multiplicative correction for beluga whales in groups that are missed,

$G_{j,s,y}$ = the number of groups found in survey *j* of section *s* of year *y*,

$\hat{n}_{i,j}$ = the estimated number of beluga whales in the *i*th group found in survey *j*,

CV = the coefficient of variation (standard error/mean) of an estimate (c.f. Hobbs et al. 2000b), and

$T_{I,y}$ = the annual mean of the average dive interval (time from the end of one dive to the end of the next) resulting from variation in average behavior of groups from year to year.

Trends were estimated using weighted linear regression of the natural logarithms of the abundance estimates with the weights being the squared inverse of the coefficients of variation of the estimates. We considered the end of the unregulated subsistence hunt in 1999 to be the point in the time series where change in Cook Inlet beluga whale population dynamics may have occurred. To examine the impact of a trend in $T_{I,y}$ with survey dates, we regressed the residuals of the trend analysis against the median date for each survey."

RESULTS AND DISCUSSION

Survey Effort

The June 2014 survey included 15 flights which ranged from 0.9 to 5.8 hours in duration from takeoff to landing. Flight hours, the sum of time spent in the air whether or not a search effort was underway, totaled 51.6 for the season. Systematic search effort, not including time spent circling whale groups, deadheading without search effort, or periods with poor visibility was 24.6 hours. Poor visibility interfered with search effort 0.9 hours (2% of the search effort). This is the sum of time spent in the air when glare, fog, white caps, or similar problems interfered with the survey effort, as determined by the left-forward observer.

The 2014 aerial survey provided a thorough coverage of the coast of Cook Inlet (1,810 km) for most of the area within approximately 3 km of shore. Including mid-inlet tracklines, survey coverage totaled 32% of the 20,943 km^2 of Cook Inlet surface area (assuming a 2.0 km transect swath: 1.4 km on the left plus 1.4 km on the right, less the 0.8 km blind zone beneath the aircraft). However, these surveys covered virtually 100% of the coastal areas. Most of upper Cook Inlet was surveyed six times, especially areas where belugas have consistently been found in the past – such as the Susitna delta, Knik Arm, and Chickaloon Bay.

One of the primary observers (authors of this report) has flown with this project on almost all of these surveys since 1993 (KWS). The other observers have flown on six to eight of the surveys (LVB, CLS, KTG). Differences between observers' sighting performances (whether or not an observer found whale groups seen by others and how high or low that observer's counts were relative to the other observers) are incorporated into correction factors for the abundance estimates (see Abundance and Trend section below).

Summary Counts and Daily Reports

Median counts of beluga groups for each area are shown in Table 1. Typically, there were four good counts made by each observer for each group; therefore, medians were usually calculated using 16 counts per group. The use of medians (instead of means or maximum counts) and the consistency of the observation team have meant that changes in index counts between years are probably not a function of observer performance. The median index count for all observers for 2014 was 352, which represents the highest index count to date for this project. These summary counts do not reflect any correction for missed whales or groups (see Abundance and Trend section for correction factors and groups used in the abundance estimate for 2014). Day-by-day survey effort and marine mammal sighting locations are summarized below.

Table 1. -- Beluga counts made during aerial surveys of Cook Inlet in June 2014. Counts are medians from multiple counts of each whale group. Dashes (---) indicate no survey effort and zeroes (0) indicate that the area was surveyed but no whales were seen. Locations are listed in a clockwise order around Cook Inlet starting with Turnagain Arm. If more than one group was found within a location, the median for each group was added together (see Daily Reports for specific group locations).

Location	6/3	6/4	6/5	6/6	6/7	6/8	6/9	6/10	6/11	6/12
Turnagain Arm	---	---	0	---[d]	0	---	0	0	0	0
Chickaloon Bay/ Point Possession	---	---	35[b]	---[d]	7[f]	[g]	51	19	44	25
Point Possession to Moose Point/ East Foreland	---	---	0	---	---	[g]	---	---	---	0
Mid-inlet east of Trading Bay	0	0	---	---	---	---	---	---	---	---
East Foreland to Homer	---	0	---	---	---	---	---	---	---	---
Kachemak Bay to Elizabeth Island	---	0	---	---	---	---	---	---	---	---
West side of lower Cook Inlet	0	---	---	---	---	---	---	---	---	---
Redoubt Bay	0	---	---	---	---	---	---	---	---	---
Trading Bay	---	---	0	---	---	---	---	---	---	---
Susitna delta [a]	---	---	201[c]	33[e]	61[f]	68[g]	180	333	293	107[h]
Knik Arm	---	---	0	---[d]	0	0	0	0	0	0
Fire Island	---	---	0	---[d]	0	0	0	0	0	0
Index counts	0	0	236[b,c]	[d]	[f]	[g]	231	**352**	337	[h]

[a] The coast between North Foreland and Point MacKenzie is defined as the Susitna delta.

[b] Two groups (1 and 2) very spread out near Chickaloon River and off Chickaloon Bluffs; difficult to video/count.

[c] Two groups (3 and 4) in east tributary of Susitna River. Counts and video compromised by whitecaps and glare.

[d] Flight aborted due to illness of crew member (note: tides were not optimal and winds were increasing).

[e] Counts/video of group near Theodore River represent minimum count (33) as whales were widely scattered. Large, compact group near Little Susitna River appeared similar to group 3 observed on 5 June.

[f] Counts/video compromised by high winds in Chickaloon Bay and widely scattered whales near Theodore River.

[g] Groups too dispersed to get accurate counts, whales were found scattered from Moose Point/Point Possession to the Susitna delta.

[h] Subset of very scattered group(s) from Chuitna River to Susitna River seen both nearshore and mid-inlet; unable to obtain accurate counts/video.

3 June 2014

Lower inlet surveys were planned for the beginning of the project because tides were more favorable (low tides later in the day) for upper inlet surveys during the second week of the study. The plane departed Anchorage and followed mid-inlet sawtooth transects (Waypoint 12) that ended in Kachemak Bay (Waypoint 22) (Fig. 1), at which point we flew to Homer to refuel. We continued the sawtooth pattern (Waypoint 22) ending at the waypoint north of Cape Douglas (Waypoint 25). At Cape Douglas, we began the coastal survey heading north with a brief transit mid-inlet to circle Augustine Island. At Tuxedni Bay, we briefly ended the survey to deadhead to Kenai to refuel, returning to Tuxedni Bay then surveying Redoubt Bay before ending the survey at West Foreland and deadheading back to Anchorage.

Marine mammal sightings included: harbor porpoise (*Phocoena phocoena*), sea otters (*Enhydra lutris*), Steller sea lions (*Eumetopias jubatus*), harbor seals (*Phoca vitulina*), fin whales (*Balaenoptera physalus*), and humpback whales (*Megaptera novaeangliae*) (Fig. 6, also see Appendix). Harbor porpoise (65 sightings, 89 animals) were seen on all mid-inlet tracklines in the lower inlet, and in Kamishak Bay, near Oil Bay, in Chinitna Bay, and south and north of Tuxedni Bay during the coastal survey. Sea otters (59 sightings, 385 animals [biased downward as sightings and group sizes were lumped together and estimated at times at great distances from the plane]) were seen on mid-inlet tracklines, in Kachemak and Kamishak bays, around Augustine Island, and along the shoreline from Iniskin Bay to Tuxedni Bay. Steller sea lions (2 sightings, 41 animals) were seen near Shaw Island and Bruin Bay. Two fin whales were seen mid-inlet west of Cape Douglas. Humpback whales (3 sightings, 5 animals) were seen along mid-inlet tracklines northwest of Elizabeth Island and near Bruin Bay. Harbor seals (11 sightings, 250 animals) were hauled out or in the water in Iniskin Bay, Chinitna Bay, Tuxedni Bay, and Redoubt Bay. Viewing conditions were excellent to fair during much of the 7.9 hour

survey, with brief periods of poor visibility due to glare (0.4 hour). Winds were mostly calm (Beaufort sea states ranged from 1 to 4) throughout much of the survey area.

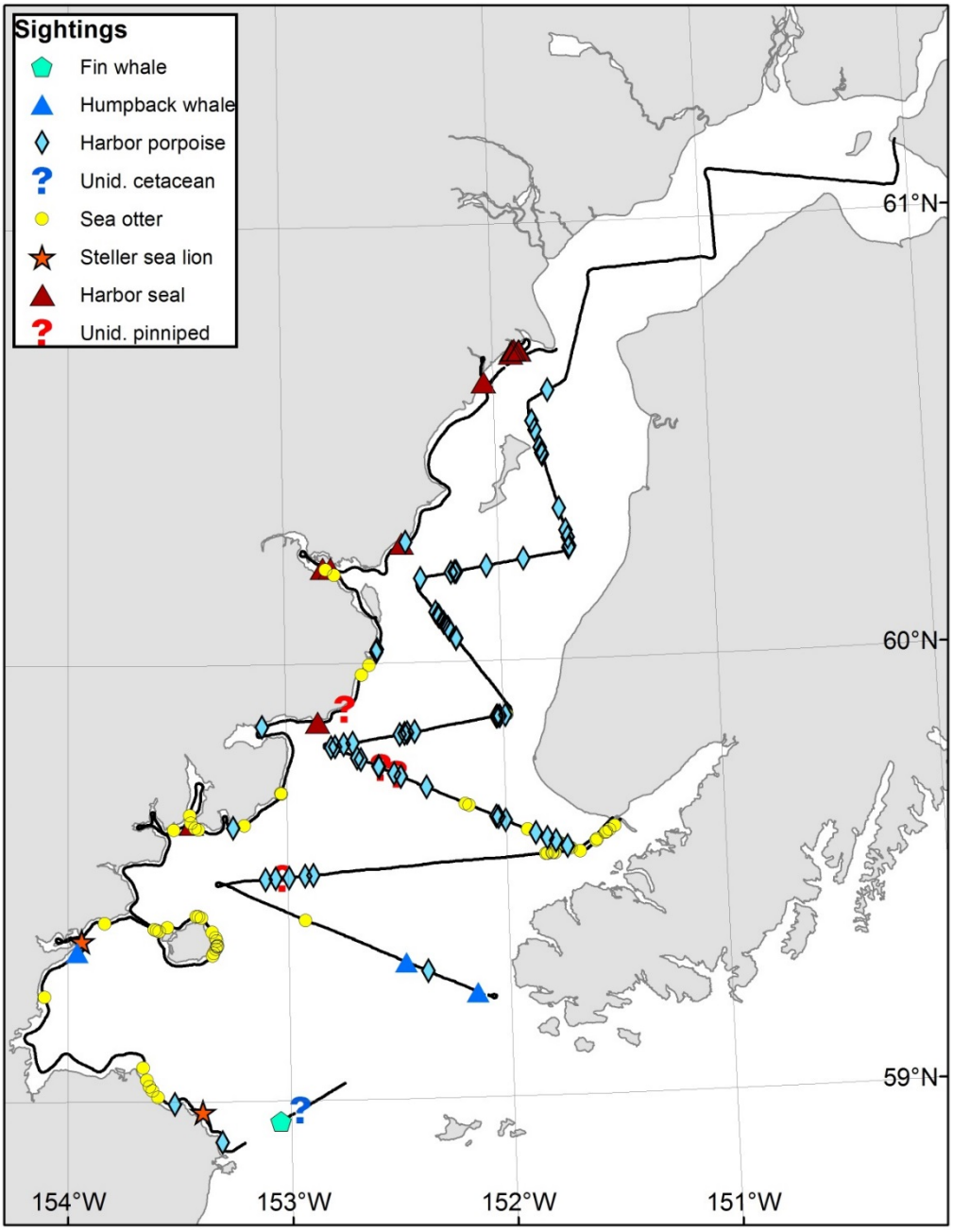

Figure 6. -- On-effort trackline and marine mammal sightings on 3 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

4 June 2014

Lower inlet surveys continued for a second day, covering the eastern coastline from East Foreland to Elizabeth Island where mid-inlet tracklines were flown in a sawtooth pattern north to Kachemak Bay for a refueling stop. Mid-inlet tracklines were then surveyed to Kalgin Island where we briefly departed the line to circle the island before surveying the remaining lines to Anchorage. Marine mammal sightings included harbor seals (8 sightings, 399 animals) at Kenai River and in Kachemak Bay; sea otters (71 sightings, 1,440 animals) near Kasilof Point, along the shoreline from Anchor Point to Elizabeth Island, and along mid-inlet tracklines in Kamishak Bay; Steller sea lions (2 sightings, 2 animals) in Seldovia Bay and south of English Bay; humpback whales (1 sighting, 6 animals) south of Augustine Island; fin whales (1 sighting, 2 animals) mid-inlet between Elizabeth Island and Kamishak Bay; and harbor porpoise (30 sightings, 40 animals) on all mid-inlet tracklines south of Tuxedni Bay (Fig. 7, Appendix). Sea states ranged from Beaufort 1 to 4, with brief periods of poor visibility (0.02 hour) during the 6.9 hour survey.

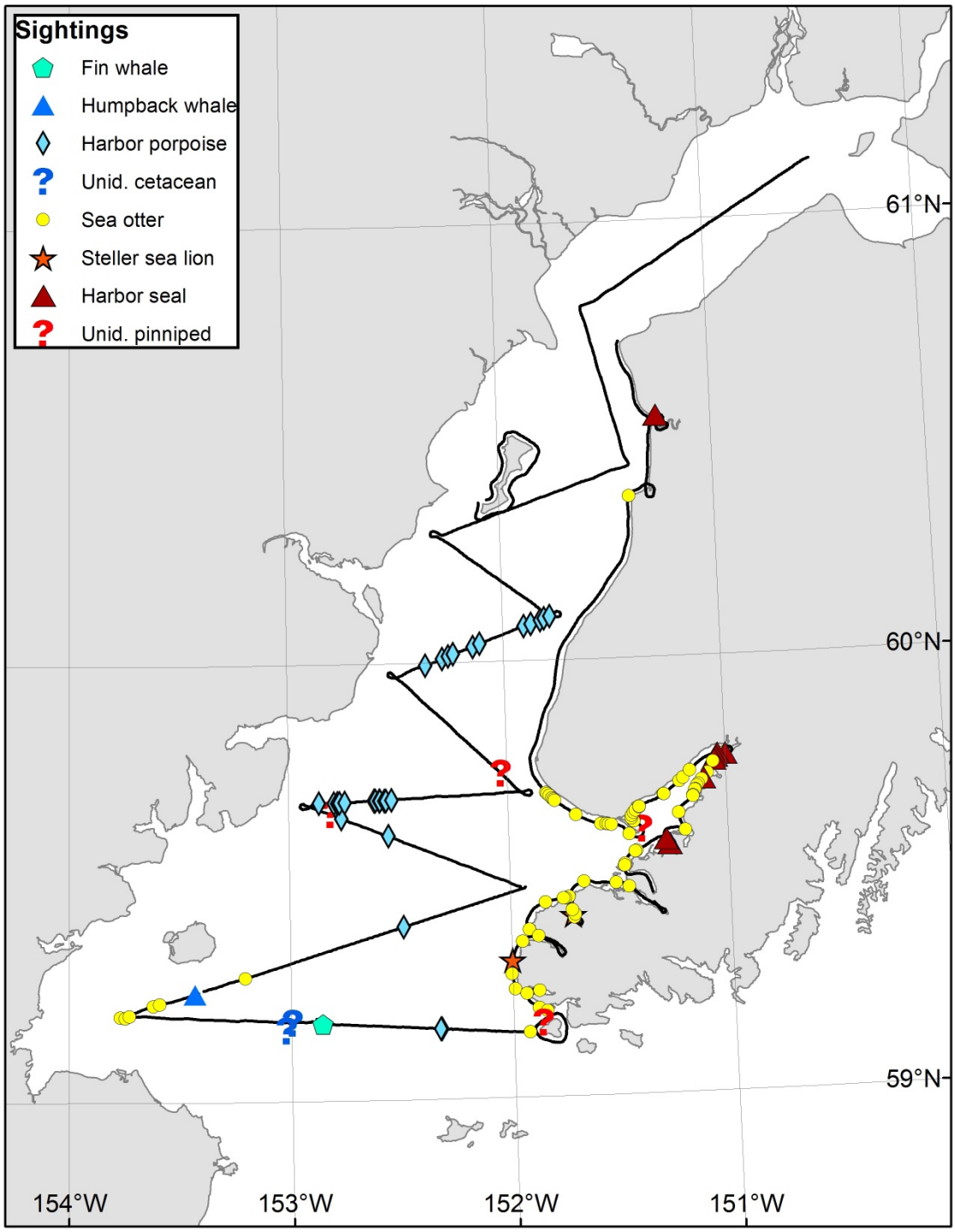

Figure 7. -- On-effort trackline and marine mammal sightings on 4 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

5 June 2014

The first survey of upper Cook Inlet included all coastal areas north of East and West Foreland. We departed Anchorage and circled the west shore of Fire Island before entering Turnagain Arm. We surveyed the entire Arm and continued the survey into Chickaloon Bay, surveying up Chickaloon River and along the bluffs where two beluga groups were found near the mouth of the river and spread out from the bluffs into mid-inlet waters (Fig. 8). We resumed the coastal survey from Point Possession to East Foreland, crossing the inlet to West Foreland then headed north. We surveyed up the McArthur River, Beluga River, and Susitna River, crossing the mouth of the Susitna River where two compact groups of belugas were found. We circled and attempted counting/video passes but these were compromised by the high tide and sea states. We continued the coastal survey to the Little Susitna River, surveying up the river, then before reaching Point MacKenzie we crossed over land (due to airport traffic) to Goose Bay in Knik Arm. We landed in Anchorage after surveying Knik Arm. Other marine mammal sightings included harbor seals hauled out on the Chickaloon River mudflats and hauled out on the Theodore and Lewis rivers (6 sightings, 373 animals) (Fig. 8, Appendix). Sea states ranged from Beaufort 1 to 5. Sighting conditions were poor to excellent, with weather affecting 0.2 hour of the 4.6 hour survey.

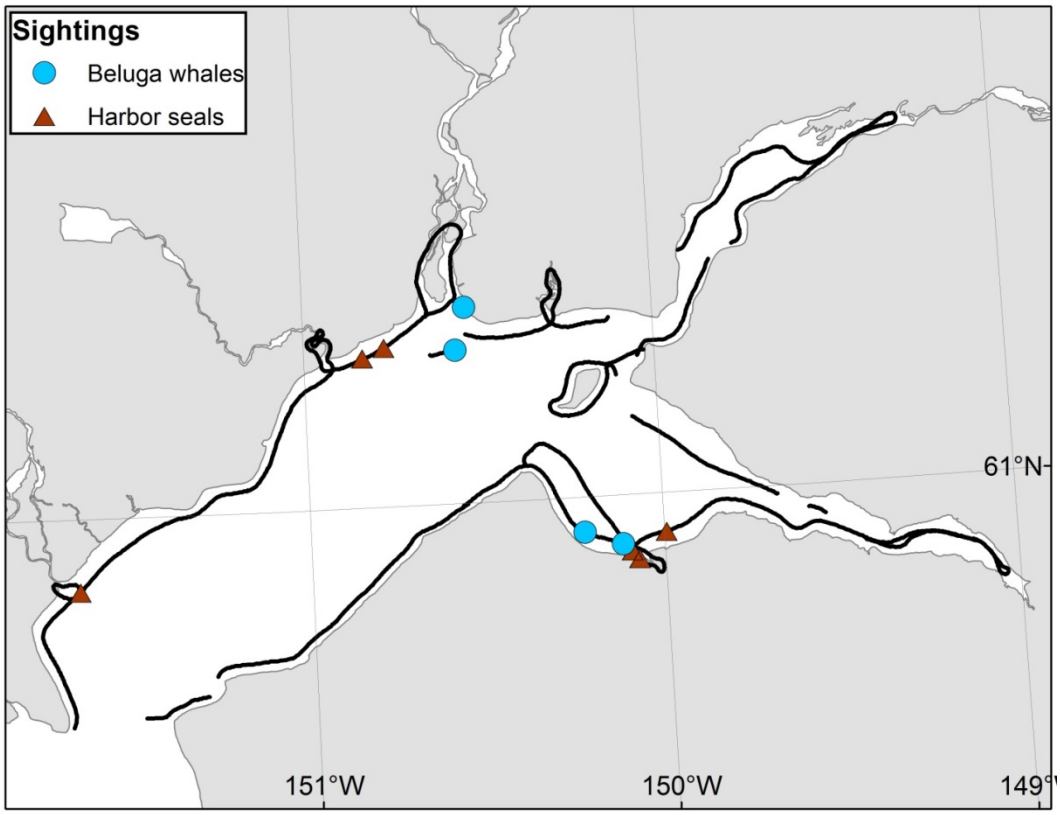

Figure 8. -- On-effort trackline and marine mammal sightings on 5 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

6 June 2014

Because low tides were still at 7 to 8 ft, we decided to survey the Susitna delta during the morning low tide. Two groups were found: one seen off effort near the Little Susitna River while transiting to Beluga River, the other spread out from Beluga River toward the western tributary of the Susitna River (Fig. 9). We attempted four counting/video passes of the group near Beluga River, but whales were dispersed and weather and tides were not optimal. We aborted the flight and returned to Anchorage after a crew member fell ill. Total survey time was 1 hour.

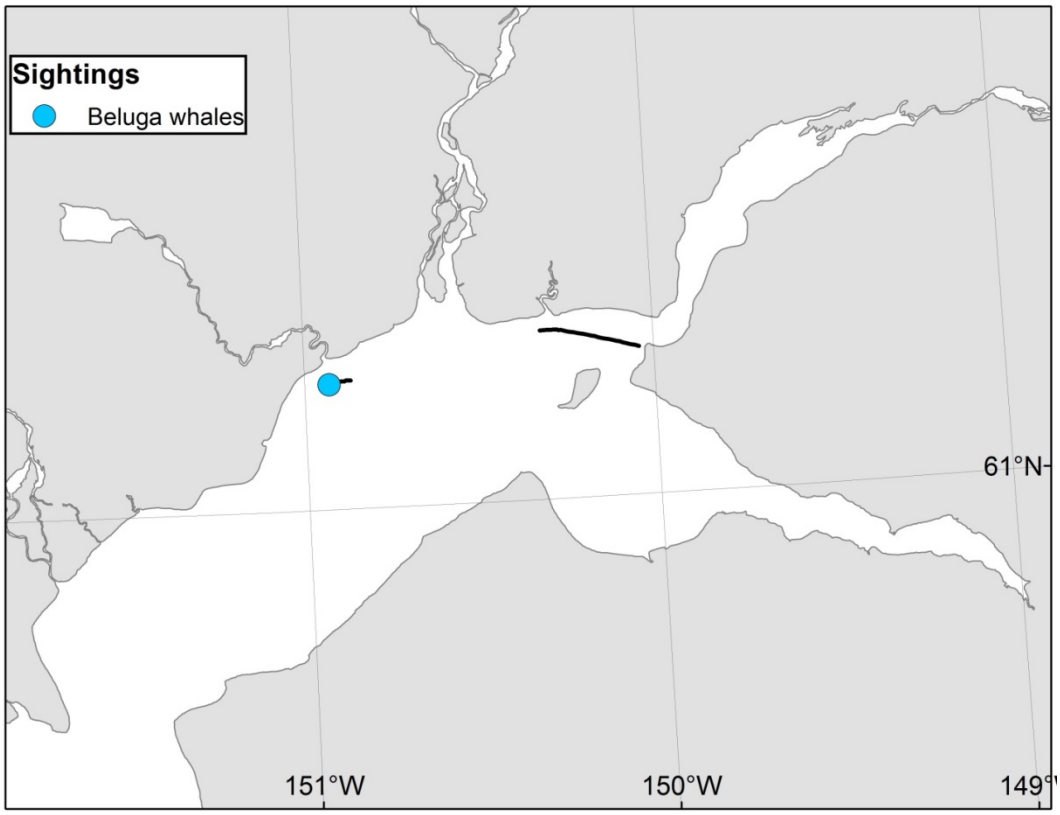

Figure 9. -- On-effort trackline and marine mammal sightings on 6 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

7 June 2014

We started the survey at Beluga River to take advantage of the low tide in the Susitna delta (still at 7 ft), following the shoreline clockwise to Point Possession. The first group of belugas was near the Theodore River (Fig. 10). We attempted 12 video/counting passes but the whales were too spread out and glare affected visibility. The second group of belugas was west of Chickaloon River. Here we completed six video/counting passes. Sighting conditions deteriorated throughout the 3.9 hour survey with poor visibility due to higher sea states (0.1 hour) resulting in termination of the survey at Point Possession. Other marine mammal sightings included harbor seals (4 sightings, 501 animals) in the Susitna delta (Fig. 10, Appendix).

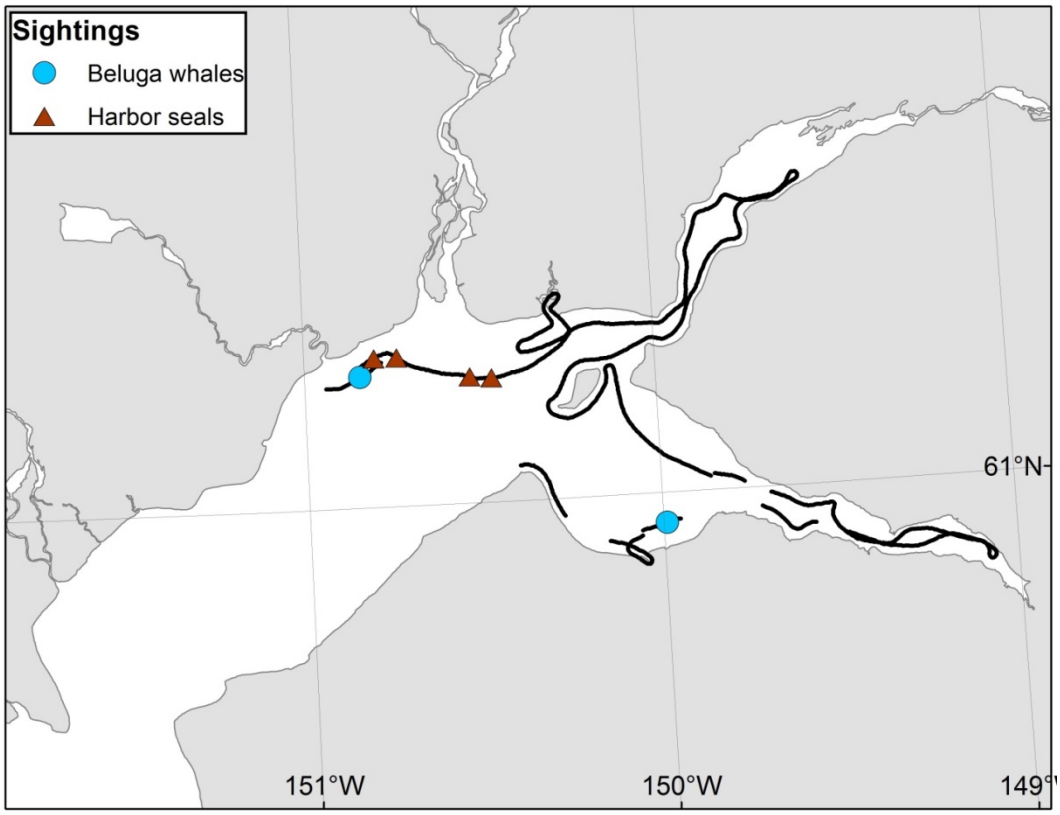

Figure 10. --On-effort trackline and marine mammal sightings on 7 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

8 June 2014

We began the survey at Beluga River, similar to the previous two days. Belugas were seen in five groups (Fig. 11). Group 1 was observed at Beluga River and Group 2 between the Lewis and Ivan rivers. Both groups were small in number, so we conducted only counting passes on Group 1 and four video/counting passes on Group 2. We surveyed along the unexposed mudflat edge where Group 3 (a large, spread-out group) was found. While circling Group 3, Group 4 was observed off effort closer to the shoreline between Moose Point and Point Possession. Video/counting passes were attempted but these groups were too dispersed to get accurate counts. The coastal survey resumed back at the Susitna River including the mouth of the Little Susitna River then Knik Arm before transiting to Burnt Island in Chickaloon Bay. Group 5 was spread out from Chickaloon River to Point Possession, a rough estimate of group size was obtained but video/counting passes were not attempted. Other marine mammal sightings

included harbor seals (2 sightings, 2 animals) in Chickaloon Bay (Fig. 11, Appendix). Sightings conditions were good to fair with sea states ranging from 1 to 3 during the 3.6 hour survey.

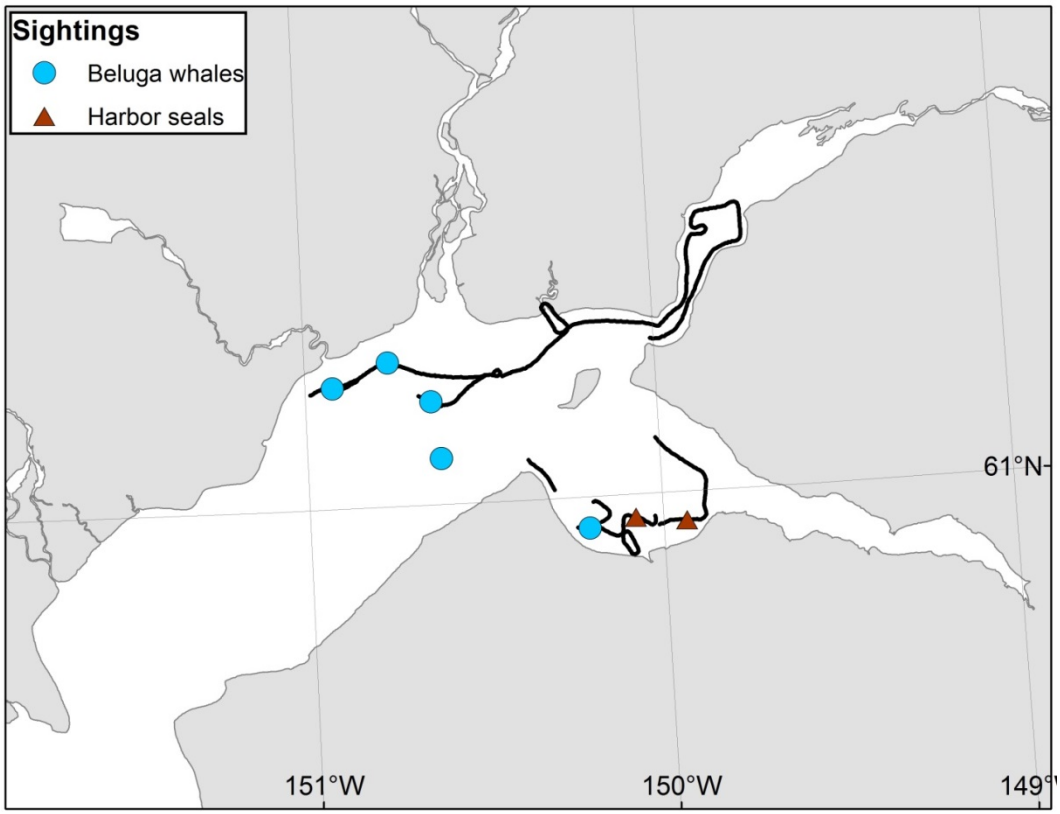

Figure 11. --On-effort trackline and marine mammal sightings on 8 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

9 June 2014

We headed to Beluga River to begin the survey. We found a scattered group of beluga whales that was difficult to count and decided to return on the low tide when whales were more likely to gather along the mudflat edge. We transited off effort to Turnagain Arm, surveying the Arm and Chickaloon Bay. Two groups were observed near the Chickaloon bluffs (Fig. 12). Group 1 included a few scattered whales while Group 2 whales were in a tight configuration. We obtained counting passes of Group 1 and video/counting passes of Group 2. The survey team returned to Beluga River about one hour before low tide (11:23; 3.6 ft.). A small group (Group 3) was encountered and counted just southeast of Beluga River. Video/counting passes were

completed on three more groups: Group 4, a group lined up along the mudflats between Beluga River and Lewis River; Group 5, off the east tributary of the Susitna River; and Group 6, a compact group between the Susitna and Little Susitna rivers. The coastal survey continued into Knik Arm and ended after circling Fire Island. Sighting conditions continued to improve with fair to excellent visibility and sea states ranging from Beaufort 1 to 4 during the 5.6 hour survey. Other marine mammal sightings included harbor seals (5 sightings, 322 animals) in the Susitna delta between Beluga River and the eastern tributary of the Susitna River (Fig. 12, Appendix).

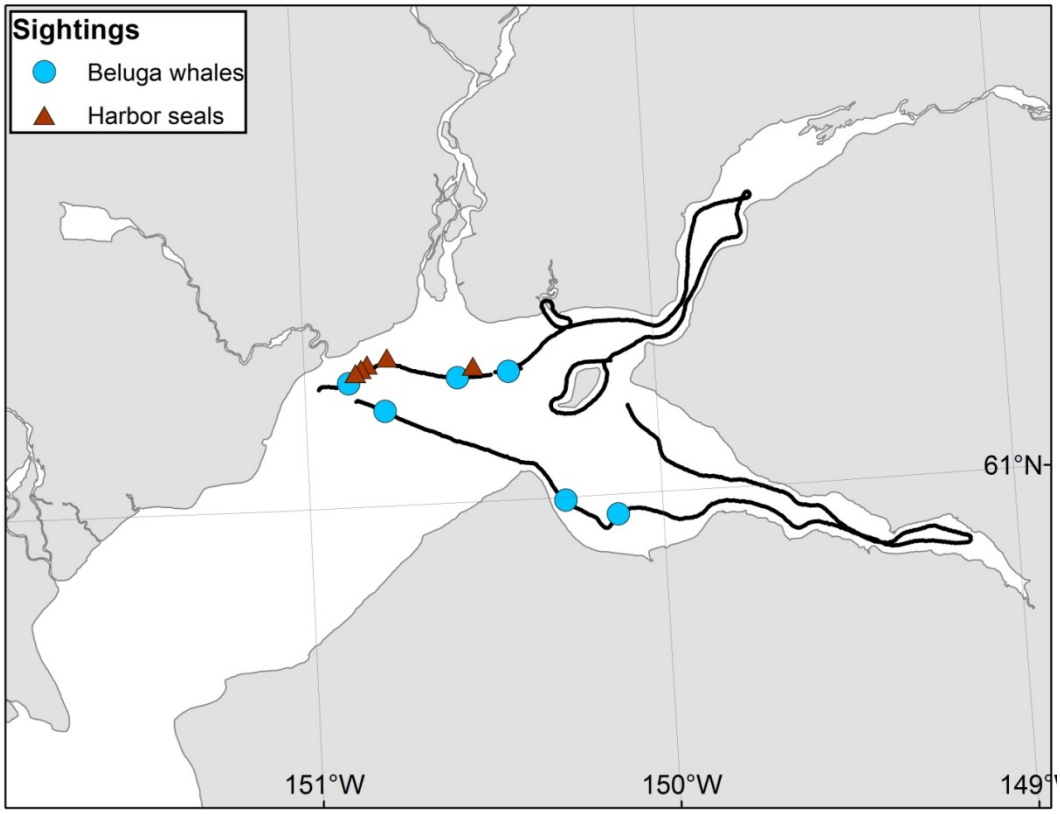

Figure 12. --On-effort trackline and marine mammal sightings on 9 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

10 June 2014

The weather forecast for the day was not promising: winds gusting up to 15 knots in Turnagain Arm and scattered showers. We circled Fire Island then cut across Chickaloon Bay to escape the high winds. We were not able to safely survey Turnagain Arm at this time. Conditions

were calm along the south shore and Chickaloon Bay bluffs where Group 1 (6 video/counting passes) was encountered. Group 2, another small group, was observed enroute to Point Possession (7 video/counting passes). We continued to survey the coastline from Point Possession to Moose Point, completed a mid-inlet trackline to Beluga River, and resumed the coastal survey along the west side of the inlet. Group 3 included a few whales southeast of Beluga River. Video/counting passes were obtained on three more groups: Group 4, a large group lined up along the mudflats between the Beluga and Ivan rivers; Group 5, an extremely large group off the east tributary of the Susitna River; and Group 6, a small group between the Susitna and Little Susitna rivers. When we reached Point MacKenzie, we broke off effort to land in Anchorage to refuel. The survey resumed at Point MacKenzie, heading into Knik Arm, after which the team flew back to Chickaloon Bay and completed surveying Turnagain Arm. Sighting conditions were excellent to fair with sea states ranging from Beaufort 1 to 4 during the 6.6 hour survey. Other marine mammal sightings included harbor seals (2 sightings, 109 animals) at Chickaloon River and the eastern tributary of the Susitna River (Fig. 13, Appendix).

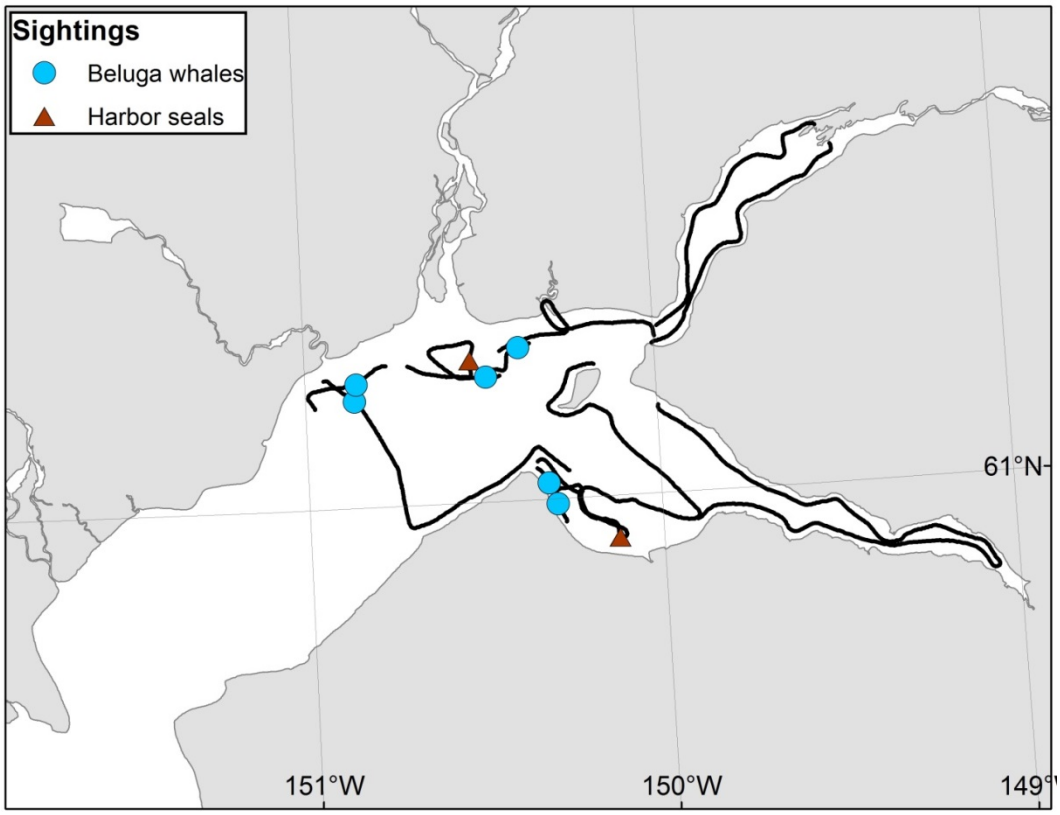

Figure 13. --On-effort trackline and marine mammal sightings on 10 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

11 June 2014

We completed a full survey of the upper inlet north of Moose Point and the mudflats west of Beluga River, following a clockwise pattern beginning at Fire Island and ending after Knik Arm. The flight coincided with the falling tide in Turnagain Arm and low tide in the Susitna delta (low at 12:57, -0.4 ft). Beluga groups were observed near the Chickaloon Bay bluffs (Group 1), off Lewis River (Group 2), and off the western tributary of the Susitna River (Group 3) (Fig. 14). Group 3 was so large that after three counting passes, the survey team determined it was possible to break the group into two groups, one in the tributary and the other along the mudflat edge, and resumed video/counting passes. Sighting conditions were mostly excellent to fair, with brief periods of poor visibility (0.1 hour), and sea states ranging from Beaufort 0 to 4 during the 5.8 hour survey. Other marine mammal sightings included harbor seals (2 sightings, 151 animals) off Beluga River and the eastern tributary of the Susitna River (Fig. 14, Appendix).

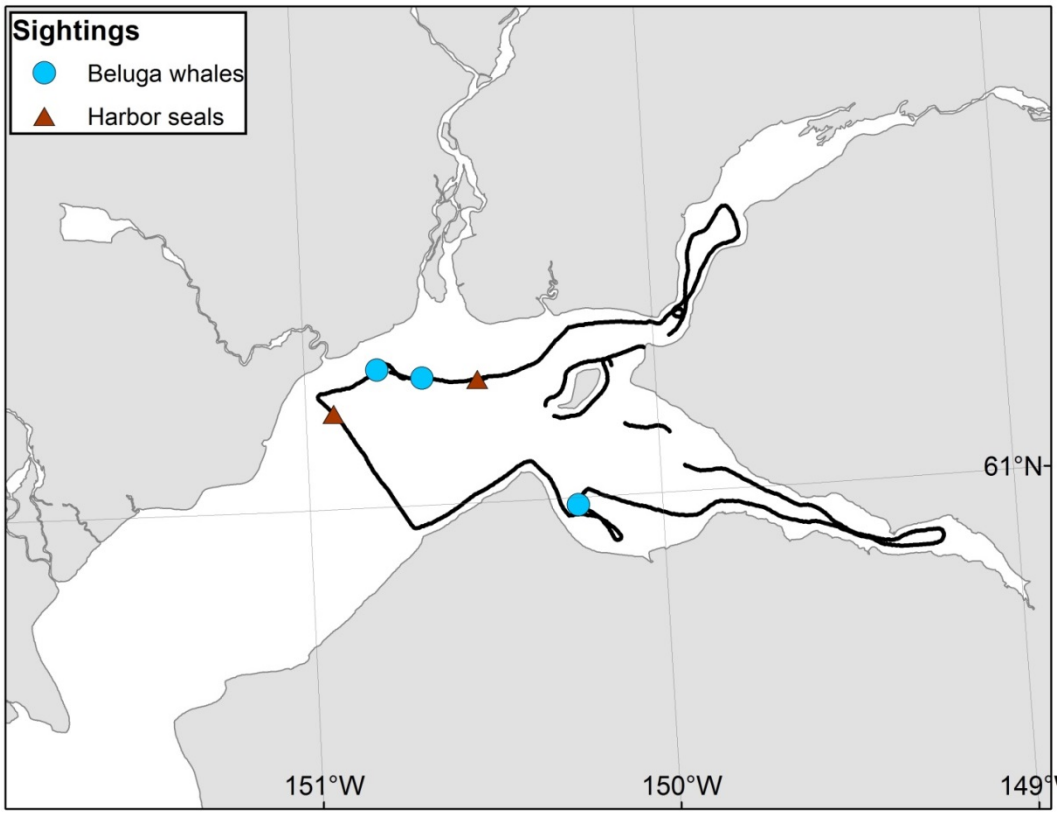

Figure 14. --On-effort trackline and marine mammal sightings on 11 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

12 June 2014

We completed a full survey of the upper inlet north of Moose Point and North Foreland, following the clockwise pattern beginning at Fire Island and ending after Knik Arm. The flight coincided with the falling tide in Turnagain Arm and low tide in the Susitna delta (low at 13:43, -2.1 ft). Beluga groups were observed near Chickaloon River (Group 1), the Chickaloon Bay bluffs (Group 2), near Point Possession (Group 3), and from the Chuitna River to the Susitna River (Group 4) (Fig. 15). Group 4 was so large and dispersed that the survey team instead continued the coastal survey to Point MacKenzie then landed in Anchorage to refuel. The team returned to Chuitna River at low tide but the group was still too dispersed, so they surveyed Knik Arm before heading back one final time to Chuitna River. Unfortunately the group was too spread out to obtain accurate video or counting passes, so the survey was terminated and the team returned to Anchorage. Sighting conditions were excellent to fair and sea states ranging

from Beaufort 1 to 3 during the 5.6 hour survey. Other marine mammal sightings included harbor seals (1 sighting, 8 animals) near Chickaloon River (Fig. 15, Appendix).

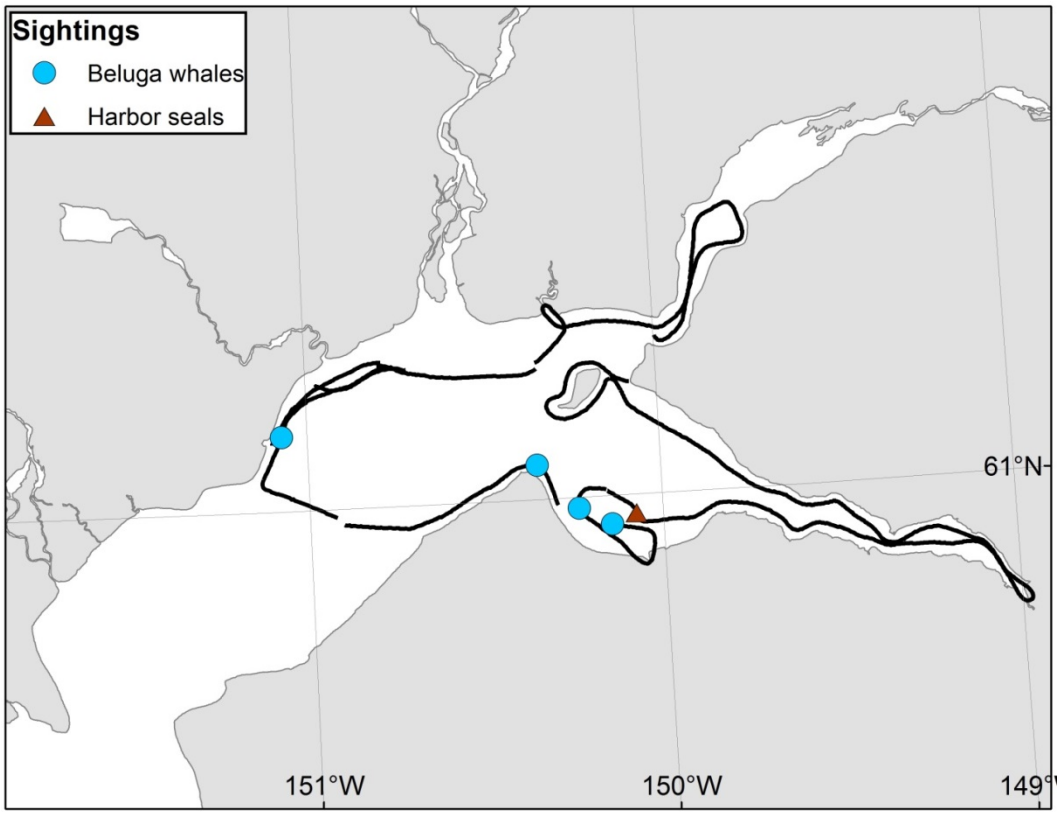

Figure 15. -- On-effort trackline and marine mammal sightings on 12 June during the 2014 beluga whale aerial abundance survey, Cook Inlet, Alaska.

Summary

In 2014, the daily medians ranged from 231 to 352 (Table 1). The 2014 index count (the median count from the best survey day) of 352 belugas, falls outside the range of index counts made annually since 1993, and is the highest index count since this project began (Table 2). Similar to past years, belugas were found in the Susitna delta and Chickaloon Bay. None were seen in Knik Arm and Turnagain Arm, or in Trading Bay or the lower inlet, despite fair to excellent sighting conditions in these regions (see Appendix for all other marine mammal sightings).

While counts in the Susitna delta have remained fairly constant during the 20+-year span of these surveys, whales have not been observed in Knik Arm the past six survey years (2008-2012, 2014, Table 2). Belugas were usually seen in Chickaloon Bay near the south shore, most often in an area 3 km southeast of Point Possession between the bluffs and Chickaloon River. Annual counts in Chickaloon Bay were often in the range of 20-60 belugas (Table 2). However, in 2004, counts were as high as 176, and for the first time there appeared to be exchanges of belugas between the Susitna delta and Chickaloon Bay/Turnagain Arm within the timeframe of the survey; that is, when counts were low in the Susitna area, they were high in Chickaloon Bay and vice versa (Rugh et al. 2005a). Similar apparent exchanges were seen in 2010 and 2011, but did not appear to occur in 2014 (Table 2), though dispersed groups were observed between the Susitna delta and Point Possession.

Table 2. -- Summary of index counts made during aerial surveys of belugas in Cook Inlet in June/July 1993-2014. Highest median counts of belugas in each of six zones are shown. The sum of these high counts does not necessarily equal the index counts because, in the latter case, highest daily sums were used, not highest counts per zone (e.g., see Table 1).

Year	Index count	Zones in Cook Inlet (highest median count per zone per survey)					
		1	2	3	4	5	6
1993	302	1	9	169	80	8	49
1994	276	10	1	248	0	6	17
1995	322	14	4	287	1	0	18
1996	287	0	0	368	29	0	41
1997	261	1	0	73	161	0	29
1998	192	0	0	109	93	0	42
1999	217	0	0	160	28	0	30
2000	184	0	0	114	42	0	28
2001	210	2	0	114	127	10	34
2002	181	0	0	93	97	0	11
2003	174	0	0	41	94	25	65
2004	187	0	0	99	0	50	176
2005	192	0	0	155	43	21	66
2006	153	0	15	126	9	0	60
2007	224	0	0	152	27	76	50
2008	126	0	0	103	0	0	33
2009	303	0	0	290	0	0	40
2010	291	0	0	160	0	4	131
2011	208	0	0	187	0	0	72
2012	319	7	21	286	0	2	30
2014	352	0	0	333	0	0	51

ZONES:

1) Lower Cook Inlet, including all areas south of East and West Foreland

2) Mid-inlet, bordered on the south by East/West Foreland and north by Point Possession/North Foreland

3) Susitna delta, bordered by Beluga River and Point MacKenzie, including Fire Island.

4) Knik Arm, with a southern boundary defined by Point MacKenzie and Point Woronzof

5) Turnagain Arm, including waters east of Fire Island, but not Chickaloon Bay

6) Chickaloon Bay, bordered by Point Possession and Burnt Island

Abundance and Trend

Calculations for whale groups missed during the Cook Inlet beluga aerial surveys and estimates of abundance are described in detail in Hobbs et al. (2000a, b, in press). The abundance estimates are on average 1.7 times greater than the index counts; however, in recent years, the index counts have been very near or above the abundance estimate (Fig. 16). The index counts do not factor in variables such as whale group density, individual observer performance, search time, and whale surfacing behavior. These corrections were applied to estimate the abundance for June 2014.

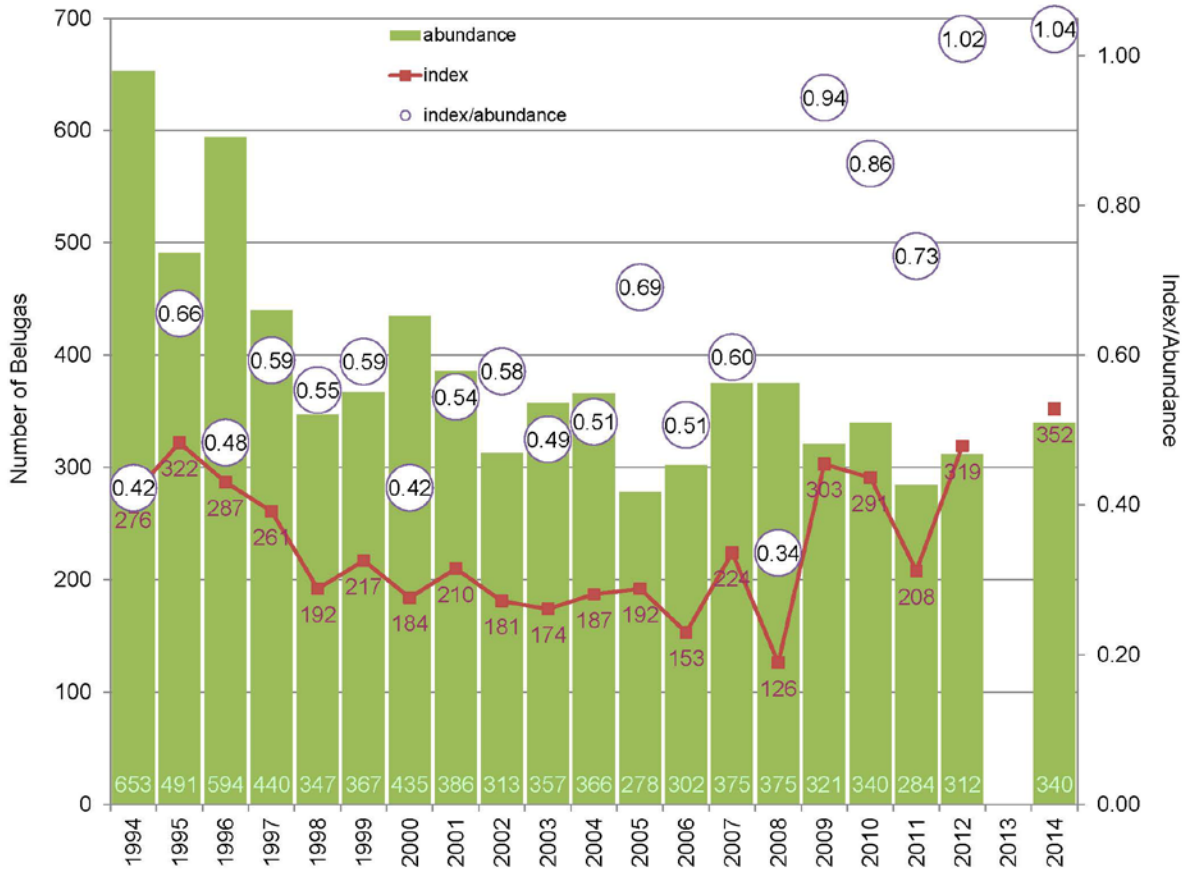

Figure 16. -- Annual abundance estimates (bars) and median index counts (line) for beluga aerial surveys, Cook Inlet, Alaska, 1994-2014. Circles show index counts divided by abundance estimates (note: in most years the index count is between 50% and 70% of the total abundance estimate).

Six of the days in June 2014 resulted in complete surveys of beluga habitat in the upper inlet (out of eight attempts); and two days included surveys of the lower inlet (3 and 4 June). One day was incomplete due to weather and illness of a crew member (6 June) and another did not include Turnagain Arm (8 June). This season there was a fairly typical presentation of beluga groups, with two or more large groups in the Susitna delta and a few smaller groups in Chickaloon Bay. Of the six upper inlet surveys, only three were used in the abundance estimate (9 to 11 June) as beluga behavior and sighting conditions compromised counts and video recording on 5 June, 7 June, and 12 June (Table 3).

Of the 15 groups found and counted on the 3 days used in the abundance estimate, we had video of sufficient quality to estimate group sizes for 11 groups. The remaining were estimated using corrections developed from the groups with both video and observer counts following the methods of Hobbs et al. (2000b) (Table 3). Glare, whitecaps, missing part of a group, and poor image quality were the most frequent conditions that rendered video quality too poor to count.

A total of 2,796 whale images were detected during analysis of 71 video sequences. Image sizes in the counting video ranged between 2 pixels and 13.5 pixels and had increasing probability of being seen with the 50% probability at 3 pixels. Images of 10 pixels in size had a probability > 95% of being seen. The average correction for belugas missed at the surface due to image size was 1.28 (Table 3).

The density of belugas in some groups resulted in density corrections for three of the observers. The fourth observer did not count against any of the useable video, so correction parameters from the 2012 survey were used for this observer. These correction parameters were used with the linear correction as described in Hobbs et al. (2000b). All groups on survey days other than 9 to 11 June were estimated by this method, as were four smaller groups on 9 and 10 June. The average correction for individual whales missed because they were below the surface of the muddy waters of the upper inlet was 1.93 (based on an average time at surface of 1.775 and surfacing interval of 24.1 (Lerczak et al., 2000)).

Very few groups were missed by either observer when paired observations occurred during the first week of the survey. Due to illness of a member of the team, paired observations

did not occur during the second week. Therefore, the missed group correction of 1.036 (*CV* = 0.005) was calculated by applying missed group results from the same observers who participated during the 2012 survey. This correction was slightly greater than recent missed group corrections (e.g., 1.012 (in 2009), 1.031 (in 2010 and 2011), and 1.001 (in 2012)).

Groups found during each survey day (Table 3), were summed to complete the total for that day. The surveys on 5 June, 7 June, and 12 June included poor sighting conditions and widely dispersed groups during part of the survey day that may account for the low number of whales (Table 4). Estimates that fell below 60% of the greatest daily estimate (on 10 June) were not included when calculating the overall abundance estimate (Table 4).

The overall estimate of abundance for June 2014 was 340 (*CV* = 0.08, 95% CI: 291 to 398, Nmin = 318). The 10-year trend (2004-2014) was -0.4% /year with a SE of 1.3% (i.e., a declining trend: *P* (< 0.0) = 62%). During the period since management of the hunt began (1999-2014), the trend was -1.3% /year with a SE of 0.7% (i.e., a declining trend: *P* (< 0.0) = 97%) (Fig. 17).

Table 3. -- Beluga whale groups in Cook Inlet, Alaska, June 2014, used to estimate abundance and/or corrections for missed groups. “Est. group size” is the corrected estimate for the respective group. CV = coefficient of variation. NC = no count.

Date	Group ID	Number of counts averaged	Location	Correction for missed whales	Correction for sub-surface whales	Est. group size	CV (%)	Counting method	Used in abundance estimate
6/5/14	1	2	Chickaloon Bay			27	8%	observer	no
6/5/14	2	2	Chickaloon Bay			3	29%	observer	no
6/5/14	3	2	Susitna R.			155	4%	observer	no
6/5/14	4	1	Susitna R.			16	0%	observer	no
6/7/14	1	5	Theodore R.			73	10%	observer	no
6/7/14	2		Chickaloon Bay			NC			no
6/8/14	1	8	Beluga R.			10	17%	observer	no
6/8/14	2	16	Lewis R.			19	22%	observer	no
6/8/14	3	3	Susitna R.			49	5%	observer	no
6/8/14	4	2	Pt. Possession			2	5%	observer	no
6/8/14	5		Chickaloon Bay			NC			no
6/9/14	1	8	Chickaloon Bay			4	28%	observer	yes
6/9/14	2	6	Chickaloon Bay	1.23	2.52	79	13%	video	yes
6/9/14	3	8	Beluga R.			8	28%	observer	yes
6/9/14	4	4	Lewis R.	1.24	2.00	97	12%	video	yes
6/9/14	5	7	Susitna R.	1.29	1.75	79	13%	video	yes
6/9/14	6	6	Little Susitna R.	1.28	2.11	57	15%	video	yes
6/10/14	1	2	Chickaloon Bay	1.16	2.03	19	27%	video	yes
6/10/14	2	10	Pt. Possession			11	54%	observer	yes
6/10/14	3	1	Beluga R.			2	0%	observer	yes
6/10/14	4	6	Lewis R.	1.33	1.70	162	9%	video	yes
6/10/14	5	8	Susitna R.	1.33	1.90	141	10%	video	yes
6/10/14	6	3	Little Susitna R.	1.26	2.18	27	22%	video	yes
6/11/14	1	7	Chickaloon Bay	1.29	2.16	68	14%	video	yes
6/11/14	2	7	Lewis R.	1.33	1.87	65	14%	video	yes
6/11/14	3*	2	Susitna R.	1.31	1.44	128	11%	video	yes
6/11/14	3a*	3	Susitna R.	1.29	1.58	66	14%	video	yes
6/11/14	3b*	10	Susitna R.	1.29	1.83	142	10%	video	yes
6/12/14	1	8	Chickaloon Bay			7	37%	observer	no
6/12/14	2	17	Chickaloon Bay			18	25%	observer	no
6/12/14	3	11	Pt. Possession			4	83%	observer	no
6/12/14	4	2	Susitna R.			83	15%	observer	no

* Group 3 was split during the counting passes. The overall estimated group size after combining the results was 168 (CV = 11%).

Table 4. -- Sums by day for complete surveys of the upper Cook Inlet during the June 2014 beluga whale aerial survey. The dates 5, 7 and 12 June were not used in the abundance estimate because of poor surveying/counting conditions. CV = coefficient of variation.

Survey day	Sum of group sizes	CV (%)	Used in abundance estimate
6/5/14	201	4%	no
6/7/14	73	10%	no
6/8/14	81	6%	no
6/9/14	324	6%	yes
6/10/14	361	6%	yes
6/11/14	301	8%	yes
6/12/14	113	12%	no
Overall abundance*	340	8%	

* Average abundance after including missed group correction (1.036).

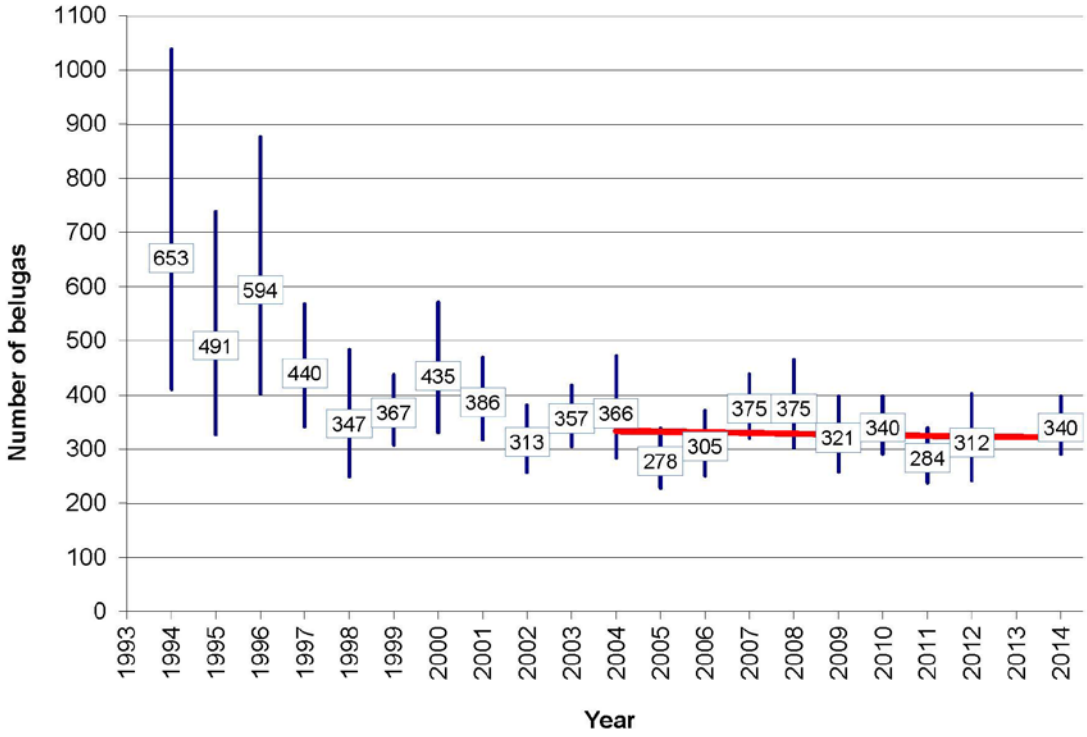

Figure 17. --Abundance estimates for beluga whales in Cook Inlet with 95% confidence intervals for revised coefficients of variation (CVs) (vertical bars). From 1994 to 1998, when the harvest was unrestricted, the annual rate of decline was -13.7% (SE = 0.045) per year. In the years since a hunting quota has been in place (1999-2014), the rate of decline was -1.3% (SE = 0.7%) per year. The 10-year trend (2004-2014) was -0.4% (SE = 1.3%) per year.

CONCLUSIONS

In Cook Inlet, belugas concentrate near river mouths or shallow bays during late spring and early summer in the northernmost reaches of the inlet, especially in the Susitna delta, Knik Arm, and Chickaloon Bay (Rugh et al. 2000b, 2005b, Shelden et al. 2013). These concentrations usually last from mid-May to July or later and are very likely associated with the migration of anadromous fish, particularly eulachon (*Thaleichthys pacificus*) and several species of Pacific salmon (*Oncorhynchus* spp., Moore et al. 2000). Research protocol and coverage area for the June aerial surveys of Cook Inlet have been kept consistent to minimize variables in inter-year analyses. The type of aircraft, window configuration, altitude, air speed, and coastal search patterns were constant, and most of the observers have been on many or all of the surveys, maintaining continuity in effort. On all but one of these 21 surveys, flights were in the first half of June. Each year there have been 4-6 replicate flights around upper Cook Inlet. The large number of flights per year across many years and the consistency of effort have helped us detect patterns of whale distribution and identify changes that have occurred.

Historically many belugas were seen in both upper and lower Cook Inlet in June and July (Rugh et al. 2000b, Shelden et al. in review). However, between 1993 and 1995, during the first 3 years of the NMFS surveys, very few belugas (less than 3% of all of the annual sightings) were in the lower inlet, south of East Foreland and West Foreland (Table 2), and in subsequent years, 1996-2011, hardly any (one whale in Tuxedni Bay in 1997 and two in Kachemak Bay in 2001) were seen in the lower inlet during these surveys. Many marine mammals were seen in the lower inlet throughout the study period: sea otters, harbor seals, harbor porpoise, fin whales, humpback whales, and Steller sea lions (Appendix), which indicates the lack of beluga sightings was not due to poor visibility.

Furthermore, in the southern half of the upper inlet, south of North Foreland and Point Possession, sighting rates dropped from an annual average of 1.5% during the period 1993-1995, to zero for all subsequent years until June 2012. Sighting conditions have generally been ideal during these aerial surveys, but until June 2012 (when a group was consistently found in Trading Bay) the only places where belugas were consistently found were waters north of North Foreland

and Moose Point, which was the case again in June 2014 (Table 2). A steep decline in the number of June sightings in both Knik Arm and Turnagain Arm also occurred after 2007 (Table 2). While a similar lack of whales was observed in Turnagain Arm during the 1990s, this was not the case in Knik Arm.

Although these aerial surveys do provide a broad-scale picture of the whale distribution each June, satellite-tagging provides much more detail over longer time periods, albeit of only a few whales (e.g., 14 belugas: see Hobbs et al. 2005, Goetz et al. 2012b, Shelden et al. in review). Results from tagged whales (from 1999 to 2003) show that the beluga distribution seen during the June aerial surveys is representative of most of the summer through late autumn, with whales remaining in waters north of East and West Foreland (Shelden et al. in review). In winter, some of the whales dispersed into deeper waters and a few explored waters farther south (Chinitna Bay) before returning to the upper inlet, but they never left Cook Inlet (Hobbs et al. 2005, Goetz et al. 2012b, Shelden et al. in review).

Median estimates presented in Table 1 are a rough index of relative abundance; however, calculated abundances with their respective *CV*s (Hobbs et al. in press) include corrections for whales missed within the viewing range of observers, whales missed because they were beneath the surface throughout an aerial counting pass, as well as density corrections. The abundance estimates, with their associated *CV*s, are the appropriate values to use in inter-year trend analyses. The abundance estimates show a steep decline until 1998 and then a gradual decline from 1999 to the present (Fig. 17). In recent years, abundance has dipped to as few as 278 whales (in 2005) but also as many as 375 whales (in 2007 and 2008), thus trends over shorter time periods can vary, and may be positive for some periods although the long-term trend continues to show a decline. The 10-year trend (2004-2014) indicates the population is still gradually declining. The next biennial survey is scheduled for June 2016.

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Clearwater Air, Inc. provided the aircraft and crew. Our pilots in 2014 were Jake Turner and John Spiegel. Our pilots filled a critical role in keeping the aircraft at the preferred altitude and distance from shore, while flying precise patterns over moving whales and watching for aircraft in an exceptionally busy airspace. This survey was conducted under MMPA Scientific Research Permit No. 14245.

Survey data were entered using a software program specifically developed for the Cook Inlet beluga aerial survey by Niel and Kimberly Goetz. Video analyses were conducted by Christy Sims, Linda Vate Brattström, and Lisa Neyman.

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Appendix. -- Sighting data for other marine mammals observed during beluga abundance surveys, June 2014.

Common name	Group size	Date	Latitude (decimal degrees)	Longitude (decimal degrees)	Time (AK DST)	Flight no.	General location
Fin whale	2	6/3/2014	58.954	-153.046	14:45:08	2	E of Cape Douglas/ mid inlet
Fin whale	2	6/4/2014	59.178	-152.859	12:28:17	4	Btwn Elizabeth I-Kamishak Bay/mid inlet
Humpback whale	1	6/3/2014	59.314	-152.471	14:04:39	2	W of Koyuktolik Bay/ mid inlet
Humpback whale	3	6/3/2014	59.241	-152.151	14:10:38	2	W of Koyuktolik Bay/ mid inlet
Humpback whale	1	6/3/2014	59.344	-153.96	15:29:28	2	Bruin Bay
Humpback whale	6	6/4/2014	59.249	-153.434	13:08:25	4	Kamishak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.617	-151.747	10:36:39	1	NE of Kalgin Is./ mid inlet
Harbor porpoise	5	6/3/2014	60.547	-151.826	10:39:27	1	NE of Kalgin Is./ mid inlet
Harbor porpoise	1	6/3/2014	60.526	-151.813	10:40:06	1	NE of Kalgin Is./ mid inlet
Harbor porpoise	1	6/3/2014	60.485	-151.791	10:41:18	1	NE of Kalgin Is./ mid inlet
Harbor porpoise	2	6/3/2014	60.473	-151.784	10:41:39	1	NE of Kalgin Is./ mid inlet
Harbor porpoise	1	6/3/2014	60.469	-151.781	10:41:47	1	NE of Kalgin Is./ mid inlet
Harbor porpoise	2	6/3/2014	60.345	-151.712	10:45:28	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.294	-151.683	10:47:02	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.278	-151.675	10:47:31	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.258	-151.668	10:48:07	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.254	-151.672	10:48:15	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	2	6/3/2014	60.232	-151.884	10:51:22	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.218	-152.057	10:53:58	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.206	-152.198	10:56:07	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.206	-152.206	10:56:14	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.205	-152.223	10:56:28	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.193	-152.365	10:58:34	1	Btwn Kalgin Is.-Tuxedni Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.115	-152.299	11:01:27	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.107	-152.286	11:01:47	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.104	-152.282	11:01:54	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.09	-152.262	11:02:24	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	2	6/3/2014	60.079	-152.244	11:02:51	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	2	6/3/2014	60.074	-152.236	11:03:03	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.054	-152.207	11:03:48	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	60.053	-152.207	11:03:50	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.875	-151.99	11:10:42	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	6	6/3/2014	59.873	-152.016	11:11:06	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	4	6/3/2014	59.873	-152.025	11:11:14	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.872	-152.031	11:11:19	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.842	-152.409	11:16:59	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.84	-152.443	11:17:31	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.838	-152.455	11:17:42	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.836	-152.478	11:18:03	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.818	-152.695	11:21:23	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	2	6/3/2014	59.815	-152.736	11:21:59	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.811	-152.775	11:22:34	1	Btwn Tuxedni -Chinitna Bay/ mid inlet

Harbor porpoise	1	6/3/2014	59.809	-152.794	11:22:51	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.784	-152.676	11:26:31	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.78	-152.658	11:26:51	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.764	-152.579	11:28:18	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.762	-152.575	11:28:23	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	2	6/3/2014	59.747	-152.508	11:29:39	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.74	-152.477	11:30:14	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.74	-152.476	11:30:15	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.714	-152.36	11:32:23	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	3	6/3/2014	59.643	-152.045	11:38:04	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.641	-152.034	11:38:16	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	2	6/3/2014	59.634	-152.002	11:38:51	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.603	-151.867	11:41:11	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.591	-151.814	11:42:06	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.583	-151.775	11:42:47	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.57	-151.723	11:43:43	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/3/2014	59.517	-152.884	13:40:47	2	NE of Augustine Is./ mid inlet
Harbor porpoise	1	6/3/2014	59.515	-152.922	13:41:23	2	NE of Augustine Is./ mid inlet
Harbor porpoise	1	6/3/2014	59.512	-152.995	13:42:35	2	NE of Augustine Is./ mid inlet
Harbor porpoise	1	6/3/2014	59.51	-153.056	13:43:36	2	NE of Augustine Is./ mid inlet
Harbor porpoise	1	6/3/2014	59.508	-153.103	13:44:27	2	NE of Augustine Is./ mid inlet
Harbor porpoise	1	6/3/2014	59.293	-152.372	14:06:30	2	W of Koyuktolik Bay/ mid inlet
Harbor porpoise	2	6/3/2014	58.907	-153.31	14:57:06	2	N of Cape Douglas
Harbor porpoise	1	6/3/2014	58.995	-153.523	15:03:08	2	N of Shaw Is.
Harbor porpoise	1	6/3/2014	59.627	-153.247	16:36:07	2	Oil Bay
Harbor porpoise	1	6/3/2014	59.858	-153.11	16:47:42	2	Chinitna Bay
Harbor porpoise	1	6/3/2014	60.026	-152.578	16:59:20	2	Btwn Chinitna Bay-Tuxedni Bay
Harbor porpoise	1	6/3/2014	60.032	-152.573	16:59:31	2	Btwn Chinitna Bay-Tuxedni Bay
Harbor porpoise	2	6/3/2014	60.277	-152.431	18:29:10	3	N of Tuxedni Bay
Harbor porpoise	1	6/4/2014	59.162	-152.324	12:19:21	4	Btwn Elizabeth I-Kamishak Bay/mid inlet
Harbor porpoise	1	6/4/2014	59.162	-152.329	12:19:26	4	Btwn Elizabeth I-Kamishak Bay mid inlet
Harbor porpoise	1	6/4/2014	59.397	-152.488	13:30:24	4	Btwn Augustine I-Kachemak Bay/mid inlet
Harbor porpoise	1	6/4/2014	59.606	-152.547	15:16:05	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.648	-152.76	15:19:57	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.684	-152.861	15:25:15	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.683	-152.793	15:26:24	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	2	6/4/2014	59.683	-152.779	15:26:38	5	Btwn Chinitna -Kachemak Bay/ mid inlet

Harbor porpoise	1	6/4/2014	59.683	-152.776	15:26:41	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	2	6/4/2014	59.684	-152.768	15:26:49	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.684	-152.744	15:27:13	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	2	6/4/2014	59.687	-152.611	15:29:26	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.687	-152.608	15:29:29	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.687	-152.604	15:29:33	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	3	6/4/2014	59.687	-152.587	15:29:50	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.687	-152.584	15:29:53	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.687	-152.563	15:30:13	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.687	-152.556	15:30:20	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	1	6/4/2014	59.688	-152.53	15:30:46	5	Btwn Chinitna -Kachemak Bay/ mid inlet
Harbor porpoise	2	6/4/2014	59.995	-152.361	15:59:04	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.009	-152.284	16:00:19	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.015	-152.255	16:00:48	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.02	-152.233	16:01:10	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	2	6/4/2014	60.035	-152.141	16:02:40	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.042	-152.109	16:03:13	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	3	6/4/2014	60.079	-151.903	16:06:46	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.084	-151.87	16:07:18	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.092	-151.826	16:08:01	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	2	6/4/2014	60.096	-151.808	16:08:19	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Harbor porpoise	1	6/4/2014	60.1	-151.782	16:08:44	5	Btwn Tuxedni Bay-Ninilchik/ mid inlet
Steller sea lion	40	6/3/2014	58.978	-153.397	15:00:28	2	near Shaw Is.
Steller sea lion	1	6/3/2014	59.371	-153.939	15:38:14	2	Bruin Bay
Steller sea lion	1	6/4/2014	59.416	-151.719	11:39:32	4	Kachemak Bay
Steller sea lion	1	6/4/2014	59.316	-152	11:56:30	4	Btwn English Bay-Koyuktolik Bay
Sea otter	2	6/3/2014	59.876	-151.982	11:10:34	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Sea otter	2	6/3/2014	59.876	-151.986	11:10:38	1	Btwn Tuxedni -Chinitna Bay/ mid inlet
Sea otter	4	6/3/2014	59.674	-152.184	11:35:32	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	1	6/3/2014	59.671	-152.168	11:35:50	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	3	6/3/2014	59.612	-151.903	11:40:32	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	2	6/3/2014	59.579	-151.76	11:43:03	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	2	6/3/2014	59.575	-151.745	11:43:19	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	1	6/3/2014	59.573	-151.736	11:43:28	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	1	6/3/2014	59.573	-151.735	11:43:30	1	Btwn Chinitna -Kachemak Bay/ mid inlet
Sea otter	20	6/3/2014	59.568	-151.717	11:43:50	1	Kachemak Bay
Sea otter	3	6/3/2014	59.566	-151.708	11:43:59	1	Kachemak Bay
Sea otter	2	6/3/2014	59.558	-151.667	11:44:43	1	Kachemak Bay

Sea otter	1	6/3/2014	59.581	-151.594	11:46:03	1	Kachemak Bay
Sea otter	1	6/3/2014	59.584	-151.588	11:46:10	1	Kachemak Bay
Sea otter	30	6/3/2014	59.598	-151.55	11:46:47	1	Kachemak Bay
Sea otter	50	6/3/2014	59.6	-151.544	11:46:52	1	Kachemak Bay
Sea otter	25	6/3/2014	59.605	-151.53	11:47:07	1	Kachemak Bay
Sea otter	2	6/3/2014	59.614	-151.506	11:47:31	1	Kachemak Bay
Sea otter	1	6/3/2014	59.556	-151.783	13:22:31	2	Kachemak Bay
Sea otter	1	6/3/2014	59.556	-151.793	13:22:42	2	Kachemak Bay
Sea otter	1	6/3/2014	59.556	-151.794	13:22:43	2	Kachemak Bay
Sea otter	50	6/3/2014	59.555	-151.816	13:23:06	2	Kachemak Bay
Sea otter	1	6/3/2014	59.555	-151.823	13:23:12	2	Kachemak Bay
Sea otter	1	6/3/2014	59.414	-152.924	13:56:19	2	NE of Augustine Is./ mid inlet
Sea otter	2	6/3/2014	59.012	-153.597	15:04:32	2	N of Shaw Is.
Sea otter	1	6/3/2014	59.027	-153.623	15:05:11	2	N of Shaw Is.
Sea otter	4	6/3/2014	59.037	-153.636	15:05:34	2	N of Shaw Is.
Sea otter	8	6/3/2014	59.051	-153.647	15:06:04	2	N of Shaw Is.
Sea otter	1	6/3/2014	59.08	-153.663	15:07:04	2	N of Shaw Is.
Sea otter	1	6/3/2014	59.242	-154.107	15:24:58	2	S of Bruin Bay
Sea otter	1	6/3/2014	59.411	-153.834	15:44:38	2	N of Bruin Bay
Sea otter	1	6/3/2014	59.397	-153.609	15:48:47	2	Augustine Is.
Sea otter	1	6/3/2014	59.395	-153.599	15:48:58	2	Augustine Is.
Sea otter	1	6/3/2014	59.392	-153.588	15:49:10	2	Augustine Is.
Sea otter	1	6/3/2014	59.336	-153.346	15:59:15	2	Augustine Is.
Sea otter	12	6/3/2014	59.342	-153.341	15:59:24	2	Augustine Is.
Sea otter	2	6/3/2014	59.351	-153.332	15:59:43	2	Augustine Is.
Sea otter	1	6/3/2014	59.356	-153.326	15:59:54	2	Augustine Is.
Sea otter	2	6/3/2014	59.358	-153.325	15:59:56	2	Augustine Is.
Sea otter	2	6/3/2014	59.359	-153.324	15:59:58	2	Augustine Is.
Sea otter	1	6/3/2014	59.37	-153.327	16:00:18	2	Augustine Is.
Sea otter	1	6/3/2014	59.377	-153.332	16:00:31	2	Augustine Is.
Sea otter	21	6/3/2014	59.39	-153.348	16:00:59	2	Augustine Is.
Sea otter	11	6/3/2014	59.422	-153.396	16:02:10	2	Augustine Is.
Sea otter	60	6/3/2014	59.426	-153.41	16:02:24	2	Augustine Is.
Sea otter	11	6/3/2014	59.426	-153.42	16:02:34	2	Augustine Is.
Sea otter	6	6/3/2014	59.401	-153.55	16:04:58	2	Augustine Is.
Sea otter	1	6/3/2014	59.624	-153.518	16:23:38	2	Iniskin Bay
Sea otter	1	6/3/2014	59.657	-153.445	16:25:06	2	Iniskin Bay
Sea otter	6	6/3/2014	59.64	-153.439	16:30:59	2	Iniskin Bay
Sea otter	1	6/3/2014	59.628	-153.421	16:31:31	2	Iniskin Bay
Sea otter	4	6/3/2014	59.625	-153.406	16:31:48	2	Iniskin Bay
Sea otter	1	6/3/2014	59.633	-153.196	16:37:00	2	Oil Bay
Sea otter	2	6/3/2014	59.705	-153.026	16:40:32	2	Chinitna Pt.
Sea otter	5	6/3/2014	59.706	-153.026	16:40:35	2	Chinitna Pt.
Sea otter	1	6/3/2014	59.975	-152.647	16:57:23	2	Btwn Chinitna Bay-Tuxedni Bay
Sea otter	1	6/3/2014	59.997	-152.611	16:58:14	2	Btwn Chinitna Bay-Tuxedni Bay
Sea otter	2	6/3/2014	60.205	-152.765	18:15:42	3	Tuxedni Bay
Sea otter	1	6/3/2014	60.217	-152.806	18:16:27	3	Tuxedni Bay
Sea otter	2	6/4/2014	60.37	-151.394	10:19:17	4	Kasilof Pt.
Sea otter	1	6/4/2014	59.697	-151.825	10:46:33	4	Kachemak Bay
Sea otter	7	6/4/2014	59.695	-151.819	10:46:40	4	Kachemak Bay
Sea otter	4	6/4/2014	59.69	-151.809	10:46:53	4	Kachemak Bay

Sea otter	3	6/4/2014	59.684	-151.797	10:47:10	4	Kachemak Bay
Sea otter	1	6/4/2014	59.681	-151.791	10:47:18	4	Kachemak Bay
Sea otter	1	6/4/2014	59.679	-151.786	10:47:24	4	Kachemak Bay
Sea otter	3	6/4/2014	59.644	-151.691	10:49:17	4	Kachemak Bay
Sea otter	2	6/4/2014	59.622	-151.579	10:51:13	4	Kachemak Bay
Sea otter	1	6/4/2014	59.621	-151.555	10:51:37	4	Kachemak Bay
Sea otter	1	6/4/2014	59.62	-151.544	10:51:48	4	Kachemak Bay
Sea otter	248	6/4/2014	59.619	-151.531	10:52:01	4	Kachemak Bay
Sea otter	1	6/4/2014	59.596	-151.451	10:53:42	4	Kachemak Bay
Sea otter	1	6/4/2014	59.625	-151.429	10:56:21	4	Kachemak Bay
Sea otter	1	6/4/2014	59.625	-151.429	10:56:22	4	Kachemak Bay
Sea otter	15	6/4/2014	59.632	-151.439	10:56:40	4	Kachemak Bay
Sea otter	1	6/4/2014	59.638	-151.437	10:56:54	4	Kachemak Bay
Sea otter	2	6/4/2014	59.645	-151.428	10:57:10	4	Kachemak Bay
Sea otter	1	6/4/2014	59.65	-151.42	10:57:24	4	Kachemak Bay
Sea otter	165	6/4/2014	59.657	-151.402	10:57:49	4	Kachemak Bay
Sea otter	128	6/4/2014	59.658	-151.402	10:57:50	4	Kachemak Bay
Sea otter	145	6/4/2014	59.685	-151.288	10:59:57	4	Kachemak Bay
Sea otter	46	6/4/2014	59.685	-151.287	10:59:58	4	Kachemak Bay
Sea otter	95	6/4/2014	59.713	-151.215	11:01:29	4	Kachemak Bay
Sea otter	7	6/4/2014	59.721	-151.197	11:01:53	4	Kachemak Bay
Sea otter	16	6/4/2014	59.737	-151.164	11:02:38	4	Kachemak Bay
Sea otter	2	6/4/2014	59.772	-151.024	11:05:16	4	Kachemak Bay
Sea otter	10	6/4/2014	59.773	-151.016	11:05:24	4	Kachemak Bay
Sea otter	4	6/4/2014	59.773	-151.014	11:05:26	4	Kachemak Bay
Sea otter	1	6/4/2014	59.755	-151.057	11:08:36	4	Kachemak Bay
Sea otter	1	6/4/2014	59.73	-151.085	11:09:32	4	Kachemak Bay
Sea otter	1	6/4/2014	59.715	-151.111	11:10:13	4	Kachemak Bay
Sea otter	1	6/4/2014	59.705	-151.128	11:10:38	4	Kachemak Bay
Sea otter	2	6/4/2014	59.701	-151.135	11:10:49	4	Kachemak Bay
Sea otter	5	6/4/2014	59.693	-151.143	11:11:07	4	Kachemak Bay
Sea otter	2	6/4/2014	59.692	-151.144	11:11:10	4	Kachemak Bay
Sea otter	296	6/4/2014	59.679	-151.154	11:11:40	4	Kachemak Bay
Sea otter	72	6/4/2014	59.678	-151.154	11:11:41	4	Kachemak Bay
Sea otter	5	6/4/2014	59.641	-151.223	11:13:34	4	Kachemak Bay
Sea otter	1	6/4/2014	59.601	-151.195	11:15:05	4	Kachemak Bay
Sea otter	1	6/4/2014	59.569	-151.267	11:19:05	4	Kachemak Bay
Sea otter	1	6/4/2014	59.558	-151.42	11:22:17	4	Kachemak Bay
Sea otter	38	6/4/2014	59.556	-151.427	11:22:25	4	Kachemak Bay
Sea otter	1	6/4/2014	59.529	-151.475	11:23:37	4	Kachemak Bay
Sea otter	6	6/4/2014	59.525	-151.476	11:23:45	4	Kachemak Bay
Sea otter	2	6/4/2014	59.476	-151.46	11:32:46	4	Kachemak Bay
Sea otter	1	6/4/2014	59.486	-151.518	11:33:49	4	Kachemak Bay
Sea otter	3	6/4/2014	59.491	-151.664	11:36:20	4	Kachemak Bay
Sea otter	3	6/4/2014	59.457	-151.735	11:38:06	4	Kachemak Bay
Sea otter	1	6/4/2014	59.41	-151.712	11:39:45	4	Kachemak Bay
Sea otter	2	6/4/2014	59.417	-151.709	11:41:36	4	Kachemak Bay
Sea otter	1	6/4/2014	59.427	-151.721	11:42:00	4	Kachemak Bay
Sea otter	9	6/4/2014	59.454	-151.751	11:43:08	4	Kachemak Bay
Sea otter	1	6/4/2014	59.454	-151.761	11:43:18	4	Kachemak Bay
Sea otter	2	6/4/2014	59.446	-151.842	11:44:38	4	Kachemak Bay

Sea otter	2	6/4/2014	59.385	-151.919	11:47:26	4	English Bay
Sea otter	2	6/4/2014	59.37	-151.878	11:48:20	4	English Bay
Sea otter	1	6/4/2014	59.358	-151.951	11:54:51	4	English Bay
Sea otter	1	6/4/2014	59.284	-152.003	11:57:36	4	Btwn English Bay-Koyuktolik Bay
Sea otter	1	6/4/2014	59.25	-151.989	11:58:53	4	Koyuktolik Bay
Sea otter	1	6/4/2014	59.239	-151.938	11:59:56	4	Koyuktolik Bay
Sea otter	1	6/4/2014	59.245	-151.881	12:01:01	4	Koyuktolik Bay
Sea otter	2	6/4/2014	59.205	-151.884	12:03:17	4	near Elizabeth Is.
Sea otter	1	6/4/2014	59.198	-151.848	12:03:50	4	near Elizabeth Is.
Sea otter	1	6/4/2014	59.15	-151.929	12:13:00	4	near Elizabeth Is.
Sea otter	15	6/4/2014	59.197	-153.77	13:02:01	4	Kamishak Bay/ mid inlet
Sea otter	25	6/4/2014	59.196	-153.748	13:02:29	4	Kamishak Bay/ mid inlet
Sea otter	1	6/4/2014	59.2	-153.73	13:02:51	4	Kamishak Bay/ mid inlet
Sea otter	10	6/4/2014	59.223	-153.622	13:04:53	4	Kamishak Bay/ mid inlet
Sea otter	2	6/4/2014	59.227	-153.593	13:05:23	4	Kamishak Bay/ mid inlet
Sea otter	1	6/4/2014	59.285	-153.206	13:18:33	4	Kamishak Bay/ mid inlet
Harbor seal	10	6/3/2014	59.638	-153.438	16:31:03	2	Iniskin Bay
Harbor seal	3	6/3/2014	59.868	-152.854	16:52:07	2	Chinitna Bay
Harbor seal	1	6/3/2014	60.221	-152.819	18:16:41	3	Tuxedni Bay
Harbor seal	2	6/3/2014	60.22	-152.782	18:21:42	3	Tuxedni Bay
Harbor seal	1	6/3/2014	60.274	-152.45	18:28:51	3	N of Tuxedni Bay
Harbor seal	1	6/3/2014	60.639	-152.045	18:53:58	3	Redoubt Bay
Harbor seal	105	6/3/2014	60.71	-151.875	18:59:44	3	Redoubt Bay
Harbor seal	30	6/3/2014	60.712	-151.898	19:00:09	3	Redoubt Bay
Harbor seal	25	6/3/2014	60.71	-151.907	19:00:19	3	Redoubt Bay
Harbor seal	12	6/3/2014	60.703	-151.914	19:00:37	3	Redoubt Bay
Harbor seal	60	6/3/2014	60.71	-151.878	19:04:08	3	Redoubt Bay
Harbor seal	1	6/4/2014	60.554	-151.256	10:08:35	4	Kenai River
Harbor seal	369	6/4/2014	59.773	-151.001	11:05:39	4	Kachemak Bay
Harbor seal	4	6/4/2014	59.774	-151.036	11:07:52	4	Kachemak Bay
Harbor seal	2	6/4/2014	59.767	-151.044	11:08:09	4	Kachemak Bay
Harbor seal	20	6/4/2014	59.76	-151.052	11:08:25	4	Kachemak Bay
Harbor seal	1	6/4/2014	59.719	-151.103	11:10:01	4	Kachemak Bay
Harbor seal	1	6/4/2014	59.571	-151.267	11:19:08	4	Kachemak Bay
Harbor seal	1	6/4/2014	59.583	-151.283	11:19:40	4	Kachemak Bay
Harbor seal	2	6/5/2014	60.947	-149.994	10:44:09	6	Chickaloon Bay
Harbor seal	5	6/5/2014	60.912	-150.074	10:49:02	6	Chickaloon Bay
Harbor seal	15	6/5/2014	60.923	-150.093	11:07:31	6	Chickaloon Bay
Harbor seal	1	6/5/2014	60.901	-151.66	12:16:24	6	McArthur R.
Harbor seal	250	6/5/2014	61.205	-150.833	12:38:27	6	Theodore R.
Harbor seal	100	6/5/2014	61.218	-150.771	12:39:26	6	Lewis R.
Harbor seal	40	6/7/2014	61.204	-150.8	10:40:15	8	Theodore R.
Harbor seal	1	6/7/2014	61.204	-150.735	10:41:28	8	Lewis R.
Harbor seal	400	6/7/2014	61.173	-150.529	10:45:05	8	Susitna R.
Harbor seal	60	6/7/2014	61.17	-150.467	10:46:08	8	Susitna R.
Harbor seal	1	6/8/2014	60.961	-149.934	12:43:17	9	Chickaloon Bay
Harbor seal	1	6/8/2014	60.969	-150.079	12:48:20	9	Chickaloon Bay
Harbor seal	1	6/9/2014	61.203	-150.763	10:58:24	10	Lewis R.
Harbor seal	5	6/9/2014	61.195	-150.821	10:59:31	10	Theodore R.
Harbor seal	6	6/9/2014	61.189	-150.839	10:59:54	10	Beluga R.

Harbor seal	10	6/9/2014	61.184	-150.855	11:00:15	10	Beluga R.
Harbor seal	300	6/9/2014	61.186	-150.519	13:01:03	10	Susitna R.
Harbor seal	9	6/10/2014	60.943	-150.125	10:56:39	11	Chickaloon R.
Harbor seal	100	6/10/2014	61.195	-150.528	13:30:55	11	Susitna R.
Harbor seal	1	6/11/2014	61.131	-150.922	11:44:45	13	Beluga R.
Harbor seal	150	6/11/2014	61.169	-150.508	13:07:23	13	Susitna R.
Harbor seal	8	6/12/2014	60.975	-150.076	10:38:19	14	Chickaloon Bay