

# AERIAL SURVEYS OF BELUGAS IN COOK INLET, ALASKA, JUNE 2008

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**ABSTRACT**--The National Marine Fisheries Service (NMFS) conducted surveys of the beluga population in Cook Inlet, Alaska, 3-12 June 2008. The aerial surveys (47.7 flight hours) were flown 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), consistent with NMFS' surveys of Cook Inlet conducted each year since 1993. The study in June 2008 included surveys of coastal areas (flown 1.4 km offshore) around most of the Inlet and 1,776 km of transects across the Inlet, effectively searching 34% of offshore Cook Inlet and 100% of the coastline. Paired, independent observers searched on the coastal (left) side of the plane where virtually all 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 doing four or more independent counts of each group. Daily median counts made on seven different days ranged from 34 to 103 belugas in the Susitna delta (between the Beluga and Little Susitna rivers), and 5 to 33 belugas in Chickaloon Bay. Belugas were not observed in lower Cook Inlet, which is typical of annual surveys in most of the recent years. In June 2008, the highest daily median estimate, used here as an index for relative abundance (not corrected for effort nor for estimates of missed whales), was 126 belugas. This is below index counts for all 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, and 224 in 2007).

## 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). This project is 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 2008 survey was to maintain continuity with preceding NMFS surveys to allow for inter-year trend analyses.

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. Until 1999, Cook Inlet belugas were subjected to an unregulated subsistence harvest (Mahoney and Shelden 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. As of April 20, 2007 (72 FR 19854), this population has been proposed for listing as endangered under the Endangered Species Act. Cook Inlet belugas are now managed with a small, regulated subsistence harvest.

## Methods

### Aircraft and data

The survey aircraft used in June 2008, an Aero Commander 680 (*N98UP*), has twin-engines, high-wings, and more than 8-hour flying capability. Bubble windows were at the right forward, left forward, and left rear observer positions, maximizing the search area. A window behind the left rear observer position was opened during counting passes to provide unobstructed video recordings of the beluga groups. The intercom system provided communication among the observers, data recorder, and pilots, but a selective listening device was used to aurally isolate the left observer positions. The data recorder used a laptop computer<sup>1</sup> to record sighting data and download location data from a portable Global Positioning System (GPS). Data entries included routine updates of time, locations, percent cloud cover, sea state (Beaufort scale), glare (on the left and right sides of the aircraft), and visibility (on the left and right sides). Visibility was documented in five subjective categories from excellent to useless; conditions rated poor or useless were considered unsurveyed. Each start and stop of a transect leg was recorded. Observer seating positions were noted each time they were changed, generally every 1-2 hours to minimize fatigue.

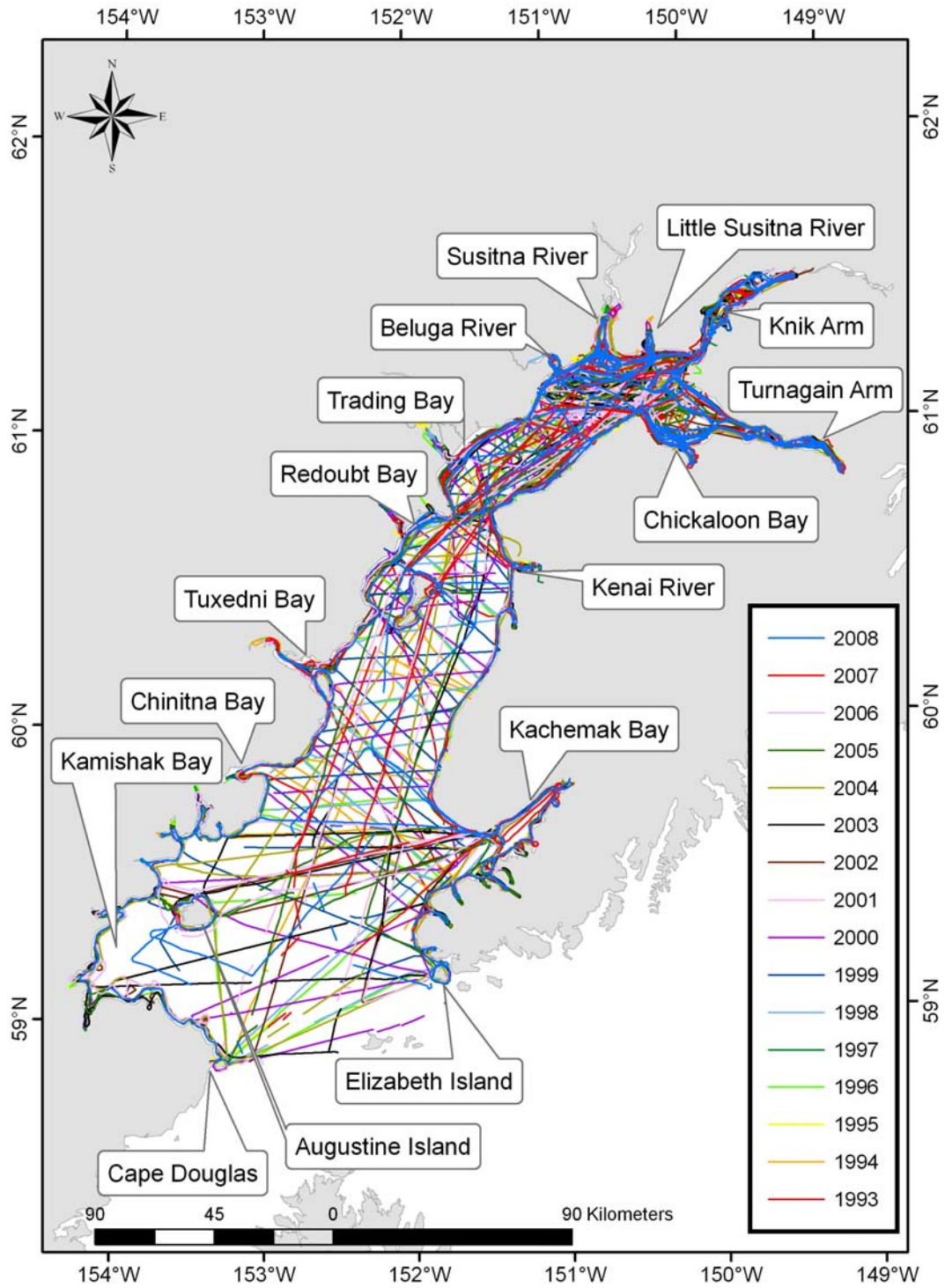
### Tracklines

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). 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. Offshore tracklines were designed to run the length of Cook Inlet or cross it, minimizing overlap within the 2008 survey effort and between previous survey 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 aerial surveys of belugas in Cook Inlet, 1993-2008.

## **Tides**

Due to the broad geographical range of these surveys, in conjunction with rapidly changing tide heights, surveys were not flown at specific tidal conditions throughout Cook Inlet. There generally was an 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 find and count. Because tide changes in Turnagain Arm can be so rapid that tide rips with white caps compromise visibility, attempts were made to survey Turnagain Arm at slack tide. In Chickaloon Bay, belugas tend to be close to shore or in Chickaloon River at high tide, where they were relatively easy to video and count. Aerial surveys south of East and West Foreland were scheduled as a function of weather, not tides.

Although there are many daylight hours in this area during June, light levels were low enough at night so that no surveying was done prior to 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 independently 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. An important component to the survey protocols was the independence of the paired observers (i.e., that they not cue each other to sightings). This was done by having a visual barrier between the two left observers and audio shutoffs at each observer position. After a beluga group was reported, the trackline was maintained until the group was well behind the aircraft. This allowed each observer an opportunity to independently sight and report whale groups, and helped identify which beluga groups were missed by an observer. The pilot and data recorder did not call out beluga sightings until the whales were past the wing and likely missed by observers on that side of the aircraft. After passing the whales, the systematic search effort was stopped, and all headsets were activated so that everyone was able to communicate during counting passes.

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 one 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 count. 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 quality A and B estimates were 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 2008. 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  | 6/3       | 6/4       | 6/5       | 6/6       | 6/7        | 6/9 | 6/10 | 6/11      | 6/12       |
|---|-----------|-----------|-----------|-----------|------------|-----|------|-----------|------------|
| Turnagain Arm                                       | 0         | 0         | 0         | 0         | ---        | --- | ---  | 0         | 0          |
| Chickaloon Bay/<br>Point Possession                 | 0         | 0         | 32        | 5         | 33*        | --- | ---  | **        | 0          |
| Point Possession to<br>Moose Point/East<br>Foreland | 0         | 0         | ---       | ---       | 0          | 0   | ---  | ---       | ---        |
| Mid-inlet east of<br>Trading Bay                    | 0         | 0         | 0         | 0         | 0          | 0   | 0    | 0         | ---        |
| East Foreland to<br>Homer                           | ---       | 0***      | ---       | ---       | ---        | 0   | ---  | ---       | ---        |
| Kachemak Bay to<br>Elizabeth Island                 | ---       | ---       | ---       | ---       | ---        | 0   | ---  | ---       | ---        |
| West side of<br>lower Cook Inlet                    | ---       | ---       | ---       | ---       | ---        | --- | 0    | ---       | ---        |
| Redoubt Bay   | ---       | 0***      | ---       | ---       | ---        | --- | 0    | ---       | ---        |
| Trading Bay   | 0         | 0         | ---       | ---       | ---        | --- | ---  | ---       | ---        |
| Susitna delta****                                   | 58        | 93        | 34        | 85        | 93         | --- | ---  | 10**      | 103        |
| Knik Arm  | 0         | 0         | 0         | 0         | 0          | --- | ---  | 0         | 0          |
| Fire Island   | 0         | 0         | 0         | 0         | 0          | --- | ---  | 0         | 0          |
| <b>Totals</b>                                       | <b>58</b> | <b>93</b> | <b>66</b> | <b>90</b> | <b>126</b> |     |      | <b>**</b> | <b>103</b> |

\*median count for Chickaloon Bay includes the morning and afternoon counts.

\*\*groups too dispersed to video or count in Chickaloon Bay and near the Susitna and Little Susitna rivers. A group of 10 whales (median count) was counted and video-taped at the Beluga River.

\*\*\*surveyed to Kenai River (up river to shallow water) before crossing inlet to Drift River in Trading Bay and surveying to West Foreland.

\*\*\*\*For purposes of dividing Cook Inlet into coverage areas, this table includes all coastline between North Foreland and Point MacKenzie as a part of the Susitna delta, although beluga groups (1-3 per day) were found only between the Beluga and Little Susitna rivers.

## **Cameras**

Paired High Definition (HD) 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 the new HD cameras provide better resolution offering 1280 x 720 pixels. The paired cameras were operated on all counting passes when group size appeared to be more than 20 belugas. Video clips from the two cameras will be studied in the laboratory to obtain precise beluga counts. These beluga counts will be assessed for the amount of time the 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 in the video images will be used to determine the 2008 Cook Inlet beluga abundance estimate (e.g., Hobbs et al. 2000a).

## **Results**

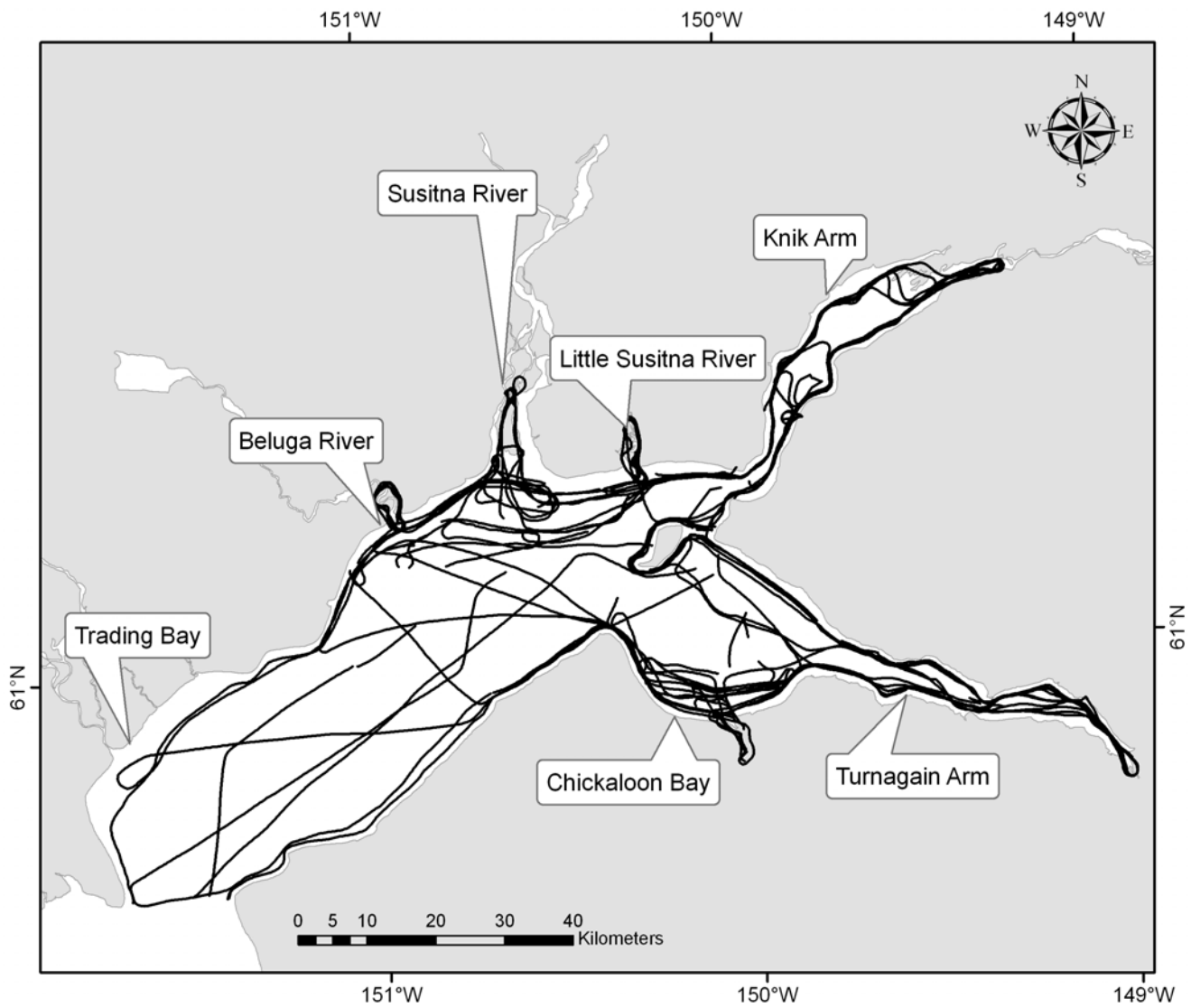
### **Survey effort**

A total of 47.7 hours were flown around Cook Inlet 3-12 June 2008. All flights (14 take-offs and landings ranging from 1.8 to 5.1 hours) were based out of Anchorage, sometimes with refueling stops in Homer. Of the 47.7 flight hours, 29.5 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). Visibility conditions interfered with the survey effort during 2.8 hours (9.5% of the effective search time) when the left-front observer considered the visibility poor or useless.

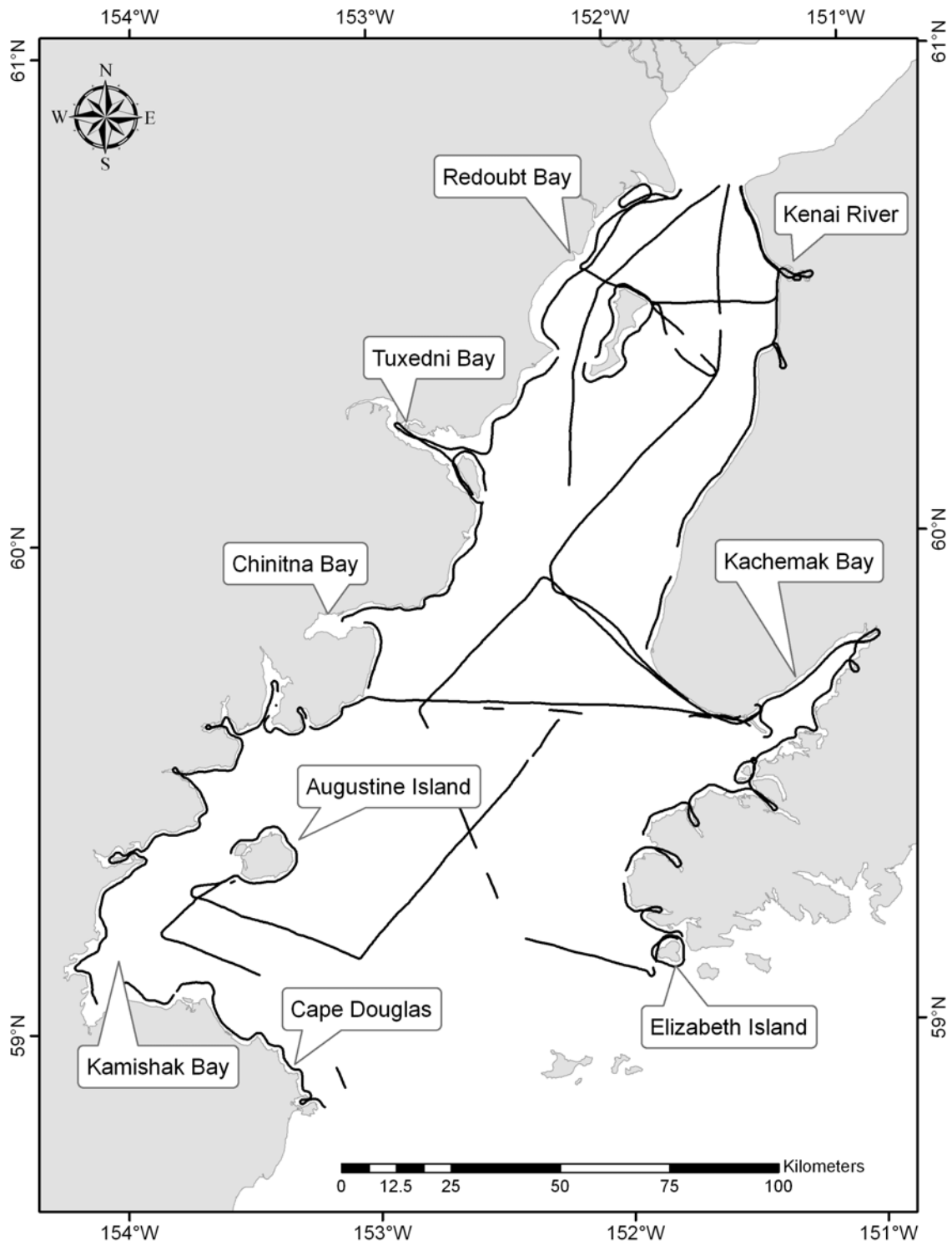
Three observers in 2008 have participated in the Cook Inlet beluga surveys in most or all seasons since the project began in 1993. One observer had participated since 2005. One observer had not participated in surveys of Cook Inlet before.

### **Coverage**

The June 2008 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, 1,776 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 7,172 km<sup>2</sup>, which is 34% 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 seven days in 2008, concentrating in areas where beluga groups have consistently been found in the past, such as Susitna delta, Knik Arm, Turnagain Arm, and Chickaloon Bay. Excluding repetitions of the upper inlet, the sum of all offshore transects and coastline surveys (550 km,) relative to the surface area covered 88% of upper Cook Inlet in 2008. In lower Cook Inlet, surveys covered 23% of the area (based on 1,260 km of coastline plus offshore transects relative to a surface area of 17,130 km<sup>2</sup>).



**Figure 2.** On-effort tracklines for aerial surveys of belugas, upper Cook Inlet, June 2008.



**Figure 3.** On-effort tracklines for aerial surveys of belugas, lower Cook Inlet, June 2008.



## 2008 daily reports

### June 3

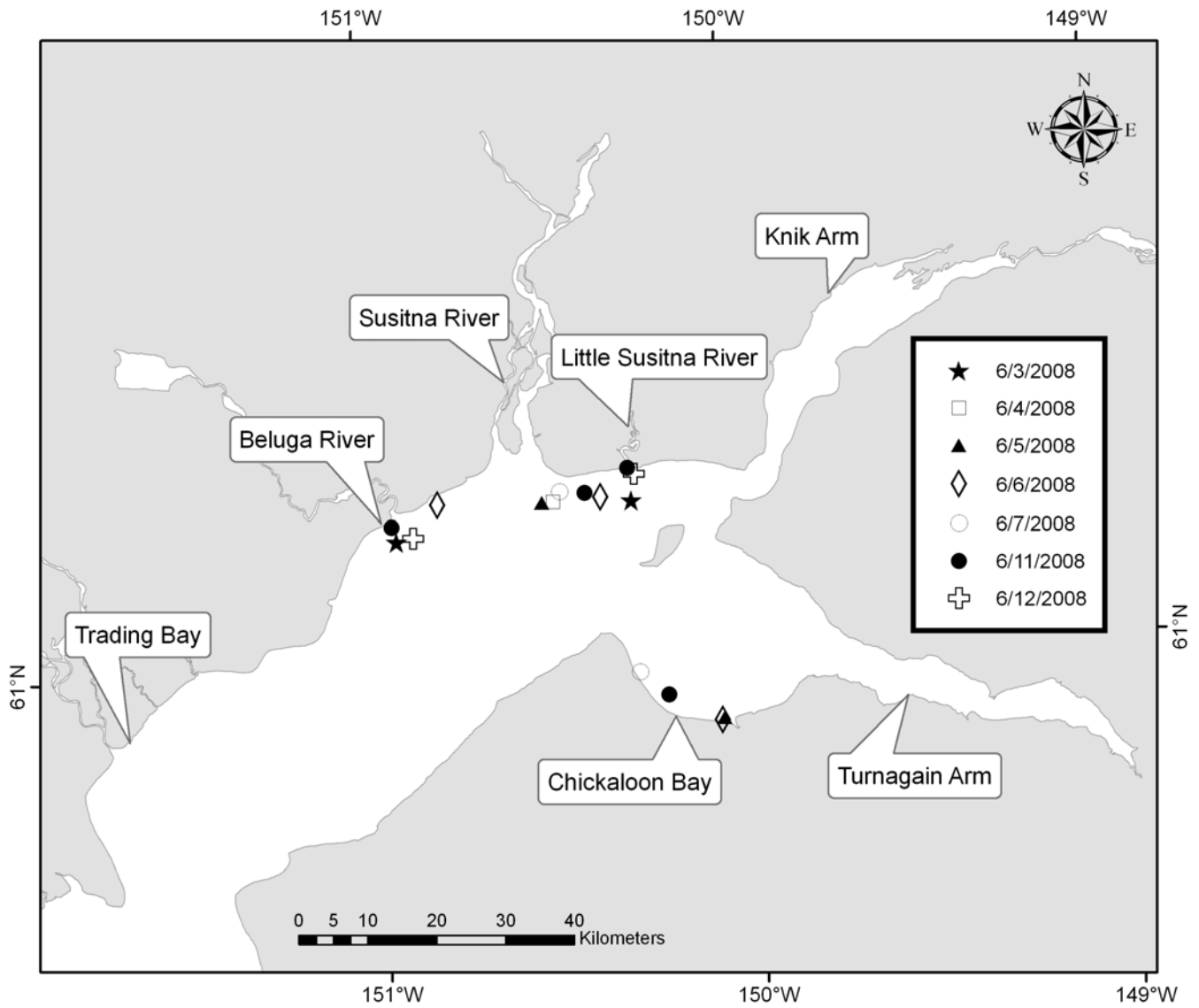
The season began with a survey of upper Cook Inlet. We departed Anchorage 3 hours past high tide (Anchorage, Knik Arm station) and flew the coast of Fire Island, proceeded into Turnagain Arm up to Twenty-mile, completed Chickaloon Bay and River (up to shallow water), the east coast to East Foreland, crossed the inlet to West Foreland and completed the west coast to Little Susitna River. Belugas (Group 1) were first encountered at the mouth of the Beluga River (Fig. 4). We attempted video and counting passes (7) but the group was spread out from the mouth of the river and scattered offshore. We decided to land in Anchorage and wait for the low tide to complete the survey. On transit to Anchorage, belugas (Group 2) were observed offshore of the Little Susitna River (Fig. 4). Their location was marked in the record for the next flight. After 45 minutes at the airport, we returned to the Beluga River. Afternoon conditions had worsened with high winds and lots of white caps. We did not find Group 1 so we continued the coastal survey, flying up to the power lines on the Susitna and Little Susitna Rivers, and completing Knik Arm, including surveying up to the bridge. Group 2 was still at the Little Susitna River and we completed 11 counting and video passes. Birds and white caps made counting extremely difficult. Other marine mammal sightings included: 15 harbor seals (*Phoca vitulina*) at Chickaloon River and 55 harbor seals on the Susitna River mudflats.

### June 4

On the first flight of the day, we completed a full survey of the upper inlet (including major rivers and an offshore trackline one mile off the Susitna delta) north of Moose Point and the McArthur River. The survey began an hour after high tide at Anchorage and included returning to Chickaloon Bay after completing Knik Arm to survey this area again closer to low tide. We encountered only one large, compact group of belugas (Group 1, Fig. 4) offshore of the Susitna River (11 video and counting passes). After an hour long break in Anchorage, we transited to East Foreland and surveyed the coast to Kenai River crossed the inlet to Drift River and surveyed the coast to West Foreland. No beluga groups were encountered during the flight though viewing conditions were good to excellent. On the transit back to Anchorage, Group 1 was again observed offshore of the Susitna River. Other marine mammal sightings included: 13 adult harbor seals with pups at Chickaloon River, 192 harbor seals hauled out on the Ivan River, 11 harbor seals on the Susitna mudflats, 2 harbor seals near the Little Susitna River, and 82 harbor seals hauled out near Big River.

### June 5

We completed a full survey of the upper inlet (including major rivers and a trackline one mile off the Susitna delta) north of Point Possession and North Foreland. The survey began a half hour after high tide at Anchorage and was timed to coincide with high, slack tide in Turnagain Arm. Belugas were in two groups: Group 1 at the Chickaloon River (10 video and counting passes) and Group 2 offshore of the Susitna River (16 video and counting passes) (Fig. 4). Other marine mammal sightings included: 55 harbor seals hauled out at Chickaloon River, 44 harbor seals offshore of the Susitna River, and an additional 4 harbor seals near the mouth of the Little Susitna River.



**Figure 4.** Beluga sightings in Cook Inlet, June 2008.

### June 6

We completed a full survey of the upper inlet (including major rivers and a trackline one mile off the Susitna delta) north of Point Possession and the town of Beluga. Similar to June 5, the survey began a half hour after high tide at Anchorage and was timed to coincide with high, slack tide in Turnagain Arm. Belugas were in three groups: Group 1 at the Chickaloon River (5 video and counting passes); Group 2, a pair of whale seen by one observer near the Lewis River; and Group 3 offshore of the Little Susitna River (14 video and counting passes) (Fig. 4). Other marine mammal sightings included: harbor seals hauled out at Chickaloon River (55), Lewis River (140), Theodore River (220), Susitna River (4) and Little Susitna River (2).

### June 7

The survey began at high tide at Anchorage and was timed to coincide with high, slack tide in Turnagain Arm, however, winds had picked up overnight, gusting to 29 knots in Turnagain Arm. Avoiding Turnagain Arm, we surveyed the west side of Fire Island and crossed to Point Possession, from there a trackline was surveyed one mile offshore from Point Possession across Chickaloon Bay to a mile past Burnt Island. We then turned toward shore and began the coastal survey from Burnt Island to Moose Point (including Chickaloon River), crossed the inlet to the town of Beluga, and continued the coastal survey (including Beluga and Little Susitna River) through Knik Arm (as far as Eklutna). Belugas were in two groups: Group 1 at the Chickaloon River was spread out along the coast and offshore in an L-shape (5 video and counting passes); while belugas in Group 2 were in a large, tight group offshore of the Susitna River (10 video and counting passes) (Fig. 4). White caps and the spread of the group at Chickaloon Bay compromised counts and video. After completing the first flight, we landed in Anchorage and waited an hour, then returned to Chickaloon Bay closer to the low tide. Group 1 (renamed as Group 3 in the abundance analysis) had moved to the area along the bluffs between Chickaloon River and Point Possession and belugas were now strung along the coastline in a long line (11 video and counting passes) (Fig. 4). High winds continued in Turnagain Arm, precluding any survey of that area. Harbor seals were hauled out at Chickaloon River (108), Theodore River (150), Lewis River (50), and Little Susitna River (2).

### June 8

There was mandatory down time for the pilots on this day after flying 6 days in a row.

### June 9

After completing 5 circuits of upper Cook Inlet, surveys of the lower inlet began on June 9. The morning flight covered the coastline from Point Possession to Elizabeth Island, and offshore trackline from Waypoints 1 to 3 before taking a refueling break in Homer. Sightings included: 275 sea otters (*Enhydra lutris*) in Kachemak Bay, 72 harbor seals hauled out a Fox River, and 5 humpback whales (*Megaptera novaeangliae*) off Elizabeth Island. The second flight continued the offshore trackline survey from Waypoints 3 (off Homer) to 5 (in the upper inlet), with a break at Waypoint 4 to circle Kalgin Island. Sightings included 2 sea otters, 1 harbor seal, and 3 harbor porpoise (*Phocoena phocoena*). In general, viewing conditions were fair to excellent for the coastal survey (Fig. 3).

### June 10

Lower inlet surveys continued for a second day, beginning with an offshore trackline from Waypoints 7 to 15, with a break at Waypoint 12 to circle Augustine Island. The coastal survey from Cape Douglas to Chinitna Point was completed before flying a trackline from Chinitna Point to Homer for refueling. Sightings included: 75 harbor seals on a shoal north of Kalgin Island, one humpback whale mid-inlet and one humpback whale near Augustine Island, 3 harbor porpoise on the offshore trackline, 75 Steller sea lions (*Eumatopias jubatus*) hauled out near Shaw Island, 348 harbor seals and 27 sea otters between Cape Douglas and Chinitna Point, and 120 sea otters near Augustine Island. The second flight of the day included a trackline from Homer back to Chinitna Point and a coastal survey that ended at West Foreland. Sightings included 3 sea otters in Kachemak Bay and 201 harbor seals hauled out in Tuxedni Bay. Viewing conditions were fair to excellent for much of the coastal survey (Fig. 3).

### June 11

Although 5 circuits of upper Cook Inlet had been completed and tides were not favorable (positive low tides at 3-4 ft), we decided to survey the entire upper inlet north of Point Possession and Beluga River to check the distribution of beluga groups after our three day absence. Beluga groups were widely scattered on the flooding tide: in Chickaloon Bay, belugas were scattered from the river mouth out toward Point Possession (Group 1); a small group was found near the mouth of the Beluga River (Group 2; 5 video and counting passes); a large, scattered group about a mile offshore in the delta covered 3.5 miles from the Susitna River to the Little Susitna River (Group 3); and another small group was in the first bend of the Little Susitna River (Group 4). Other sightings included harbor seals in the waters near Chickaloon River (2), Beluga River (5), Theodore River (72), and Ivan River (2). We decided to attempt one more survey of the upper inlet on the 12<sup>th</sup> and to time it to coincide as closely as possible with low tide in each region: Susitna delta and Chickaloon Bay.

### June 12

For the final survey of the season, we ran a trackline directly from Anchorage to Beluga River where we began a coastal survey that included surveying up the Little Susitna River, Knik Arm as far as Goose Bay and Eagle Bay. We continued the survey around the south side of Fire Island to Turnagain Arm, crossing to Burnt Island, and flew along the coast to Point Possession. In addition, we flew an offshore trackline one mile from the coast from Point Possession to Chickaloon River (surveying up the river to shallow water), finishing with a coastal survey of Turnagain Arm. Sighting conditions were good to excellent with winds in Turnagain less than 10 knots. Beluga groups were seen at great distances, first by the right front observer on the trackline from Anchorage to Beluga River. We continued on effort and began the coastal survey where the groups were seen by one or both left side observers. Group 1 was lined up across the mouth of the Beluga River (10 video and counting passes) and Group 2 was in the Little Susitna River as far as the first bend and just outside the mouth (5 video and counting passes) (Fig. 4). A few (11) harbor seals were seen in the water at the mouth of the Beluga River.

### Summary counts of belugas

The daily medians ranged from 58 to 126 whales (Table 1). Following the protocol from previous surveys, the highest daily median is used as the annual index count; therefore, in June 2008 the index count was 126 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 2008 (126 belugas) is lower than similar counts from 1993-2007 (153-305 belugas; Table 2).

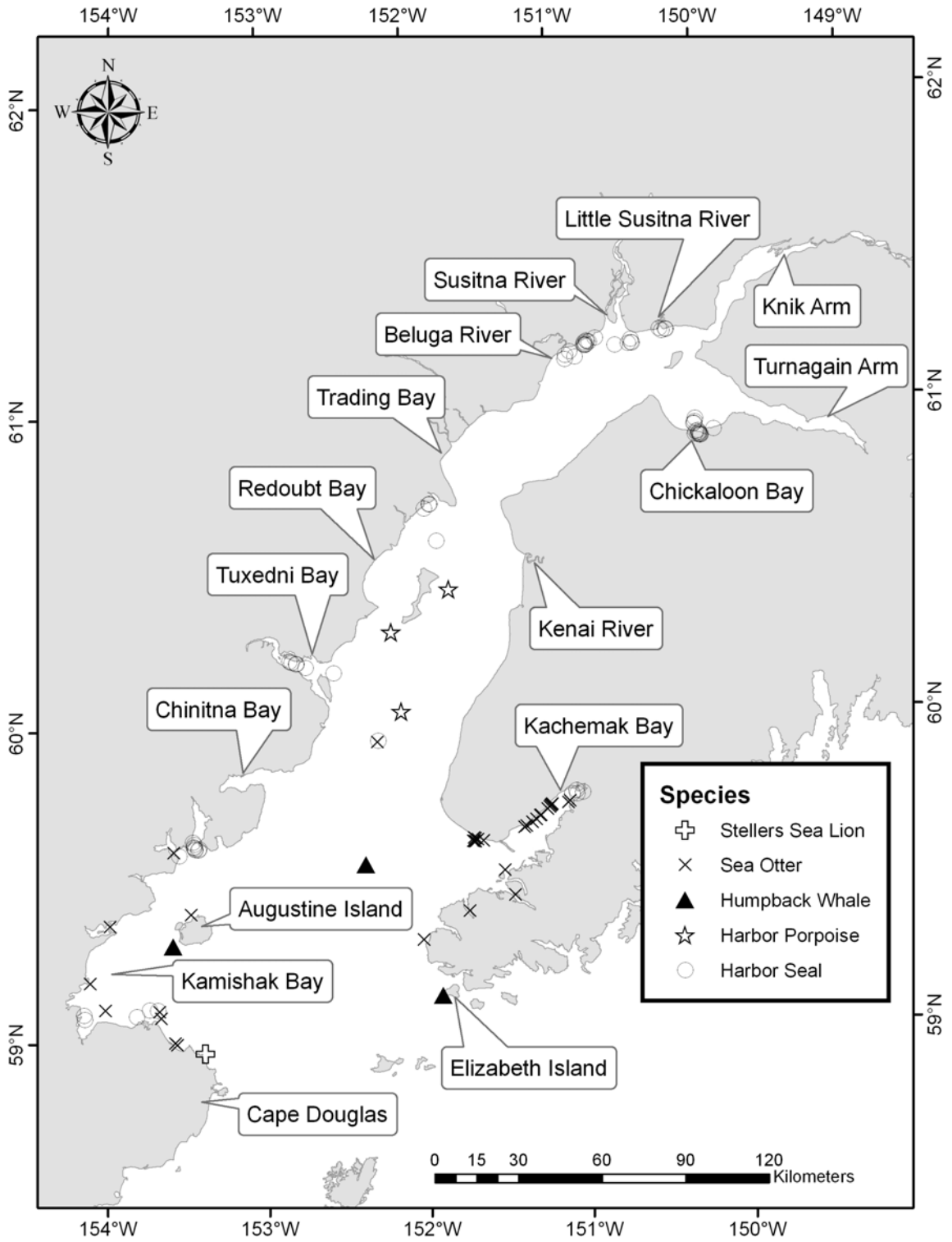
**Table 2.** Cook Inlet beluga index counts made during aerial surveys in June or July 1993-2008 showing abundance estimates with respective CVs (Hobbs et al. 2000a; NMFS unpublished data). Sighting percentages are indicated in three generalized zones.

| Year | Dates         | Index counts | Abundance estimates | CV   | Lower Cook Inlet | Susitna delta <sup>1</sup> | Elsewhere in upper Cook Inlet |
|------|---------------|--------------|---------------------|------|------------------|----------------------------|-------------------------------|
| 1993 | June 2-5      | <b>305</b>   | ---                 | ---  | 0%               | 56%                        | 44%                           |
| 1994 | June 1-5      | <b>281</b>   | 653                 | 0.43 | 4%               | 91%                        | 5%                            |
| 1995 | July 18-24    | <b>324</b>   | 491                 | 0.44 | 4%               | 89%                        | 7%                            |
| 1996 | June 11-17    | <b>307</b>   | 594                 | 0.28 | 0%               | 81%                        | 19%                           |
| 1997 | June 8-10     | <b>264</b>   | 440                 | 0.14 | 0%               | 28%                        | 72%                           |
| 1998 | June 9-15     | <b>193</b>   | 347                 | 0.29 | 0%               | 56%                        | 44%                           |
| 1999 | June 8-14     | <b>217</b>   | 367                 | 0.14 | 0%               | 74%                        | 26%                           |
| 2000 | June 6-13     | <b>184</b>   | 435                 | 0.23 | 0%               | 62%                        | 38%                           |
| 2001 | June 5-12     | <b>211</b>   | 386                 | 0.09 | 1%               | 35%                        | 64%                           |
| 2002 | June 4-11     | <b>192</b>   | 313                 | 0.12 | 0%               | 48%                        | 52%                           |
| 2003 | June 3-12     | <b>174</b>   | 357                 | 0.11 | 0%               | 9%                         | 91%                           |
| 2004 | June 2-9      | <b>187</b>   | 366                 | 0.2  | 0%               | 6%                         | 94%                           |
| 2005 | May 31-June 9 | <b>192</b>   | 278                 | 0.18 | 0%               | 60%                        | 40%                           |
| 2006 | June 5-15     | <b>153</b>   | 302                 | 0.16 | 0%               | 76%                        | 24%                           |
| 2007 | June 7-15     | <b>224</b>   | 375                 | 0.14 | 0%               | 64%                        | 36%                           |
| 2008 | June 3-12     | <b>126</b>   | 375                 | 0.23 | 0%               | 70%                        | 30%                           |

<sup>1</sup> For purposes of dividing Cook Inlet into coverage areas, this table includes all coastlines between North Foreland and Point MacKenzie as a part of the Susitna delta.

### **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 38 harbor seal sightings ranging from 1 to 150 seals per group (1,219 harbor seals total; mean group size of 32). 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 common (29 sightings ranging from 1 to 130 seals; 818 harbor seals total; mean group size of 28). Sea otters were seen in or near Kachemak Bay (24 sightings for a total of 278 otters; mean group size of 12), Kamishak Bay (8 sightings for a total of 28 otters; mean group size of 4), Augustine Island (120 otters) and mid-Inlet (1 sighting of 2 otters). Steller sea lions were only observed near Shaw Island (75 total). Cetacean sightings in lower Cook Inlet included three humpback whale sightings (seven individuals) and six harbor porpoise.



**Figure 5.** Marine mammal sightings, other than belugas, in Cook Inlet, June 2008.

## **Discussion**

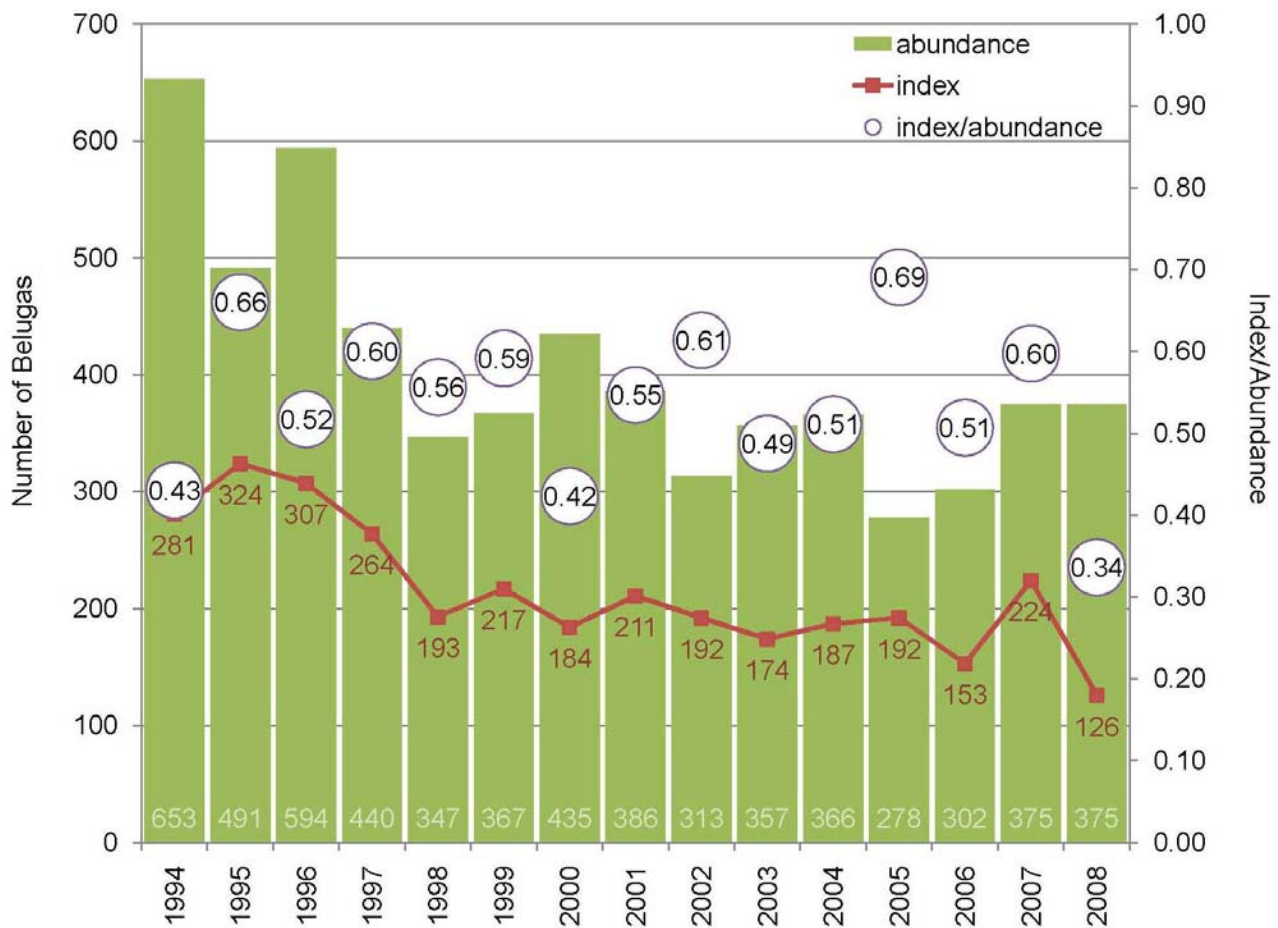
The June 2008 Cook Inlet survey was similar to previous surveys in terms of research protocol and survey area. In addition to the many years this project has been underway (1993-2007), each of these beluga surveys has involved several replicate flights around upper Cook Inlet. The large number of flights and consistency in effort has helped detect whale distribution patterns. In 2008, belugas were found in one or two groups on most days, unlike the scatter of small groups observed in 2007. Typical of most surveys in recent years, belugas were not found south of the Forelands. Prior to 1996 it was not uncommon to see beluga groups south of North Foreland (Rugh et al. 2000), but since the mid-1990s, only one or two beluga groups have been found in lower Cook Inlet (Table 2). In spite of good sighting conditions during most of these annual surveys in June, belugas were regularly observed only in upper Cook Inlet. Because many other marine mammals were seen in the lower Inlet, the lack of beluga sightings was not due to visibility.

The 2008 index count, that is, the median count from the best survey day (126 belugas) is lower than 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. These corrected abundance estimates are shown in Table 2 and Figure 6 (estimates from 1994-2000, Hobbs et al. 2000a; estimates from 2001 to 2007, Rugh et al. 2005, NMFS unpublished data). The abundance estimates, with their associated coefficients of variance, are the appropriate values to be used in interyear trend analyses.

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**Figure 6.** Annual abundance estimates (green bars) and median index counts (red line) for beluga aerial surveys, Cook Inlet, Alaska, 1994-2008. 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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