

AERIAL SURVEYS OF BELUGAS IN COOK INLET, ALASKA, JUNE 2010

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ABSTRACT--The National Marine Fisheries Service (NMFS) conducted surveys of the beluga population in Cook Inlet, Alaska, 1-10 June 2010. The aerial surveys (48.4 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 2010 included surveys of coastal areas (flown 1.4 km offshore) around most of the inlet and 1,251 km of transects across the inlet, effectively searching 29% of Cook Inlet's total area. Paired, independent observers searched on the coastal (left) side of the plane where almost 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 completing four or more independent counts of each group. Daily median counts made on six different days ranged from 64 to 160 belugas in the Susitna delta (between the Beluga and Little Susitna rivers), and 10 to 131 belugas in Chickaloon Bay (including Fire Island and Turnagain Arm). Belugas were not found in Knik Arm. Belugas were not observed in lower Cook Inlet, which is typical of annual surveys in most of the recent years. In June 2010, the highest daily median estimate, used here as an index for relative abundance (not corrected for effort nor for estimates of missed whales), was 291 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, and 303 in 2009).

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 2010 survey was to maintain continuity with preceding NMFS surveys to allow 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 2010, 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. An intercom system provided communication among the observers, data recorder, and pilots, and a selective listening device was used to aurally isolate the left observer positions. The data recorder used a laptop computer¹ 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; 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). 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 2010 survey effort and between previous survey years (Fig. 1).

¹ 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.

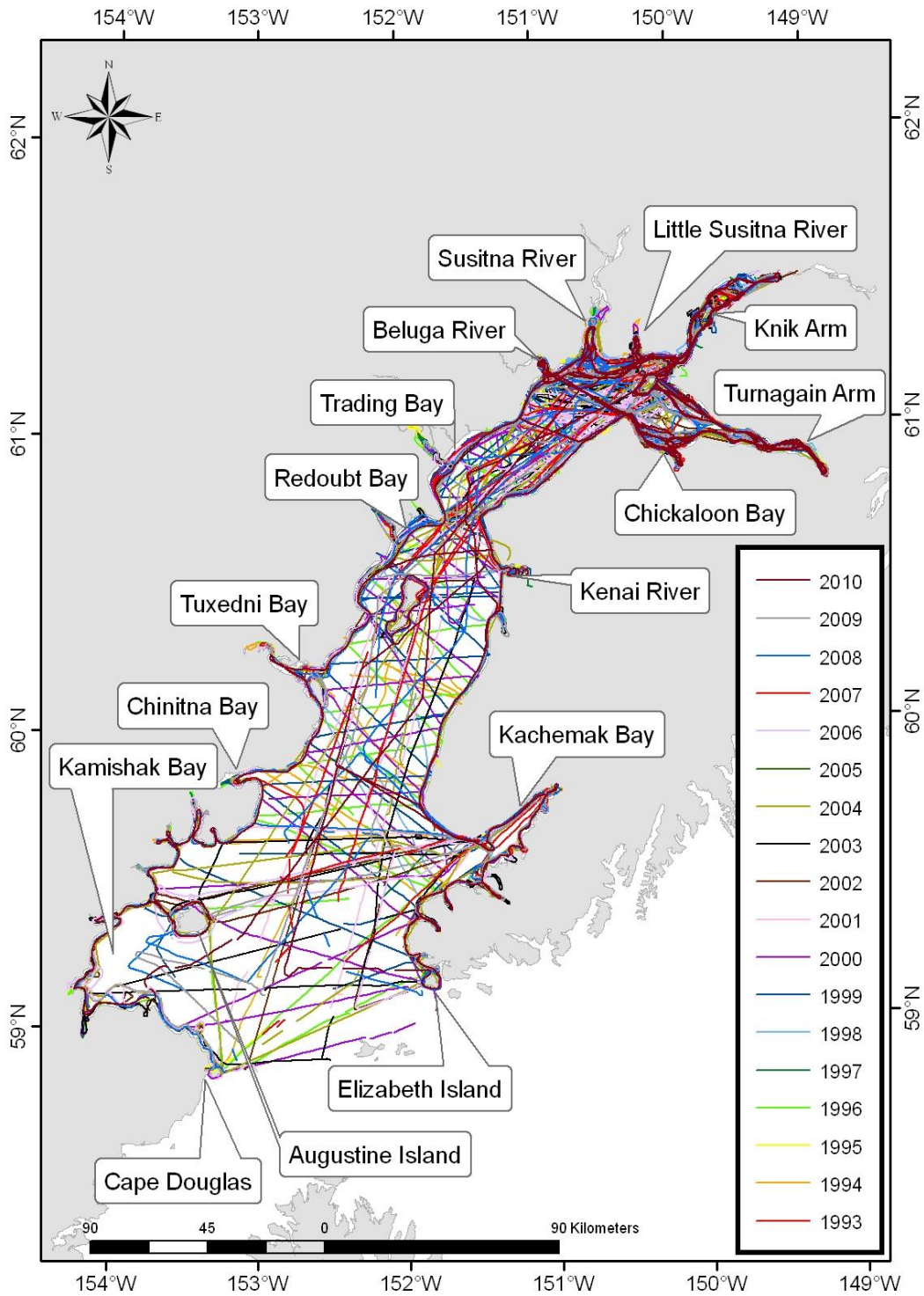


Figure 1. On-effort tracklines for June aerial surveys of belugas in Cook Inlet, 1993-2010.

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 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 find and count. Because tide changes in Turnagain Arm can be so rapid that tide rips and 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. 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 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 2010. 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	6/1	6/2	6/3	6/4	6/5	6/7	6/8	6/9	6/10
Turnagain Arm	0	0	0	1	---	---	4	0	1
Chickaloon Bay/ Point Possession	48	131	0 ^c	15	---	---	23	10	27
Point Possession to Moose Point/East Foreland	0	0	---	---	---	---	---	---	---
Mid-inlet east of Trading Bay	---	---	---	---	0	0	---	---	---
East Foreland to Homer	0 ^b	---	0 ^d	---	0 ^d	---	---	---	---
Kachemak Bay to Elizabeth Island	---	---	---	---	0	---	---	---	---
West side of lower Cook Inlet	---	---	---	---	---	0	---	---	---
Redoubt Bay	0 ^b	---	---	---	---	0	---	---	---
Trading Bay	0	---	---	---	---	---	---	---	---
Susitna delta^a	64	160	---	66	---	0 ^e	159	128	145
Knik Arm	0	0	---	0	---	---	0	0	0
Fire Island	7	0	---	0	---	---	0	0	10
Totals	119	291	0	82	0	0	186	138	183

^aThe coast between North Foreland and Point Mackenzie is defined as the Susitna delta.

^bSurveyed to Kenai River (upriver to shallows) before crossing inlet to Drift River and surveying north to West Foreland.

^cA small group was seen near the bluffs while transiting to the lower inlet on the morning flight, a large group was observed along the shore from Chickaloon River to the bluffs during the afternoon flight but we were unable to count due to deteriorating weather.

^dSurveyed from Kenai River to 10 miles south of Kasilof River where low clouds and fog ended the survey on 6/3, resumed lower inlet survey at this point on 6/5.

^eA group of belugas was observed enroute to offshore trackline Waypoint 6 but was not counted or videotaped.

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 2010 Cook Inlet beluga abundance estimate (e.g., Hobbs et al. 2000a).

Results

Survey effort

A total of 48.4 hours were flown around Cook Inlet 1-10 June 2010. All flights (12 take-offs and landings ranging from 0.6 to 6.4 hours) were based out of Anchorage, sometimes with refueling stops in Homer and Kenai. Of the 48.4 flight hours, 26 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, 0.6 hours of search effort (2% of the possible search time) was lost.

Two observers (KWS & DJR) have 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, and 2009. The remaining two observers (KTG & LWB) have participated since 2005 and 2008, respectively.

Coverage

The June 2010 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, 1251 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 6,120 km², which is 29% of the Cook Inlet surface area (20,943 km²). This coverage was similar to past beluga surveys in Cook Inlet (Rugh et al. 2000). Upper Cook Inlet was surveyed on six days in 2010, 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, 61% of upper Cook Inlet’s total area was covered by all offshore transects (1,240 km²) and

coastline surveys (1,100 km²). In lower Cook Inlet, surveys covered 22% of the area (2,519 km² of coastline plus 1,261 km² of offshore transects relative to a surface area of 17,131 km²).

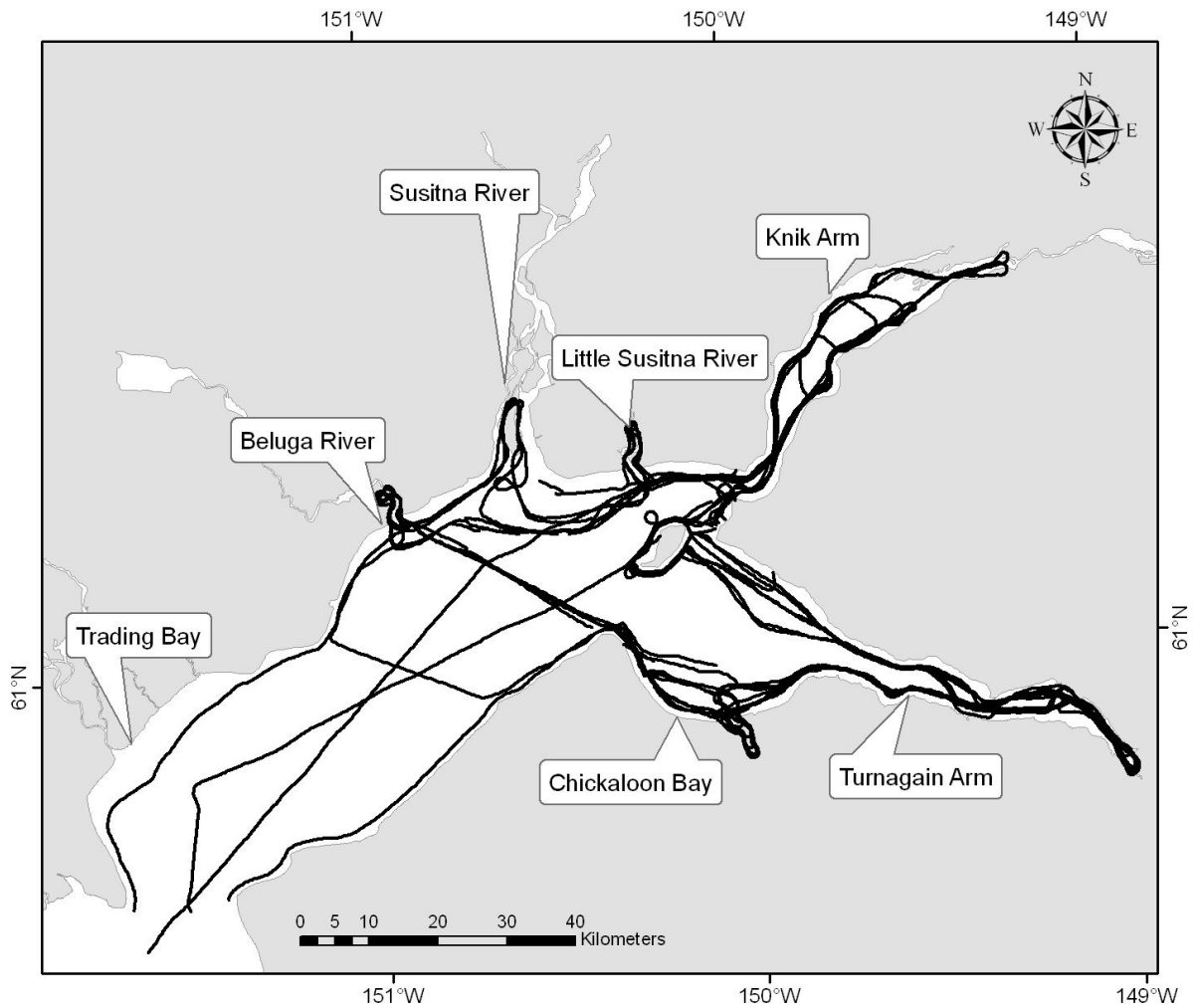


Figure 2. On-effort tracklines for aerial surveys of belugas, upper Cook Inlet, June 2010.

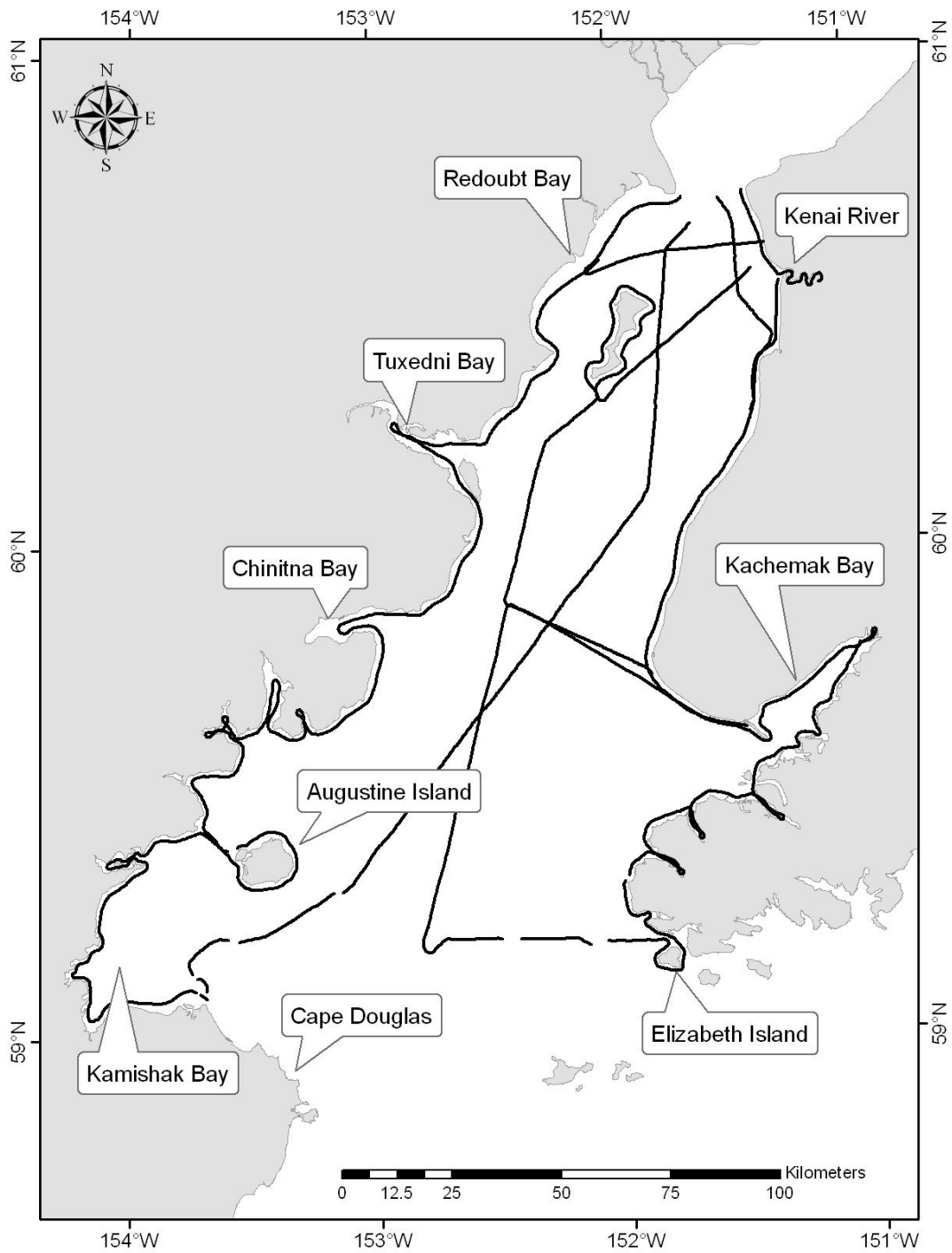


Figure 3. On-effort tracklines for aerial surveys of belugas, lower Cook Inlet, June 2010.

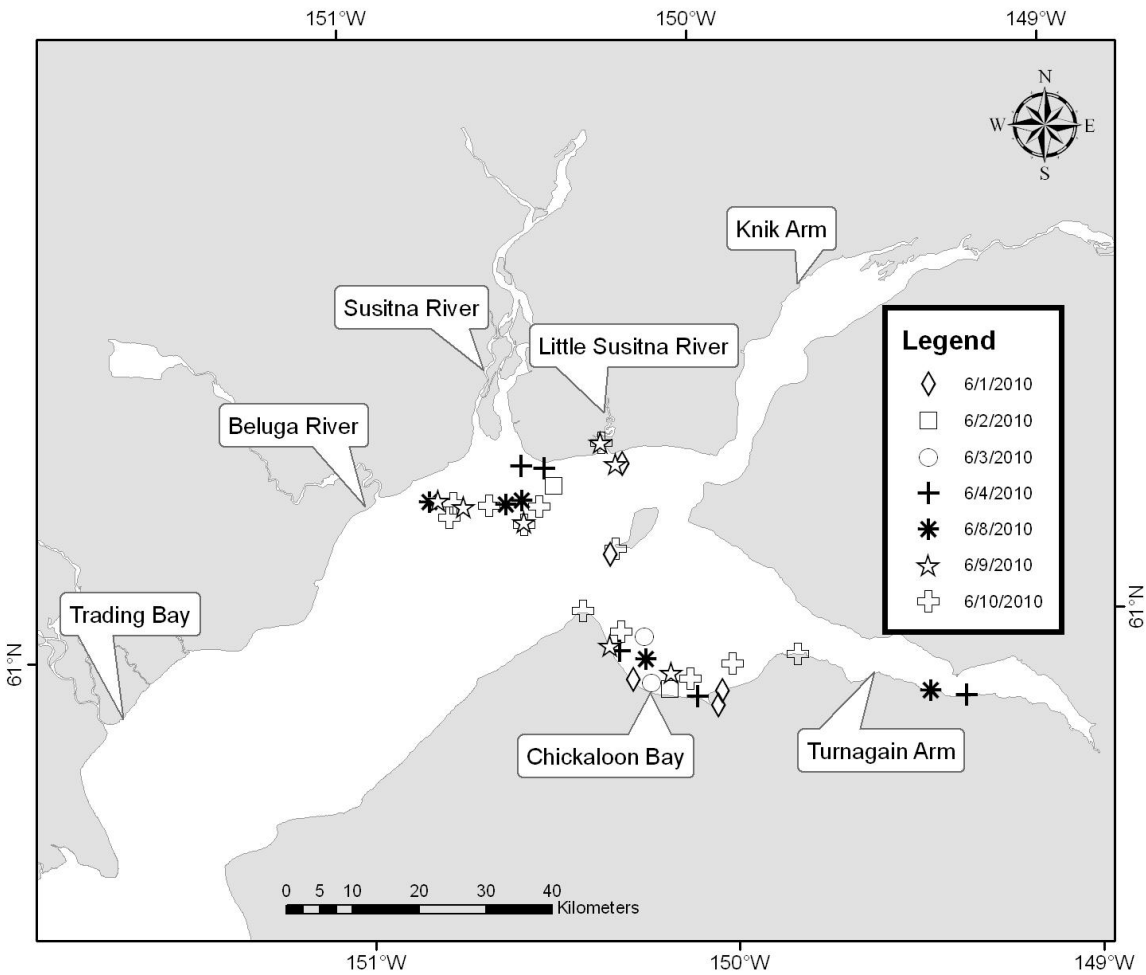


Figure 4. Beluga sightings in Cook Inlet, June 2010.

2010 Daily Reports

June 1

The season began with a survey of upper Cook Inlet extending south to the Kenai River and Drift River. We departed Anchorage and circled Fire Island where we encountered the first beluga group of the season just off the southern tip. Whitecaps precluded videotaping Group 1 (Fig. 4) during counting passes. We then surveyed Turnagain Arm, Chickaloon Bay to Point Possession then followed the coast to Kenai where we surveyed upriver. Belugas were also found along the shore between Burnt Island and Chickaloon River (Group 2: 6 video and counting passes), in Chickaloon River (Group 3: 7 video and counting passes), and where the bluffs and mudflats meet near Point Possession (Group 4: counting passes but no video due to whitecaps) (Fig. 4). After landing in Kenai to refuel, the survey continued across the inlet to Drift River following the coastline north into Knik Arm. Sighting conditions

deteriorated significantly in the Susitna delta. Group 5 was encountered just east of the mouth of the Little Susitna River (Fig.4). Again, high sea states precluded videotaping this group during counting passes. Airspace restrictions near Anchorage, Point MacKenzie, and Elmendorf Air Force Base meant those portions of the coastline were not surveyed. Off-effort searches (due to malfunction of the aural isolation system) occurred in Goose Bay, waters off Birchwood, and in Eagle Bay. Sighting conditions were fair to excellent during the survey with the exception of Turnagain Arm between Portage and Bird Point (heavy rain) and the Susitna delta. Sea states ranged from Beaufort 1 to 3 with areas in Turnagain Arm and the Susitna delta at Beaufort 4 to 5. Other marine mammal sightings included: Groups of 23 and 44 harbor seals (*Phoca vitulina*) on the Chickaloon River mudflats and 80 harbor seals on the mudflats mid-inlet between Kenai and Drift River (Fig. 5).

June 2

We completed a full survey of the upper inlet north of Moose Point and North Foreland. The flight coincided with the high tide in Turnagain Arm and falling tide in the Susitna delta. Belugas were in two groups: Group 1 covered 5 miles of shoreline from the bluffs along Chickaloon Bay up to the first bend in the Chickaloon River (9 video and counting passes) and Group 2, a large, compact group, was between the Susitna River and the Little Susitna River (11 video and counting passes) (Fig. 4). Other marine mammal sightings included: 1 harbor seal swimming near Beluga River and about 150 harbor seals hauled out at the Theodore River (Fig. 5). Sighting conditions were much improved from the previous day with calm sea states and fair to excellent visibility.

June 3

We attempted a survey of the lower inlet given marginal conditions in the upper inlet. While deadheading across Chickaloon Bay to Kenai, 4 beluga whales (Group 1) were spotted off the Chickaloon Bay bluffs (Fig. 4). The flight ended in Kenai as we needed to land to resecure the aft door. After taking off, we began the coastal survey at the mouth of the Kenai River heading south toward Homer. Conditions rapidly deteriorated with heavy rain, low clouds and fog. We aborted the survey about 10 miles south of the Kasilof River. We returned to Chickaloon Bay and began an upper inlet survey at the entry of Turnagain Arm. We completed tracklines in Turnagain Arm and Chickaloon Bay to Point Possession (including a survey up the Chickaloon River). Belugas were in a group (Group 2) scattered along the shoreline from the Chickaloon Bay bluffs to east of the mouth of the Chickaloon River (belugas were not seen in the river) (Fig. 4). Unfortunately, rain squalls and low clouds forced us to abort the survey before counting and video passes could occur. Other marine mammal sightings included: 50 harbor seals (including at least 10 pups) hauled out at the mouth of the Chickaloon River (Fig. 5).

June 4

We completed a full survey of the upper inlet north of Point Possession and North Foreland. The flight coincided with the rising tide in Turnagain Arm and high tide in the Susitna delta. Despite excellent sighting conditions, belugas were in dispersed groups or small groups throughout the survey area that made collecting counts and video extremely difficult. Group 1 was a lone white whale encountered in Turnagain Arm on the shore east of Six Mile Creek (no video passes) (Fig. 4). Group 2

was dispersed from the mouth of the Chickaloon River to about 2 miles offshore (attempted 6 counting and video passes). Group 3 was scattered along the Chickaloon Bay bluffs (attempted 8 counting and video passes). Group 4 included two white whales and one dark gray whale swimming east of the Susitna River (no video passes). Finally, Group 5 was a large, dispersed group in the east tributary of the Susitna River near Big Island (attempted 5 counting and video passes) (Fig. 4). Other marine mammal sightings included: 35 harbor seals hauled out at Chickaloon River and a few harbor seals in the water near Beluga River (6 seals total). Sighting conditions were fair to excellent with sea states of Beaufort 0 to 3.

June 5

A lower inlet survey was completed in lieu of another upper inlet survey because both low tides in the upper inlet were +8 feet (similar to June 4 when whales were widely dispersed on the positive tides). The survey began at waypoint 5 and ended at waypoint 3, crossed the inlet to south of the Kenai River where the coastal survey began. We surveyed the coastline to Elizabeth Island, circled the island, then flew offshore to waypoint 1 and resumed surveying the offshore trackline (20-30 kilometers offshore) until abeam of Homer. We surveyed across the inlet back to Kachemak Bay and ended the survey to refuel in Homer. During the coastline survey, marine mammal sightings included: 995 sea otters (*Enhydra lutris*) in Kachemak Bay; groups of 305, 60, 10 and 2 harbor seals hauled out at Fox River; 2 humpback whales (*Megaptera novaeangliae*), an adult with calf, in a small cove south of English Bay; and 2 (possibly 3) killer whales (*Orcinus orca*) seen on the offshore transect enroute to waypoint 1 (Fig. 5). The second flight continued the offshore trackline survey from Homer to Kenai (waypoint 2 to 3) with a break to circle Kalgin Island. Marine mammal sightings included 143 sea otters in Kachemak Bay (likely counted already during the morning flight) and 4 sightings of 5 harbor porpoise (*Phocoena phocoena*) along the trackline south of waypoint 2 (Fig. 5). In general, viewing conditions were fair to excellent for the entire survey (Fig. 3).

June 6

Down day for scheduled aircraft inspection. Observer (DJR) arrived to replace exiting observer (CLS).

June 7

Lower inlet surveys continued for a second day, covering offshore tracklines heading south to Cape Douglas, a coastal survey of the west shoreline north to Drift River, and circling Augustine Island. Low ceilings forced us to abort the offshore trackline near waypoint 9 and we were not able to survey south to Cape Douglas. Instead the coastal survey began about 15 miles north of Cape Douglas. Marine mammals sighted included harbor porpoise, sea otters, a Steller sea lion (*Eumetopias jubatus*), harbor seals, and killer whales (Fig. 5). Harbor porpoise (2 sightings for a total of 2 animals were seen on an offshore trackline (20 to 30 km from the western shore) and on the coastal survey from just south of Chinitna Bay to Redoubt Bay. Sea otters were seen on the offshore trackline (1 otter) and along the west side of the inlet from Cape Douglas to Chinitna Bay (14 sightings of 122 animals) and Augustine Island. One probable Steller sea lion was sighted offshore as we approached for the coastal survey (about 15 miles north of Cape Douglas). Two large groups of killer whales were seen near waypoint 9 on the

offshore trackline and one lone male killer whale was observed off Augustine Island. Finally, a total of 146 harbor seals were seen along the western side of Cook Inlet from Kamishak Bay to Tuxedni Bay (11 sightings). An additional 2 sightings of 2 harbor seals were seen in the northern inlet as we were transiting south. 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 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 falling/low tide (now at only +4 feet). Beluga whale groups were found in Six Mile Creek in Turnagain Arm (Group 1: 5 counting passes, no video), Chickaloon Bay from west of the river mouth along shore to the bluffs (Group 2: 6 counting and video passes), between the Beluga River and Lewis River (Group 3: 6 video and counting passes), and in the Susitna River (Group 4: 4 counting and video passes; and Group 5: 7 counting and video passes) (Fig. 4). Belugas were not seen in Knik Arm. Other marine mammal sightings included: harbor seals in the water near Chickaloon River (7 animals) and hauled out at Susitna River (3 sightings of 78 animals) and Little Susitna River (1 sighting of 3 seals) (Fig. 5). Sighting conditions were fair to excellent.

June 9

We continued surveys of upper Cook Inlet north of Point Possession and Beluga River. Surveys were timed to coincide with the falling/low tide (now at only +2.45 feet). Beluga whale groups were found along shore west of the Chickaloon River (Group 1: 6 counting and video passes), near the bluffs east of Point Possession (Group 2: 5 counting and video passes), between the Theodore and Lewis Rivers (Group 3: 7 counting and video passes), near the mudflats on the west tributary of the Susitna River (Group 4: 5 counting and video passes), in a large scattered offshore group from the east tributary of the Susitna River to mid-inlet north of Point Possession (Group 5: 12 counting and video passes), in the mouth of the Little Susitna River (Group 6: 6 counting and video passes), and in the first bend of the Little Susitna River (Group 7: 6 counting and video passes) (Fig. 4). Again, belugas were not seen in Knik Arm but we were not able to survey all of Eagle Bay due to restricted air space. A camera malfunction discovered in the evening after the survey resulted in the loss of all standard video from Group 3 Pass 5 through Group 7. Other marine mammal sightings included: harbor seals in the water near Chickaloon River (20 animals) and Lewis River (61 animals) (Fig. 5). Sighting conditions were fair to excellent.

June 10

We continued surveys of upper Cook Inlet north of Point Possession and Beluga River. Surveys were timed to coincide with the falling/low tide (now at only +0.7 feet). Beluga whale groups were found off the southwest tip of Fire Island (Group 1: 7 counting and video passes); near Gull Rock in Turnagain Arm (Group 2: 4 counting and video passes); a few whales off the mudflats offshore of Burnt Island (Group 3: 2 passes no video); west of Chickaloon River along shore heading toward the bluffs (Group 4: 7 counting and video passes); a few whales off the mudflats near the bluffs (Group 5: 4 passes no video); rounding Point Possession heading into the bay (Group 6: 7 counting and video passes); along

the mudflats on the Ivan River and west tributary of the Susitna River (Group 7: 8 counting and video passes); in a small scattered group just offshore from Group 7 (Group 8: 4 passes no video); along the mudflats mid-Susitna River (Group 9: 4 counting and video passes); along the mudflats on the east tributary of the Susitna River (Group 10: 6 counting and video passes); in a small group offshore from Group 10 (Group 11: 5 counting and video passes); and finally, in the first bend of the Little Susitna River (Group 12: 4 passes no video) (Fig. 4). Again, belugas were not seen in Knik Arm (air space was not restricted and all of Eagle Bay was surveyed). Other marine mammal sightings included: harbor seals in the water near Chickaloon River (11 animals) and Point Possession (1 animal), and hauled out along the Susitna mudflats (51 animals) (Fig. 5). Sighting conditions were good to excellent with Beaufort ranging from 0 to 2.

Summary counts of belugas

The daily medians ranged from 82 to 291 whales (Table 1). Following the protocol from previous surveys, the highest daily median is used as the annual index count; therefore, in June 2010 the index count was 291 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 2010 falls within the range of counts from 1993-2009 (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	305	---	---			
1994	June 1-5	281	653	0.43	462	1464	291
1995	July 18-24	324	491	0.44	345	1120	215
1996	June 11-17	307	594	0.28	471	1018	347
1997	June 8-10	264	440	0.14	391	578	335
1998	June 9-15	193	347	0.29	273	606	199
1999	June 8-14	217	367	0.14	326	482	279
2000	June 6-13	184	435	0.23	359	679	279
2001	June 5-12	211	386	0.09	359	458	326
2002	June 4-11	192	313	0.12	283	396	248
2003	June 3-12	174	357	0.11	326	440	290
2004	June 2-9	187	366	0.2	310	540	248
2005	May 31-June 9	192	278	0.18	239	396	196
2006	June 5-15	153	302	0.16	264	412	221
2007	June 7-15	224	375	0.14	333	493	285
2008	June 3-12	126	375	0.23	310	585	240
2009	June 2-9	303	321	0.18	276	456	226
2010	June 1-10	291	340	0.11	310	421	275

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 27 harbor seal sightings ranging from 1 to 150 seals per group (543 harbor seals total; mean group size of 20). 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 in the lower inlet (17 sightings ranging from 1 to 305 seals; 613 harbor seals total; mean group size of 36). Sea otters were seen in or near Kachemak Bay (a total of 994 otters; mean group size of 25, along the east side of the inlet, including Augustine Island (14 sightings for a total of 122 otters, mean group size of 9), and mid inlet (1 otter). Only one probable Steller sea lion was seen about 15 miles north of Cape Douglas (unidentified marine mammal). Cetacean sightings in lower Cook Inlet included two humpback whales (adult with calf), 33 killer whales (4 sightings), and 9 sightings of harbor porpoise (10 individuals).

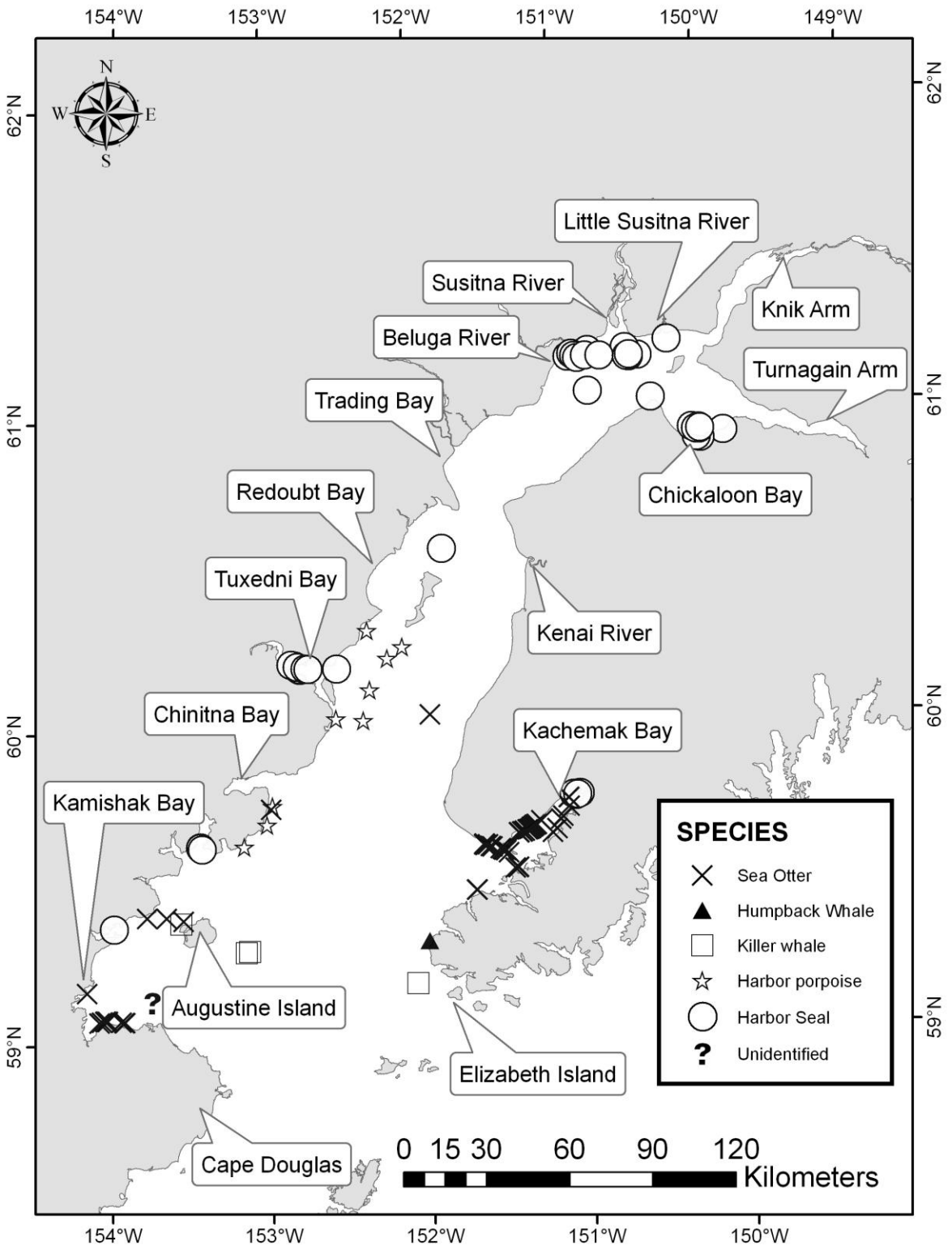


Figure 5. Marine mammal sightings other than belugas, in Cook Inlet, June 2010.

Discussion

The June 2010 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 (1993-2009), 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 2010, belugas were found in anywhere from two groups up to twelve groups in the Susitna delta and Chickaloon Bay. Typical of most surveys in recent years, belugas were not found south of the Forelands. 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 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 2010 index count, that is, the median count from the best survey day (291 belugas) 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, and 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 2010 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.

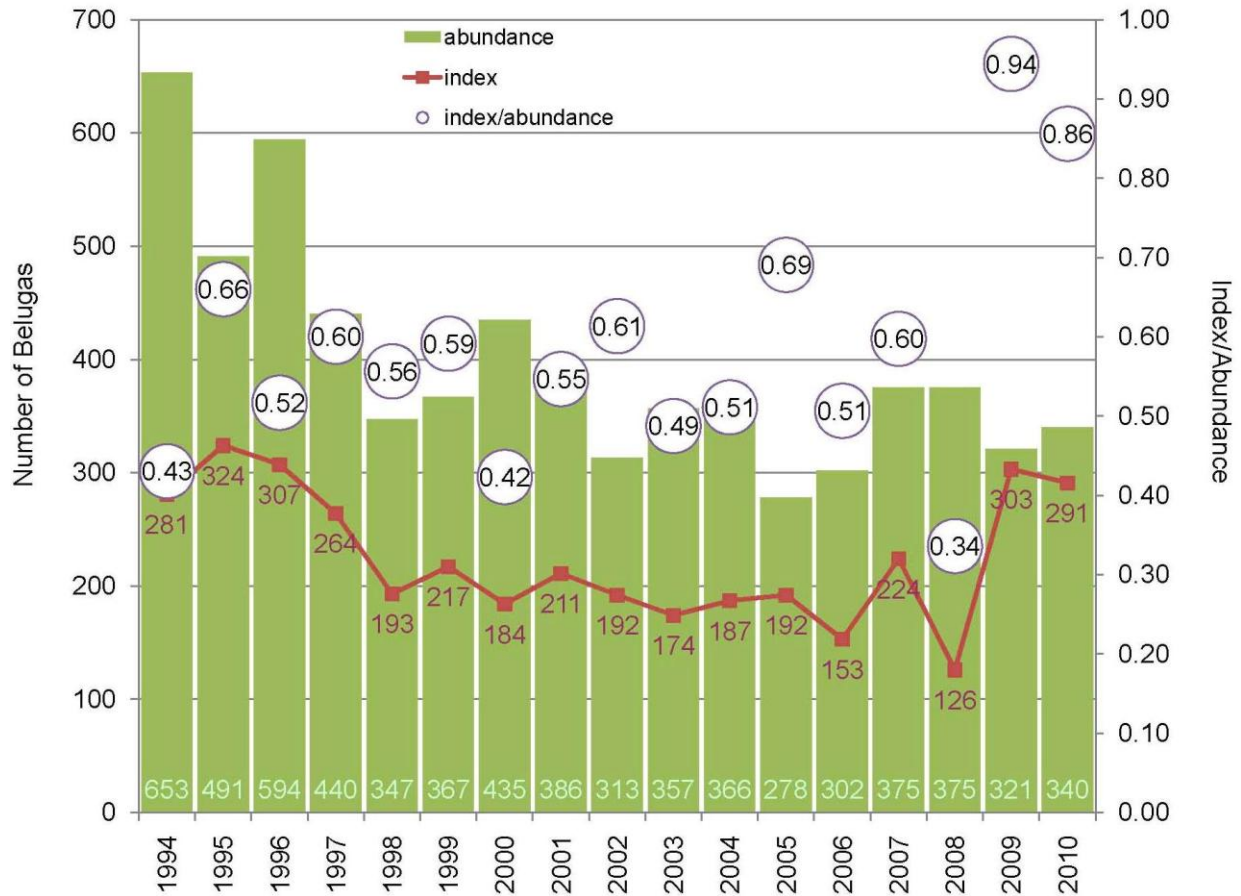


Figure 6. Annual abundance estimates (green bars) and median index counts (red line) for beluga aerial surveys, Cook Inlet, Alaska, 1994-2010. Circles show index counts divided by abundance estimates (note: in most years the index count is between 50% - 70% of the total abundance estimate).

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