

# AERIAL SURVEYS OF BELUGAS IN COOK INLET, ALASKA, JUNE 2011

Kim E. W. Shelden, Kimberly T. Goetz, Christy L. Sims,  
Linda Vate Brattström, and Roderick C. Hobbs

National Marine Mammal Laboratory,  
Alaska Fisheries Science Center  
National Marine Fisheries Service, NOAA  
7600 Sand Point Way NE,  
Seattle, Washington 98115

**ABSTRACT**--The National Marine Fisheries Service (NMFS) conducted surveys of the beluga population in Cook Inlet, Alaska, 31 May-9 June 2011. Using the same protocol since 1993, we flew aerial surveys (47 flight hours) of Cook Inlet in a twin-engine, high-wing Aero Commander aircraft at an altitude of 244 m (800 ft) and speed of 185 km/hr (100 kt). The study in June 2011 included surveys of coastal areas (flown 1.4 km offshore) around most of the inlet and 1585 km of transects across the inlet, effectively searching 32% of Cook Inlet's total area. Paired observers searched on the shore-ward (left) side of the plane where most beluga sightings occur, while a single observer and computer operator/data recorder were on the right side of the plane. After finding belugas, multiple aerial passes were made with paired observers completing four or more independent counts of each group. Daily median counts made on 7 different days ranged from 83 to 187 belugas in the Susitna delta (between the Beluga and Little Susitna rivers), and 10 to 72 belugas in Chickaloon Bay (including Fire Island and Turnagain Arm). Belugas were not found in Turnagain Arm or Knik Arm. Belugas were not observed in lower Cook Inlet, which is typical of annual surveys in most of the recent years. In June 2011, the highest daily median estimate, used here as an index for relative abundance (not corrected for effort or for whales missed by the observer), was 208 belugas. This is within the range of index counts from previous survey years (305 belugas in 1993, 281 in 1994, 324 in 1995, 307 in 1996, and 264 in 1997, 193 in 1998, 217 in 1999, 184 in 2000, 211 in 2001, 192 in 2002, 174 in 2003, 187 in 2004, 192 in 2005, 153 in 2006, 224 in 2007, 126 in 2008, 303 in 2009, and 291 in 2010).

## Introduction

The National Marine Fisheries Service (NMFS) conducts annual aerial surveys to study beluga (*Delphinapterus leucas*) distribution and abundance in Cook Inlet, Alaska. These surveys typically occur in June and have been repeated each year since 1993 (Rugh et al. 2005, 2010). This project is conducted in cooperation with the Cook Inlet Marine Mammal Council (CIMMC) and the Alaska Beluga Whale Committee (ABWC). The objectives for the annual June surveys are to document beluga sightings for distributional analysis and to count and video belugas in Cook Inlet for abundance estimates. The intent of the 2011 survey was to maintain continuity with preceding NMFS surveys allowing for inter-year trend analyses.

Until 1999, Cook Inlet belugas were subjected to an unregulated subsistence harvest (Mahoney and Sheldon 2000). Following abundance estimates that indicated this stock had declined nearly 50% between 1994 and 1998, NMFS designated the stock as depleted under the Marine Mammal Protection Act (65 FR 34590) on 31 May 2000. The small population size, approximately 300-400 whales (Hobbs et al. 2000a) and isolation of the Cook Inlet beluga stock (O’Corry-Crowe et al. 1997; Laidre et al. 2000; Rugh et al. 2000) has focused management concerns on these whales. In October 2008 (73 FR 62919), this population was listed as *endangered* under the U.S. Endangered Species Act.

## Methods

### Aircraft and data

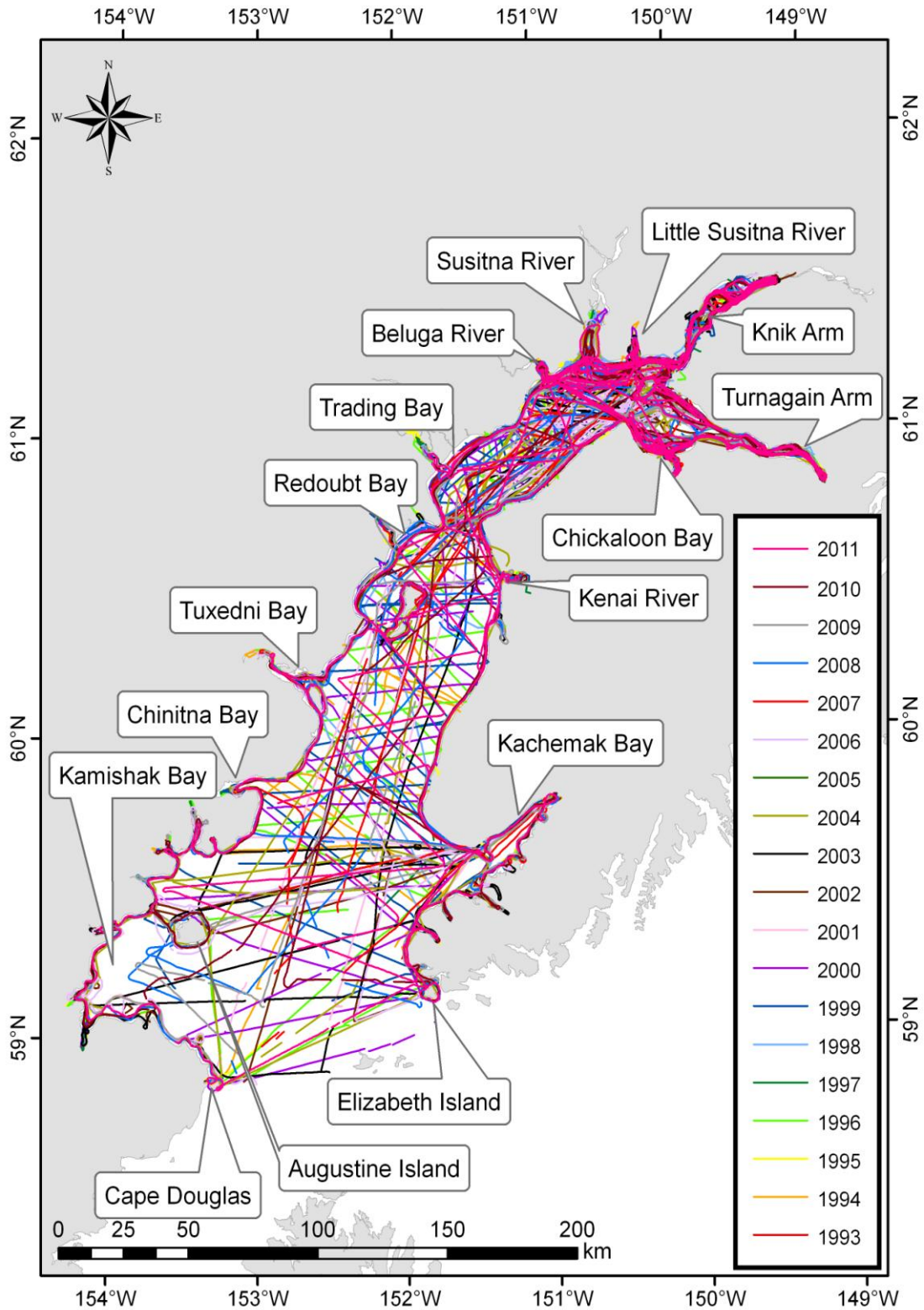
The survey aircraft used in June 2011, an Aero Commander 690 (*N222ME*), has twin-engines, high-wings, and more than 8-hour flying capability. Bubble windows were at the right and left forward observer positions, maximizing the search area. A large window behind the left front observer position was used by another observer to assess detectability of beluga groups and to count and video record beluga groups. The data recorder used a laptop computer<sup>1</sup> connected to a handheld portable Global Positioning System (GPS) to record sighting and location data from a. Data entries included routine updates of time and location, as well as percent cloud cover, sea state (Beaufort scale), glare (on the left and right sides), and visibility (on the left and right sides). Visibility was documented in five subjective categories from excellent to useless; when conditions were rated poor or useless the trackline was considered unsurveyed. Each start and stop of a transect leg was recorded. Observer seating positions were noted each time they were changed.

### Tracklines

Coastal surveys were conducted approximately 1.4 km offshore from the apparent waterline. The objective was to search all nearshore, shallow waters where belugas are typically seen in late spring/early summer (Rugh et al. 2000, 2010). The trackline distance from shore was monitored with an inclinometer such that the waterline was generally 10° below horizontal while the aircraft was at the standard altitude of 244 m (800 ft). Ground speed was approximately 185 km/hr (100 knots). This coastal survey included searches up rivers until the water appeared to be too shallow for belugas (as indicated by Native hunters who participated on surveys in the past). In addition to the coastal surveys, systematic transects were flown across the inlet in a zig-zag pattern and designed to minimize overlap with tracklines from previous years (Fig. 1).

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<sup>1</sup> Starting in 2006, survey data were entered using a new software program specifically developed for the Cook Inlet beluga aerial survey by Niel and Kimberly Goetz.



**Figure 1.** On-effort tracklines for June aerial surveys of belugas in Cook Inlet, 1993-2011.

## **Tides**

Due to the broad geographical range of these surveys in conjunction with rapidly changing tidal heights, surveys were not flown at specific tidal conditions throughout Cook Inlet. There was a general attempt to synchronize flights with low tides in the Susitna delta because: 1) the effective survey area was minimized at low tide when large areas of mudflats were exposed; and 2) beluga groups tend to concentrate along the edges of the mudflats at low tide, making them easier to locate and count. On the contrary, Turnagain Arm was surveyed on the slack tide to prevent compromised visibility which often occurs at low tide due to tide rips and white caps. Because belugas tend to be close to shore or in Chickaloon Bay and Chickaloon River, we also surveyed this area at high tide. Aerial surveys south of East and West Foreland were scheduled as a function of weather, not tides.

Although there are many daylight hours in June, light levels in Anchorage were low enough to prevent surveying before 07:30 or after 19:30, 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, each observer reported the sighting to the data recorder. As the aircraft passed abeam of the whale group, the observer(s) informed the recorder of the inclinometer angle and notable group behaviors but not group size. After a beluga group was reported, the trackline was maintained until the group was well behind the aircraft. The pilot and data recorder were instructed not to call out beluga sightings until the whales were past the wing and likely missed by observers on that side of the aircraft. After the initial sighting of belugas and passing the whale group, the systematic search effort was stopped and counting passes began.

Whale group locations were established at the onset of the counting passes by flying directly over the group and marking the group perimeters with GPS positions. 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 belugas. Whale counts were made on each pass down the long axis of the oval, with the observers and cameras on the left side of the aircraft. Counts began and ended on cue from the front counter, starting when the leading edge of the beluga group was close enough to be counted and ending when the trailing edge went behind the wing line. This provided a precise record for the duration of each counting effort. The paired observers made independent counts and recorded their results along with date, time, pass number, and quality of the counting pass. The pass quality was a function of how well the observers saw the group location – it was not a function of how many whales were at the surface on the respective pass. Ratings were A (the counting effort was uncompromised by glare, whitecaps, distance, etc.) through F (when it was not practical to count whales). Only passes given quality codes of A and B are used in the abundance analysis. Although whale tracks can be seen in muddy water, only whales at the surface during a pass were included in the counts. Daily count records were not shared within the aerial team until the survey effort was completed to maximize the independence of each observer's counts.

The daily aerial counts are represented by medians of each observer's median counts on multiple passes (typically 4 to 8 passes) over each whale group (Table 1). Using median counts instead of maximum or mean counts reduces the effect of outliers (extreme high or low counts) and makes the NMFS surveys more comparable to other surveys that lack multiple counting passes over whale groups. Median counts are also more appropriate than maximums when these counts are corrected for missed whales because correction factors should be applied to representative counts, not extremes. However,

when establishing the annual index, the procedure has been to use the highest of the daily medians instead of a median of all daily medians; this avoids including counts from days with only partial surveys.

**Table 1.** Beluga counts made during aerial surveys of Cook Inlet in June 2011. Counts are medians from multiple counts of each whale group. Dashes indicate no survey effort and zeros indicate that the area was surveyed, but no whales were seen. Sites are listed in a clockwise order around Cook Inlet starting with Turnagain Arm.

Location	5/31	6/1	6/2	6/3	6/4	6/5	6/6	6/7	6/8	6/9
<b>Turnagain Arm</b>	0	---	0	---	0	0	---	---	0	0
<b>Chickaloon Bay/ Point Possession</b>	31	17	33	72	10	21	---	---	40	<sup>d</sup>
Point Possession to Moose Point/East Foreland	0	0	---	---	---	---	---	---	---	0
Mid-inlet east of Trading Bay	---	---	---	---	---	---	---	0	---	---
East Foreland to Homer	---	0 <sup>b</sup>	---	---	---	---	---	0 <sup>c</sup>	---	---
Kachemak Bay to Elizabeth Island	---	---	---	---	---	---	0	0	---	---
West side of lower Cook Inlet	---	---	---	---	---	---	0	---	---	---
Redoubt Bay	---	---	---	---	---	---	0	---	---	---
<b>Trading Bay</b>	0	0	---	---	---	---	---	---	---	---
<b>Susitna delta<sup>a</sup></b>	127	170	105	83	117	187	---	---	128	<sup>d</sup>
<b>Knik Arm</b>	0	0	0	0	0	0	---	---	0	0
<b>Fire Island</b>	0	0	0	0	2	0	---	---	0	0
<b>Totals</b>	<b>158</b>	<b>187</b>	<b>138</b>	<b>155</b>	<b>129</b>	<b>208</b>	<b>0</b>	<b>0</b>	<b>168</b>	<sup>d</sup>

<sup>a</sup>The coast between North Foreland and Point Mackenzie is defined as the Susitna delta.

<sup>b</sup>Surveyed to Kenai River (upriver to shallows) and south to Clam Gulch where low clouds and fog ended the survey on 6/1.

<sup>c</sup>Survey began at Clam Gulch (where the 6/1 survey ended) and ended at Waypoint 1 where offshore transects were run in a sawtooth pattern back to Anchorage.

<sup>d</sup>Groups were either too small or widely dispersed to obtain video. A large, dispersed group was in Chickaloon Bay. Small groups were in the Beluga River (median count: 23 whales), Theodore River (6 whales) and Little Susitna River (2 whales). Another large, dispersed group covered the entire region from the Ivan River, the Susitna River mudflats, to just beyond the east tributary of the Susitna River.

## Cameras

Paired High Definition (HD) Sony HXR-NX5U video cameras were used to document beluga groups; one camera had a lens set at wide angle to view the entire beluga group, and the second camera lens was zoomed to magnify individual whales in the group. The zoomed video is used to determine correction factors for missed animals (see Hobbs et al. 2000b) and to examine color ratios of white

adults relative to dark juveniles (Litzky 2001; Sims et al. 2003, 2006). For many years, Cook Inlet beluga abundance surveys relied on a “standard” mini digital video camera with resolution of 720 x 480 pixels (a Sony DVCAM, DSR-PDX10 Model L10A), but from 2006 through 2010 paired JVC GR-HD1 High Definition cameras (1290 x 720) were used to provide better resolution video. In 2011, the purchase of two new Sony HXR-NX5U High Definition video cameras with 1920 x 1080 pixel resolution replaced the older video cameras to further increase the quality of video and streamline post-processing of digital video files. The paired Sony cameras were operated on all counting passes when group size appeared to be more than 10 belugas. Video clips from the two cameras will be studied in the laboratory to obtain precise beluga counts. These video beluga counts will be assessed for the amount of time the counting area was in view, and then a correction can be applied for whales under the surface and not visible in the video (Hobbs et al. 2000b). The beluga counts from the video images will be used to help determine the 2011 Cook Inlet beluga abundance estimate (e.g., Hobbs et al. 2000a).

## Results

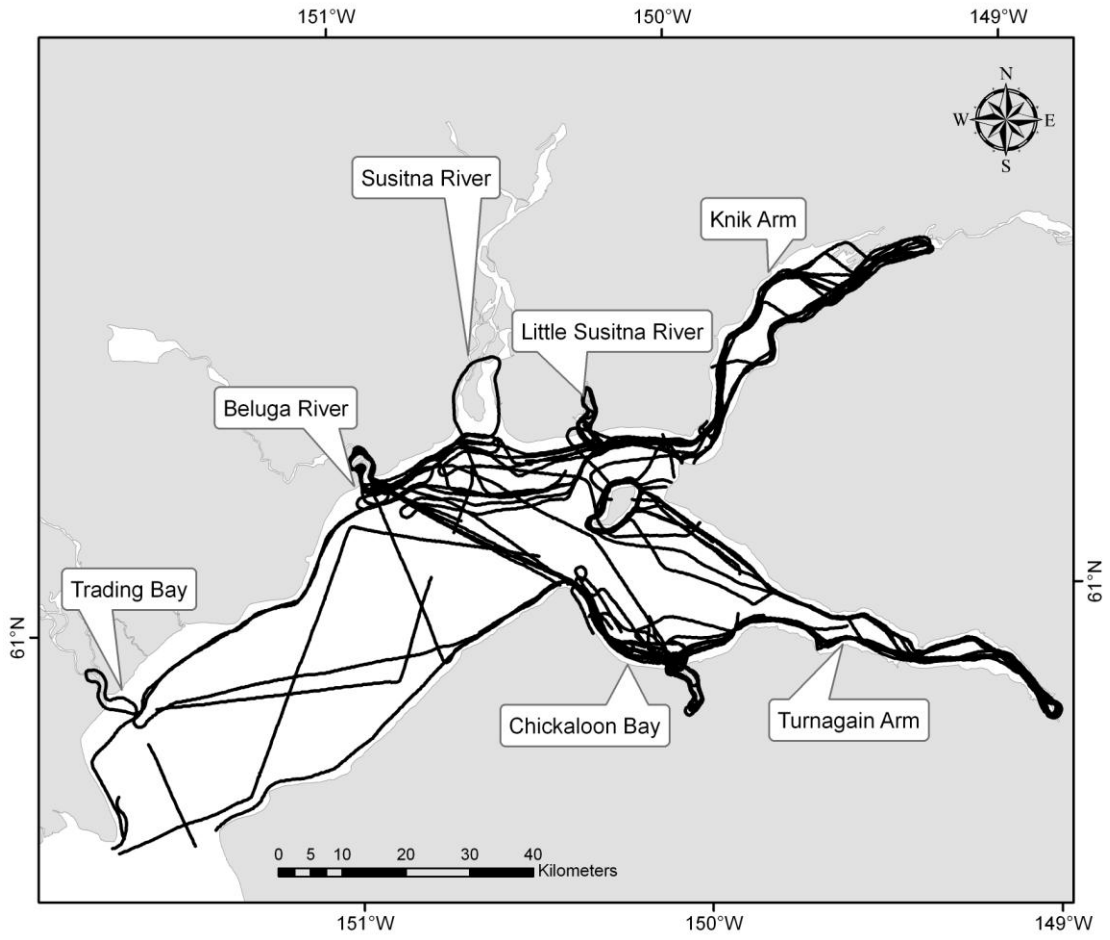
### Survey effort

A total of 47 hours were flown around Cook Inlet 31 May-9 June 2011. All flights (15 take-offs and landings ranging from 1 to 5 hours) were based out of Anchorage, sometimes with refueling stops in Homer and Kenai. Of the 47 flight hours, 30.1 hours were spent on survey effort (i.e., not including time on the runway, deadheading without a search effort, circling whale groups to conduct counts, or periods with poor or useless visibility). Due to poor or useless visibility as determined by the left-front observer, 1.2 hours of search effort (~4% of the possible search time) was lost.

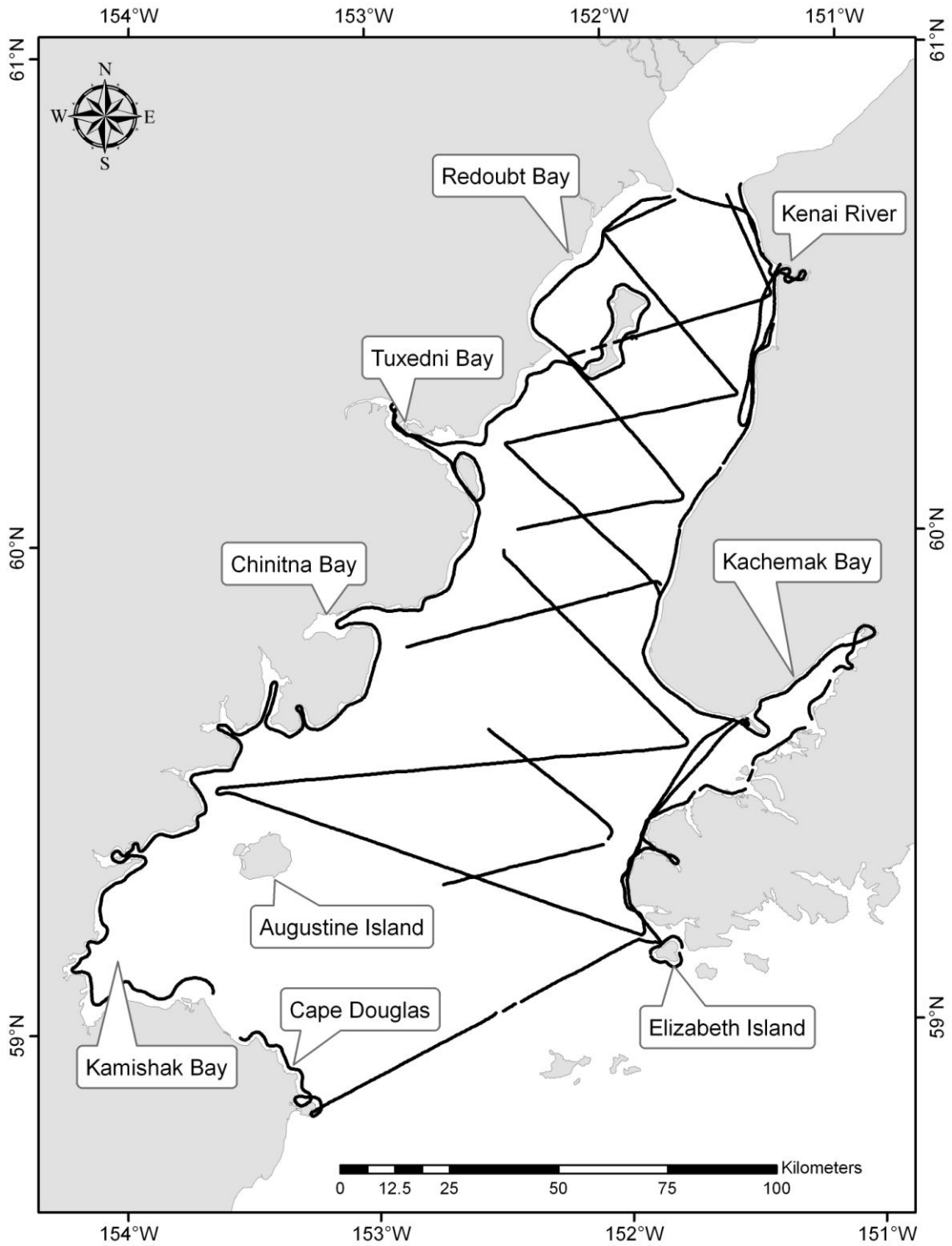
One observers (KWS) has participated in the Cook Inlet beluga surveys in most or all seasons since the project began in 1993. One observer (CLS) had participated in 2003, 2004, 2006, 2009 and 2010. The remaining two observers (KTG & LWB) have participated since 2005 and 2008, respectively.

### Coverage

The June 2011 aerial surveys provided a thorough coverage (100%) of the Cook Inlet coastline (1,810 km) for waters within approximately 3 km of shore (Figs. 2 and 3). In addition, 1,585 km of systematic transects were flown across the Inlet. Assuming a 2.0 km transect swath (1.4 km on the left side plus 1.4 km on the right side, less the 0.8 km blind zone beneath the aircraft), the cumulative survey tracklines covered 6,790 km<sup>2</sup>, which is 32% of the Cook Inlet surface area (20,943 km<sup>2</sup>). This coverage was similar to past beluga surveys in Cook Inlet (Rugh et al. 2000). Upper Cook Inlet was surveyed on six days in June 2011, concentrating in areas where beluga groups have consistently been found in the past, such as the Susitna delta, Knik Arm, Turnagain Arm, and Chickaloon Bay. Excluding repetitions of the upper inlet, 62% of upper Cook Inlet’s total area was covered by all offshore transects (1,265 km<sup>2</sup>) and coastline surveys (1,100 km<sup>2</sup>). In lower Cook Inlet, surveys covered 26% of the area (1,906 km<sup>2</sup> of coastline plus 2,519 km<sup>2</sup> of offshore transects relative to a surface area of 17,131 km<sup>2</sup>).

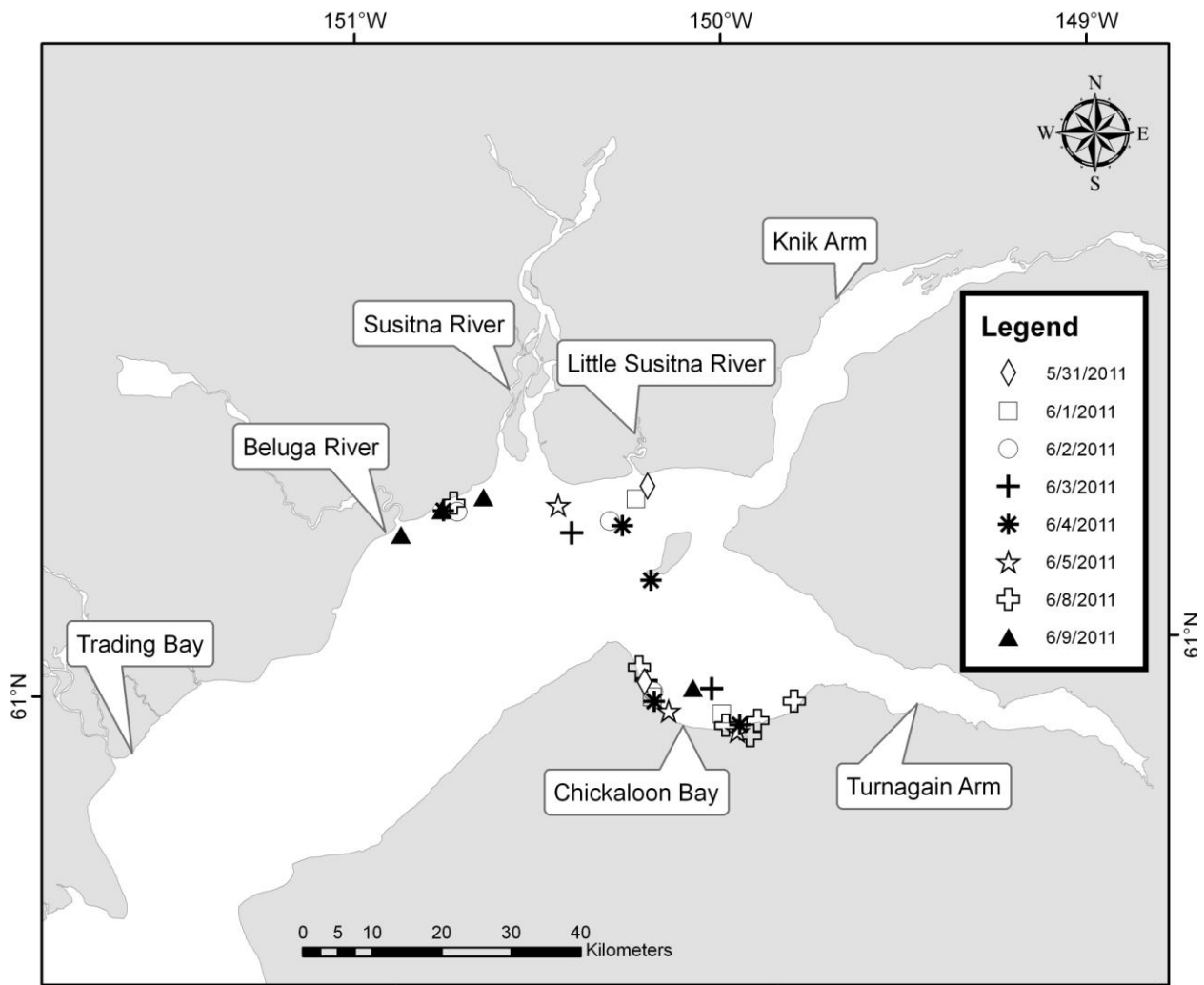


**Figure 2.** On-effort tracklines for aerial surveys of belugas, upper Cook Inlet, June 2011.



**Figure 3.** On-effort tracklines for aerial surveys of belugas, lower Cook Inlet, June 2011.





**Figure 4.** Beluga sightings in Cook Inlet, June 2011.

### 2011 Daily Reports

#### May 31

The season began with a survey of upper Cook Inlet extending south to Moose Point and McArthur River (Trading Bay). Surveys were timed to coincide with the falling/low tide (+0.48 ft) at Susitna River and Knik Arm. We departed Anchorage and circled the west shore of Fire Island before crossing Chickaloon Bay and entering Turnagain Arm. We surveyed the entire Arm and conducted video experiments through the belly port over Bird Point. The HD cameras were set at wide-angle and maximum zoom and then changed to 50% zoom and 75% zoom for passes over the stone belugas at 700, 800, and 900 ft (214-275 m). We continued the survey into Chickaloon Bay, surveying up Chickaloon River and along the bluffs where belugas (Group 1: 5 video and 6 counting passes) were encountered (Fig. 4). We resumed the coastal survey around Point Possession to Moose Point where we crossed the inlet to the McArthur River. We surveyed up the river before resuming the coastal survey to Beluga River. We surveyed up Beluga River to the power lines before crossing the mouth of the Susitna River

to the Little Susitna River where a large group of belugas (Group 2: 8 video and counting passes; the older JVC HD camera replaced one of the new Sony HD cameras during the last 4 passes for comparison purposes) was found along the shore near the river mouth with part of the group entering the Little Susitna River (Fig.4). Other marine mammal sightings included harbor seals (*Phoca vitulina*) hauled out on the Chickaloon River mudflats (12 animals) and in the water at the McArthur River (n=20), Beluga River (n=4), and just before the Susitna mudflats (n=1) (Fig. 5). After a short break in Anchorage, we conducted a second flight from the Little Susitna River, around Point Mackenzie and flew the coast around most of Knik Arm with the exception of restricted airspace south of Eagle Bay to Anchorage. No marine mammals were observed in Knik Arm. Sighting conditions were fair to excellent with Beaufort ranging from 1 to 4.

### June 1

We departed Anchorage, circled Fire Island, and then followed the shoreline before crossing Turnagain Arm to Chickaloon Bay. High winds (30 kts) and low clouds precluded surveying Turnagain Arm and offshore waters of Chickaloon Bay. Belugas (Group 1: 6 video and counting passes) were observed by the right front observer just offshore of Chickaloon River (Fig. 4). Near the same location as group 1 seen the day before, a second group of belugas (Group 2: 6 video and counting passes) was near the Chickaloon Bluffs. We then continued the coastal survey from Point Possession to Kenai. After surveying up Kenai River, we continued to fly south to Clam Gulch where rain and low clouds forced us to turn back on a trackline about one mile offshore. After landing in Kenai to refuel, the survey continued across the inlet to West Foreland following the coastline north into Knik Arm and ending at Anchorage. A large group of belugas (Group 3: 10 counting and video passes) was sighted west of the Little Susitna River, similar to the group seen the day before. Two offshore tracklines across the Susitna delta were attempted but sighting conditions deteriorated significantly. We surveyed Knik Arm with no airspace restrictions occurred between Elmendorf and Anchorage. Sighting conditions were fair to excellent during the survey with the exception of Turnagain Arm (30 kt winds), south of Clam Gulch and mid-Inlet (heavy rain) and offshore in the Susitna delta (high sea states). Sea states ranged from Beaufort 0 to 3 with areas in Chickaloon Bay and the Susitna delta at Beaufort 4 to 5. Other marine mammal sightings included: 8 harbor seals hauled out near Chickaloon River, 2 harbor seals in the water near Beluga River, and 10 harbor seals hauled on the Susitna Delta mudflats (Fig. 5).

### June 2

We completed a full survey of the upper inlet north of Point Possession and North Foreland (including Turnagain Arm, Chickaloon Bay, Susitna Delta, and Knik Arm and offshore transects in Chickaloon Bay). The flight coincided with the high tide in Turnagain Arm and falling tide in the Susitna delta. Belugas were in three groups: Group 1 was scattered along the bluffs of Chickaloon Bay (7 video and counting passes), Group 2 was near Lewis River, travelling toward Beluga River (6 video and counting passes), and Group 3, a large, compact group, was between Susitna River and Little Susitna River (9 video and counting passes) (Fig. 4). Other marine mammal sightings included: 16 harbor seals hauled out in two groups (n=2 and 14) at Chickaloon River and about 70 harbor seals hauled out at the Theodore River (Fig. 5). Sightings conditions were much improved from the previous day with calm sea states and fair to excellent visibility.

### June 3

We completed a full survey of the upper inlet north of Point Possession and North Foreland, with the exception of Turnagain Arm (due to high winds). The morning flight coincided with the rising tide in Turnagain Arm and high tide in the Susitna delta. Belugas were found in dispersed groups throughout Chickaloon Bay (Group 1) or scattered from the mouth of the Little Susitna and into the first bends of the river (Group 2) which made collecting counts and video extremely difficult. We also counted 26 harbor seals hauled out at Chickaloon River. After completing a morning coastal survey, we landed to wait for the low tide (15:28 at -0.95 ft). During the afternoon flight, sighting conditions continued to deteriorate (Beaufort sea states ranging from 3 to 6). The Chickaloon Bay group was amassed along the bluffs (Group 1B: 7 video and counting passes) and in a small group in the mouth of the Chickaloon River (Group 1A: 4 video and counting passes) (Fig. 4). The Little Susitna River group had moved out of the river and was traveling along the east tributary of the Susitna River, heading west (Group 2: 9 counting passes but only 2 video passes due to high sea states). Other marine mammal sightings included: 41 harbor seals hauled out at Chickaloon River and about 150 harbor seals hauled out at the Lewis River (Fig. 5).

### June 4

We completed a full survey of the upper inlet north of Point Possession and Beluga River. The flight coincided with the high tide in Turnagain Arm and falling tide in the Susitna delta. Belugas were in dispersed or small groups throughout the survey area that made counting and videoing difficult. Winds also increased throughout the day, along with sunbreaks and intermittent rain, affecting counts and video with whitecaps, glare, and obscured visibility through the bubble windows. Group 1 was a pair of large, white whales encountered off the south tip of Fire Island (no video passes) (Fig. 4). Group 2 was traveling from the mouth of the Chickaloon River toward Turnagain Arm (4 counting and video passes). Group 3 was scattered along the Chickaloon Bay bluffs (4 counting and video passes). Group 4 was in the mouth of the Theodore River and spread in a line headed toward Beluga River (12 counting and video passes). Finally, Group 5 was a large, dispersed group in the Little Susitna River. One counting pass was attempted before we decided to continue the survey into Knik Arm. After surveying Knik Arm, we returned to group 5. Only about 3-5 whales remained in the Little Susitna River while the rest of the group was found heading east toward the eastern tributary of the Susitna River (7 counting and video passes) (Fig. 4). Sighting conditions were poor to excellent with sea states of Beaufort 0 to 6. Other marine mammal sightings included: 31 harbor seals hauled out at Chickaloon River (in groups of 17, 9, and 5), 200+ hauled out at the Theodore River, 200+ hauled out at the Lewis River, and at least 207 hauled out at the Susitna River (Fig. 5).

### June 5

We completed a full survey of the upper inlet north of Point Possession and Beluga River. The flight coincided with the high tide in Turnagain Arm and falling tide in the Susitna delta. Winds were calm with excellent to fair (due to rain squalls) sighting conditions throughout the upper inlet. Beluga groups were observed in Chickaloon Bay and the Susitna delta. Group 1 was in the mouth of the Chickaloon River (9 counting and video passes) (Fig. 4). Group 2 was travelling west toward the Chickaloon Bay bluffs (8 counting and video passes). Group 3 was a large, dispersed group between the east tributary of the Susitna River and the Little Susitna River (9 counting and video passes). This group consolidated between the mudflats as the tide continued to fall. Other marine mammal sightings

included: 25 harbor seals hauled out at Chickaloon River, 200+ hauled out at the Theodore River, 200+ hauled out at the Lewis River, and at least 200 hauled out at the Susitna River (Fig. 5).

### June 6

A lower inlet survey was completed in lieu of another upper inlet survey because winds were predicted to be calm in the southern Inlet. The survey began in the Susitna Delta and followed sawtooth transects offshore that ended 5 km northwest of Elizabeth Island, where we flew coastal survey north to Homer to refuel. After refueling, we surveyed the coastline to Elizabeth Island, circled the island, and then flew across the inlet to Cape Douglas. We resumed the coastal survey heading north to West Foreland with a brief transit offshore to circle Kalgin Island. Marine mammals sighted included harbor porpoise (*Phocoena phocoena vomerina*), sea otters (*Enhydra lutris kenyoni*), Steller sea lions (*Eumetopias jubatus*), harbor seals, and humpback whales (*Megaptera novaeangliae*) (Fig. 5). Harbor porpoise (17 sightings for a total of 24 animals) were seen along the offshore tracklines between Kalgin Island and Augustine Island and on the coastal survey near Bruin Bay, in Illiamna Bay, and near Big River in Redoubt Bay. Sea otters were seen on offshore tracklines and along the west side of the inlet from Cape Douglas to Harriet Point (56 sightings of 230 animals). One group of Steller sea lions (100 animals) was seen hauled out close to Cape Douglas. There were 6 humpback whales (4 sightings); the first group (2 individuals) was located mid-inlet between Augustine Island and Elizabeth Island, two sightings (3 individuals) were spotted close to Elizabeth Island, and one sighting (1 individual) was located mid-inlet between Elizabeth Island and Kamishak Bay. Finally, a total of 100 harbor seals (4 sightings) were hauled out near Cape Douglas, in Tuxedni Bay, and on mudflats 5km south of Kalgin Island. Viewing conditions were excellent for much of the survey except for brief periods where low clouds or glare reduced conditions to poor or useless (Fig. 3).

### June 7

Lower inlet surveys continued for a second day, covering the coastline from Clam Gulch (where surveys ended on June 1) to just north of Elizabeth Island where offshore tracklines were flown in a sawtooth pattern north to Anchorage. Low ceilings, high sea states and rain forced us to abort the offshore trackline from Elizabeth Island to Kamishak Bay and part of the trackline from Kamishak Bay to the west side of the Inlet (Fig. 3). High sea states forced us to end the survey early before reaching the end of the trackline near Fire Island (Fig. 2). Marine mammal sightings included: sea otters were observed in Kachemak Bay (21 sightings of 297 animals) and on the offshore transect near Tuxedni Bay (1 sighting of 2 animals); groups of harbor seals were hauled out at Fox River (n=10, 6, and 55 animals) and on mudflats 5 km south of Kalgin Island (too far to estimate number but could be the same animals seen on June 6); 3 humpback whales (2 sightings) on the offshore trackline north of Anchor Point; and 4 harbor porpoise sightings (6 individuals) on offshore tracklines north of Tuxedni Bay and south of Kalgin Island (Fig. 5).

### June 8

After completing surveys of the lower inlet, we resumed surveys of upper Cook Inlet north of Point Possession and Beluga River. Surveys were timed to coincide with the rising tide (6+ ft (1.8 m) low tide). Beluga whale groups were found near Burnt Island and were headed toward Turnagain Arm (Group 1: 4 counting and video passes), east of Chickaloon River (Group 2: 4 counting passes, no video due to small group size), in Chickaloon River (Group 3: 2 whales, one white the other light gray, no

video due to small group size), west of Chickaloon River (Group 4: 4 counting passes, no video due to glare and whitecaps), along the Chickaloon Bluffs (Group 5: 5 video and counting passes), and between the Beluga River and Susitna River (Group 6: attempted 7 counting passes, no video due to the widely spaced nature of the group) (Fig. 4). As during previous flights, belugas were not seen in Turnagain Arm or Knik Arm. Other marine mammal sightings included: harbor seals hauled out near Chickaloon River (28 animals), in the water and hauled out near Beluga River (n=8), Theodore River (n=180), Lewis River (n=147), Ivan River (n=2), Susitna River (n=4) and Little Susitna River (1 sighting of 17 seals) (Fig. 5). Sighting conditions were fair to excellent.

### June 9

We continued surveys of upper Cook Inlet north of Moose Point and Beluga River. Surveys were timed to coincide with the low/rising tide (+5 ft (1.5 m)). Beluga whale groups were found dispersed over a large area of Chickaloon Bay (Group 1: no counting and video passes), in the Beluga River (Group 2: 5 counting and video passes), in the Theodore River (Group 3: circled to obtain a count but too small for video passes), dispersed from the Ivan River across the mouth of the Susitna River (Group 4: no counting and video passes), and in the Little Susitna River to (Group 5: counting passes but no video due to the small size of the group.) (Fig. 4). We were not able to obtain a median count for the day given the survey conditions. Again, belugas were not seen in Turnagain or Knik Arm. Other marine mammal sightings included: harbor seals hauled out near Chickaloon River (3 animals), Theodore River (47 animals) and Lewis River (90 animals) (Fig. 5). Sighting conditions were fair to excellent.

### **Summary counts of belugas**

The daily medians ranged from 138 to 208 whales (Table 1). Following the protocol from previous surveys, the highest daily median is used as the annual index count; therefore, in June 2011 the index count was 208 belugas. This annual index does not reflect any correction for missed whales. Calculations for whales missed during these aerial counts and abundance estimates are described in Hobbs et al. (2000a, b). The median count in 2011 falls within the range of counts from 1993-2010 (Table 2).

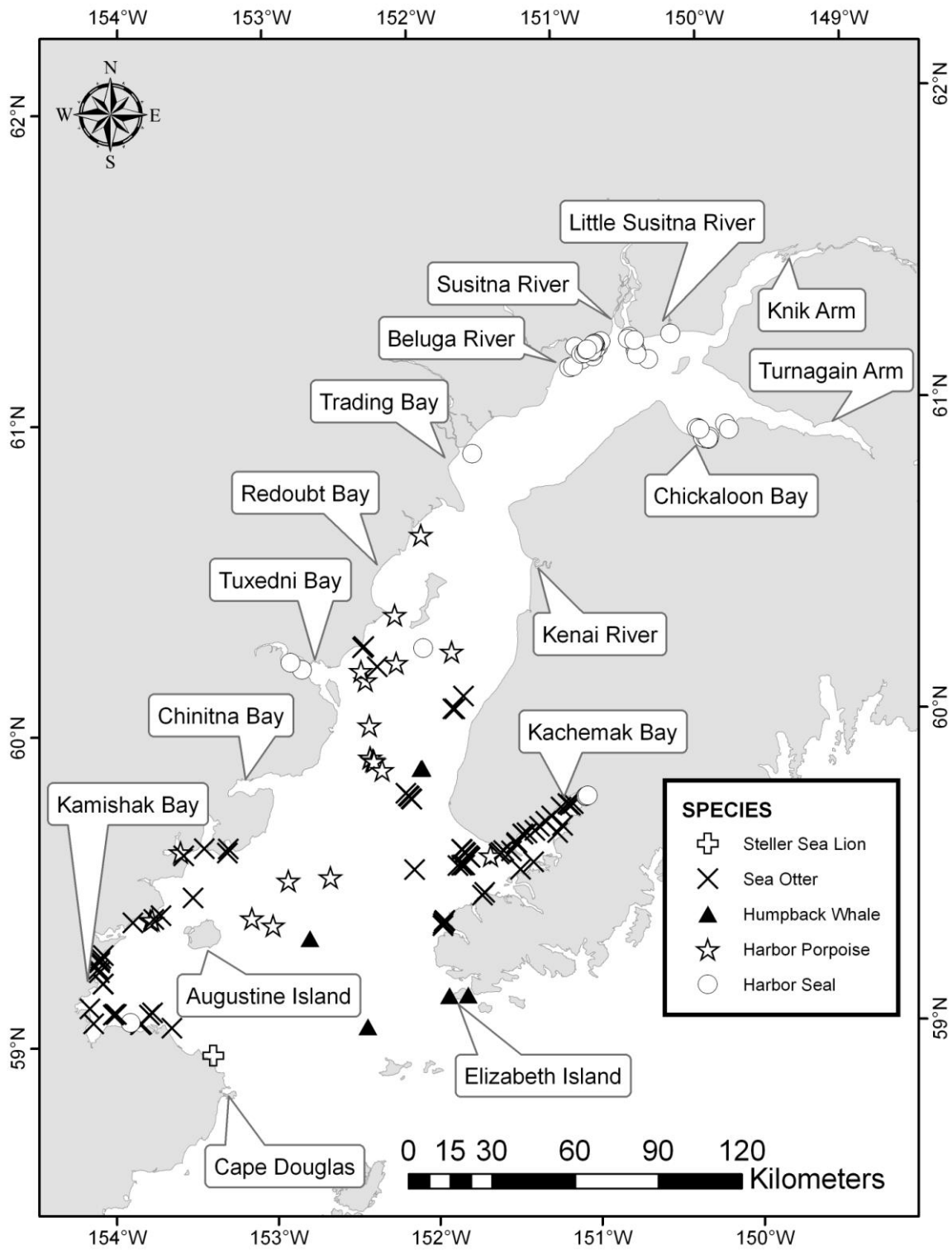
**Table 2.** Cook Inlet beluga index counts (i.e., highest daily median count) made during aerial surveys in June or July 1993-2010 showing abundance estimates with respective CVs (Hobbs et al. 2000a; NMFS unpublished data).

Year	Dates	Index counts	Abundance estimates	CV	Nmin	Upper CL	Lower CL
1993	June 2-5	<b>305</b>	---	---			
1994	June 1-5	<b>281</b>	653	0.43	462	1464	291
1995	July 18-24	<b>324</b>	491	0.44	345	1120	215
1996	June 11-17	<b>307</b>	594	0.28	471	1018	347
1997	June 8-10	<b>264</b>	440	0.14	391	578	335
1998	June 9-15	<b>193</b>	347	0.29	273	606	199
1999	June 8-14	<b>217</b>	367	0.14	326	482	279
2000	June 6-13	<b>184</b>	435	0.23	359	679	279
2001	June 5-12	<b>211</b>	386	0.17	335	537	277
2002	June 4-11	<b>192</b>	313	0.12	283	396	248
2003	June 3-12	<b>174</b>	357	0.11	326	440	290
2004	June 2-9	<b>187</b>	366	0.2	310	540	248
2005	May 31-June 9	<b>192</b>	278	0.18	239	396	196
2006	June 5-15	<b>153</b>	305	0.15	269	409	228
2007	June 7-15	<b>224</b>	375	0.14	333	493	285
2008	June 3-12	<b>126</b>	375	0.23	310	585	240
2009	June 2-9	<b>303</b>	321	0.18	276	456	226
2010	June 1-10	<b>291</b>	340	0.11	310	421	275
2011	May 31-June 9	<b>208</b>	284	0.16	248	388	208

Note: there were slight revisions to the 2001 and 2006 abundance estimates after review of the data for the 2001-2011 time series. The 2001 CV changed from 0.09 to 0.17 and 2006 changed from 302 (CV=0.16) to 305 (CV=0.15).

### Other marine mammals

Besides belugas, the only other marine mammals found in upper Cook Inlet (north of 60°43'N) were harbor seals. There were 49 harbor seal sightings ranging from 1 to 200+ seals per group (1747 harbor seals total; mean group size of 36). Harbor seals were seen on every survey day in lower and upper Cook Inlet. Although belugas were not seen in lower Cook Inlet (south of 60°43'N), many other marine mammals were recorded (Fig. 5). Harbor seals were seen in the lower inlet (7 sightings ranging from 5 to 64 animals mean group size of 24). Sea otters were seen in or near Kachemak Bay, on offshore tracklines and along the west side of the inlet from Cape Douglas to Harriet Point (a total of 527 otters; mean group size of 7). Only one group of Steller sea lion was seen hauled out close to Cape Douglas (100 animals). Cetacean sightings in lower Cook Inlet included 6 humpback whale sightings (9 whales total) near Elizabeth Island and mid Inlet south of Kalgin Island, and 21 sightings of harbor porpoise (30 individuals) seen near Kachemak Bay and on offshore transects between Augustine and Kalgin Islands.



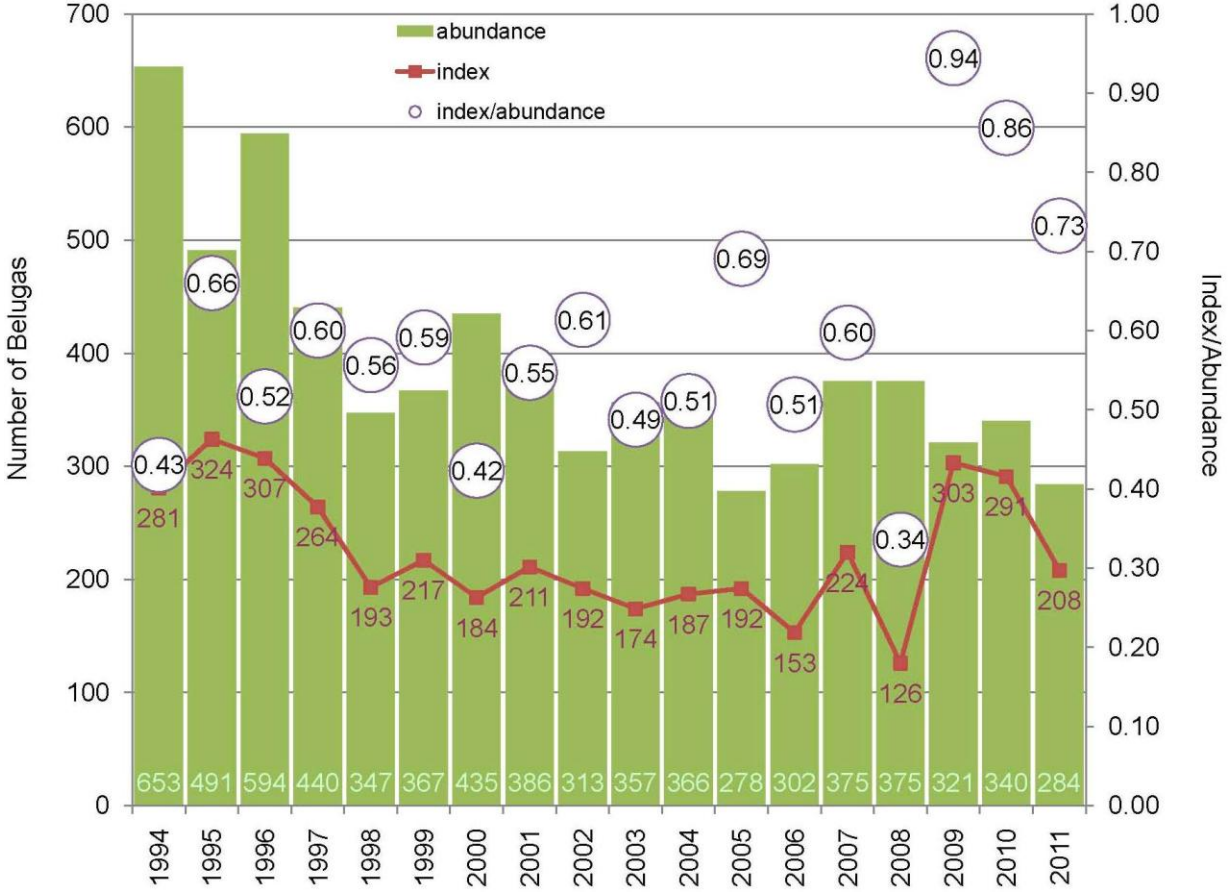
**Figure 5.** Marine mammal sightings other than belugas, in Cook Inlet, June 2011.

## Discussion

The June 2011 Cook Inlet survey was similar to previous surveys in terms of research protocol and survey area. In addition to the many years this project has been underway (since 1993), each of these beluga surveys has involved several replicate flights around upper Cook Inlet. The large number of flights and consistency in effort has helped detect whale distribution patterns. In 2011, belugas were three to six groups were found in the Susitna delta and Chickaloon Bay. Typical of most surveys in recent years, belugas were not found south of the Forelands. In addition, no belugas were sighted in Knik and Turnagain Arms. Before 1996, it was not uncommon to see beluga groups south of North Foreland (Rugh et al. 2000, 2010), but since the mid-1990s, only one or two beluga groups have been found in lower Cook Inlet (Rugh et al. 2010). In spite of good sighting conditions during most of these June annual surveys, belugas were regularly observed only in upper Cook Inlet. Given the number of other marine mammals seen in the lower Inlet, the lack of beluga sightings was not due to compromised visibility.

The 2011 index count (median count from the best survey day) was 208 belugas which is within the range of index counts made annually since 1993 (Table 2). These median counts are uncorrected for missing whales, but they do provide a quick assessment of the aerial survey effort. The annual calculated abundance includes corrections for whales missed within the viewing range of observers, whales missed because they were beneath the surface or missed due to the density of groups. These corrected abundance estimates are shown in Table 2 and Figure 6 (estimates from 1994-2000 are from Hobbs et al. 2000a; estimates from 2001 to 2011 are from Rugh et al. 2005 and NMFS unpublished data). The abundance estimates, with their associated coefficients of variance, are the appropriate values to be used in interyear trend analyses (Fig. 6).





**Figure 6.** Annual abundance estimates (green bars) and median index counts (red line) for beluga aerial surveys, Cook Inlet, Alaska, 1994-2011. Circles show index counts divided by abundance estimates (note: in most years the index count is between 50% - 70% of the total abundance estimate).

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