

**AERIAL SURVEYS OF BELUGA WHALES IN COOK INLET, ALASKA,
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ABSTRACT

The National Marine Mammal Laboratory (NMML), in cooperation with the NMFS Alaska Regional Office, the Alaska Beluga Whale Committee (ABWC) and the Cook Inlet Marine Mammal Council (CIMMC), conducted an aerial survey of the beluga whale population in Cook Inlet, Alaska, during 9-15 June 1998. The 39.4 hr survey was flown in a twin-engine, high-wing aircraft at an altitude of 244 m (800 ft) altitude and speed of 185 km/hr (100 kt) along a trackline 1.4 km from shore. This provided complete coverage of coastal areas around the entire inlet (1,388 km) one or more times and 1,320 km of transects across the inlet. Throughout most of this survey, a test of sighting rates was conducted with multiple independent observers on the coastal (left) side of the plane, where virtually all sightings occur. A single observer and a computer operator/data recorder were on the right side. After finding beluga groups, a series of aerial passes were made to allow at least two pairs of observers to make 4 or more counts of each group. The sum of the aerial estimates (using median counts from each site, not corrected for missed whales) ranged from 173 to 192 whales, depending on survey day. There were 57-109 belugas counted near the Susitna River, 42-93 in Knik Arm and 23-42 in Chickaloon Bay, but only one (dead) beluga whale was found in lower Cook Inlet.

INTRODUCTION

Beluga whales (*Delphinapterus leucas*) are distributed around most of Alaska from Yakutat to the Alaska/Yukon border (Hazard 1988). Five stocks are recognized: Cook Inlet, Bristol Bay, Eastern Bering Sea, Eastern Chukchi Sea and the Beaufort Sea (Hill and DeMaster 1998; O'Corry-Crowe *et al.* 1997). The most isolated of these is the Cook Inlet stock, separated from the others by the Alaska Peninsula. Beluga whales in Cook Inlet are very concentrated in a few river mouths during parts of the year (as reviewed in Shelden

1994). The geographic and genetic isolation of the whales in Cook Inlet, in combination with their tendency towards site fidelity, makes this stock vulnerable to impacts from large or persistent harvests. The Alaska Regional Scientific Review Group (ASRG) “felt very strongly that every effort should be made to survey this population every year” (letter from L. Lowry, Chair of ASRG, to S. Pennoyer, NMFS, dated 13 May 1997).

Since 1993, NOAA’s National Marine Mammal Laboratory (NMML) and its Alaska Regional Office have conducted annual aerial surveys to study the distribution and abundance of beluga whales in Cook Inlet (Withrow *et al.* 1994; Rugh *et al.* 1995, 1996, 1997a, 1997b) in cooperation with the Alaska Beluga Whale Commission (ABWC) and the Cook Inlet Marine Mammal Council (CIMMC). Aerial surveys have been used to collect distribution and abundance data for beluga whales in Cook Inlet since the 1960’s (Klinkhart 1966; Calkins 1984; Calkins *et al.* 1975; Murray and Fay 1979). The most recent studies have been some of the most thorough and intensive surveys conducted for beluga whales in Cook Inlet. They were also among the first aerial surveys for cetaceans in which paired, independent observation efforts were conducted systematically throughout the studies.

METHODS

Survey Aircraft

The survey aircraft, an Aero Commander 680 FL (N7UP), has twin-engines, high-wings, 10-hr flying capability, and a five-passenger plus one pilot seating capacity. There are bubble windows at each of the three primary observer positions, maximizing the search area. An intercom system provided communication among the observers, data recorder, and pilot. A selective listening control device was used to aurally isolate the observer positions. Location data were collected from the aircraft’s Global Positioning System (GPS) interfaced with the laptop 386 computer used to enter sighting data. Data entries included routine updates of locations, percent cloud cover, sea state (Beaufort scale), glare (on the left and right) and visibility (on the left and right). Each start and stop of a transect leg was reported to the recorder. Observer seating positions were recorded each time they were changed, generally every 1-2 hrs to minimize fatigue.

Tides

With the exception of surveys at the Susitna Delta, there was generally no attempt at synchronization of tidal height and survey time. The broad geographical range of these surveys in conjunction with highly variable tide heights made it impractical to survey at specific tidal conditions throughout the inlet. We occasionally took advantage of lower tides in Knik and Turnagain Arms to reduce the effective survey area (at low tide, large areas of mudflats are exposed that would otherwise have to be surveyed), but the timing with the tidal cycle was more opportunistic here than was the timing at the Susitna Delta.

Aerial Tracklines

Coastal surveys were conducted on a trackline approximately 1.4 km offshore. The objective was to find beluga whales in shallow, nearshore waters where they typically have been seen in summer (Calkins 1984). The trackline distance from shore was monitored with an inclinometer such that the waterline was generally 10° below the horizon 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 less than 1 m deep, based on the appearance of rapids and riffles.

In addition to the coastal surveys, offshore transects were flown across the inlet. A sawtooth pattern of tracklines was designed to cross over shore at points approximately 30 km apart starting from Anchorage and zigzagging to the southern limits of Cook Inlet, between Cape Douglas and Elizabeth Island (Fig. 1).

Sighting Records

Immediately upon seeing a beluga group, each observer reported the sighting to the recorder. As the aircraft passed abeam of the whales, the observer informed the recorder of the species, inclinometer angle, whale travel direction and notable behaviors but not group size. With each sighting, the observer's position (left front, left rear, etc.) was also recorded. An important component of the effort by the observers on the left was that they not cue each other to their sightings. They had visual barriers between them, and their headsets did not allow them to hear each other. When a group of whales was first seen, the aircraft continued on until the group was out of sight; then the aircraft returned to the group and began the circling routine. This allowed each observer full opportunity to independently sight the whale group. The pilot and data recorder did not call out whale sightings or in any way cue the observers to the presence of a whale group until it was out of sight.

The whale group location was established at the onset of the aerial passes by flying a criss-cross pattern over the group, recording starts and stops of group perimeters. The perimeter point closest to the aircraft's location at the initial sighting was used to calculate the sighting distance.

Counting Techniques

The flight pattern used to count a whale group involved an extended oval around the longitudinal axis of the group with turns made well beyond the ends of the group. Whale counts were made on each pass down the long axis of the oval. Because groups were circled at least four times (4 passes for each of two pairs of observers on the left side of the aircraft), there were typically 8 or more separate counts per group. Counts began and ended on a cue from the left front observer, starting when the group was close enough to be counted and ending when it went behind the wing line. This provided a record of the duration of each counting effort. The paired observers made independent counts and wrote down their results along with date, time, pass number and quality of the count. The quality of a count was a function of how well the observers saw a group, rated A (if no glare, whitecaps or distance compromised the counting effort) through F (if it was not practical to count whales on that pass). Only quality A and B estimates were used in the analysis. Sighting notes were not

exchanged with anyone else on the aerial team until after all of the aerial surveys were completed. This was done to maximize the independence of each observer's estimates.

Video images were studied in the laboratory, and counts of whales were made to compare to the infield counts (Hobbs and Waite In prep). Analysis of both the aerial counts and counts from the video tapes are described in Hobbs et al. (In prep) for 1994-98 data.

RESULTS

Survey Effort

A total of 39.4 hr of aerial surveys were flown around Cook Inlet 9-15 June 1998. All of these surveys (11 flights ranging from 1.5 to 6.8 hr) were based out of Anchorage. Systematic search effort was conducted for 21.3 hr, not including time spent circling whale groups, deadheading without a search effort, or periods with poor visibility. Visibility and weather conditions interfered with the survey effort during 1.7 hr (8% of the total flight time) when the left-front observer considered the visibility poor or worse.

On 9 June, a test flight was conducted in which problems with the GPS/data recorder interface were discovered; therefore, positional data were not collected for that day. On 10, 12 and 15 June, surveys were made around upper Cook Inlet, north of the East and West Forelands. On 13 and 14 June, the lower inlet and offshore waters were surveyed (Fig. 1).

The composite of these aerial surveys provided a thorough coverage of the coast of Cook Inlet (1,388 km) for all waters within approximately 3 km of shore (Fig. 1). In addition, there were 1,320 km of systematic transects flown across the inlet. Assuming a 2.0 km transect swath (1.4 km on the left plus 1.4 km on the right, less the 0.8 km blind zone beneath the aircraft), the coastal tracklines covered 5,709 sq km, which is approximately 29% of the surface area of Cook Inlet; however, these surveys covered virtually 100% of the coastal area where beluga whales were expected. Most of upper Cook Inlet was surveyed three times, in particular the Susitna Delta where large groups of beluga whales have usually been found.

Aerial Estimates of Beluga Group Sizes

Aerial counts of beluga whales are shown in Table 1, and sighting locations are shown in Figure 1. These counts are the medians of each primary observers' median counts on multiple passes over a group. The consistency of locations of resightings between days, particularly the whales near the Susitna River, Knik Arm and in Chickaloon Bay, allowed us to combine results among survey days, assuming whales did not travel long distances within the 7-day survey period. Therefore, using median counts from each site, the sum of the counts ranged from 173 to 192. This sum is not corrected for missed whales. Calculations for whales missed during these aerial counts and an estimate of abundance will be developed in a separate document.

DISCUSSION

In Cook Inlet, beluga whales concentrate near river mouths during spring and early summer, especially across the northernmost portion of upper Cook Inlet between the Beluga and Little Susitna Rivers (Fig. 1), described here as the Susitna Delta, or in Knik Arm. Fish also concentrate along the northwest shoreline of Cook Inlet, mostly in June and July (Moulton 1994). These concentrations of beluga whales apparently last from mid-May to mid-June (Calkins 1984) or later and are very likely associated with the migration of anadromous fish, particularly eulachon (*Thaleichthys pacificus*) (Calkins 1984; 1989). Elsewhere in upper Cook Inlet in June and July, we have consistently found a group of 20-50 whales in Chickaloon Bay. Other, smaller, groups have been observed in the inlet during aerial surveys prior to 1996, such as in Kachemak, Redoubt and Trading Bays, but only single or dead whales have been seen south of North Foreland since then. Only 0-4% of the sightings in June and July from 1993-98 have occurred in lower Cook Inlet (Table 2).

Other aerial surveys conducted in June (Calkins 1984) also found the majority of animals were in the northwest portion of the inlet (88% of the sightings made 1974-79); however, during the 1970's even in June some groups were seen in the lower inlet, such as in Redoubt Bay and south of Kasilof River. But by July 1974-79 only 15% of the sightings were in the northwest and 44% were in the lower inlet (Calkins 1984). Many groups were seen in the lower inlet, ranging in size from 11 to 100 found between the Forelands and Tuxedni Bay, primarily away from the coast. Calkins (1979:40) indicated that belugas were "seen throughout the year in the central and lower Inlet." However, whales have not been found there recently in spite of excellent viewing conditions in some years.

There have been a few reports of small numbers of beluga whales in the Gulf of Alaska outside of Cook Inlet. Harrison and Hall (1978) saw belugas near Kodiak Island in March and July. Murray and Fay (1979) also found belugas near Kodiak Island, as well as in Shelikof Strait, south of Prince William Sound and in Yakutat Bay. Leatherwood *et al.* (1983) recorded one beluga near the southwest entrance of Shelikof Strait on 6 August 1982, but no other belugas were seen by them on the north or south shores of the Alaska Peninsula. Some sightings have been made in Prince William Sound in March (Harrison and Hall 1978) and August 1998 (D. Janka, pers. commun.) and in Yakutat Bay in May (Calkins and Pitcher 1977), September (R. Ream, NMFS, NMML pers. commun.) and February (B. Mahoney, NMFS, pers. commun.), perhaps as occasional visitors from Cook Inlet (Calkins 1989). These sightings indicate that at least some of the time there are beluga whales in the northern Gulf of Alaska outside of Cook Inlet. However, no sightings of belugas were made during many intensive aerial surveys around the Alaska Peninsula (Brueggeman *et al.* 1989; Frost *et al.* 1983; Harrison and Hall 1978; Leatherwood *et al.* 1983; Murie 1959; NMFS unpubl. data) supporting the genetic evidence showing that the Cook Inlet stock is isolated from stocks in the Bering Sea (O'Corry-Crowe *et al.* 1997), and that the Cook Inlet stock is not widely dispersed.

The uncorrected sum of median estimates made from the June 1998 aerial observations in Cook Inlet ranged from 173 to 192 beluga whales. Using the same procedure of summarizing median estimates from the highest seasonal counts at each site, for June or

July for each year 1993-98, there were, respectively, 305, 281, 324, 307, 264 and 193 beluga whales (Table 2). The process of using medians instead of maximum numbers reduces the effect of outliers (extremes in high or low counts) and makes the results more comparable to other surveys which lack multiple passes over whale groups. Medians or means are also more appropriate than maximums when counts will be corrected for missed whales. Not until the respective correction factors have been applied will absolute abundances or inter-year trends be calculated.

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Table 1. Summary of counts of beluga whales made during aerial surveys of Cook Inlet in June 1998. Medians from experienced observers counts were used from aerial passes where observers considered visibility good or excellent (conditions B or A). Dashes indicate no survey, and zeros indicate that the area was surveyed but no whales were seen. Sites are listed in a clockwise order around Cook Inlet.

Location	9 June median	high	10 June median	high	12-14 June median	high	15 June median	high	Med-max Counts
Turnagain Arm (East of Chickaloon Bay)	---	---	0	0	0	0	0	0	0
Chickaloon Bay/ Pt. Possession	---	---	23	34	42	77	41	65	42-77
Pt. Possession to East Foreland	---	---	0	0	0	0	---	---	0
Mid-inlet east of Trading Bay	---	---	---	---	0	0	---	---	0
East Fore land to Homer	---	---	---	---	0	0	---	---	0
Kachemak Bay	---	---	---	---	0	0	---	---	0
W side of lower Cook Inlet	---	---	---	---	0	0	---	---	0
Redoubt Bay	---	---	---	---	0	0	---	---	0
Trading Bay	---	---	0	0	0	0	---	---	0
Susitna Delta (N Foreland to Pt. Mackenzie)	59	59	57	98	69	76	109	186	109-186
Fire Island	---	---	11	11	0	0	0	0	0*
Knik Arm	---	---	82	102	72	145	42	89	42-89

Total = 193-352

*Included in Knik Arm counts

Table 2. Summary of beluga whale sightings made during aerial surveys of Cook Inlet. Medians were used when multiple counts occurred within a day, and the high counts among days were entered here.

Year	Dates	Counts	Percent Sightings		
			Lower Cook Inlet	Susitna Delta	Elsewhere in upper Cook Inlet
1993	June 2-5	305	0	56	44
1993	July 25-29	271	0	74	26
1993	Sept 3, 19	157	9	16	75
1994	June 1-5	281	4	91	5
1995	July 18-24	324	4	89	7
1996	June 11-17	307	0	81	19
1997	June 8-10	264	0	28	72
1998	June 9-15	193	0	56	44

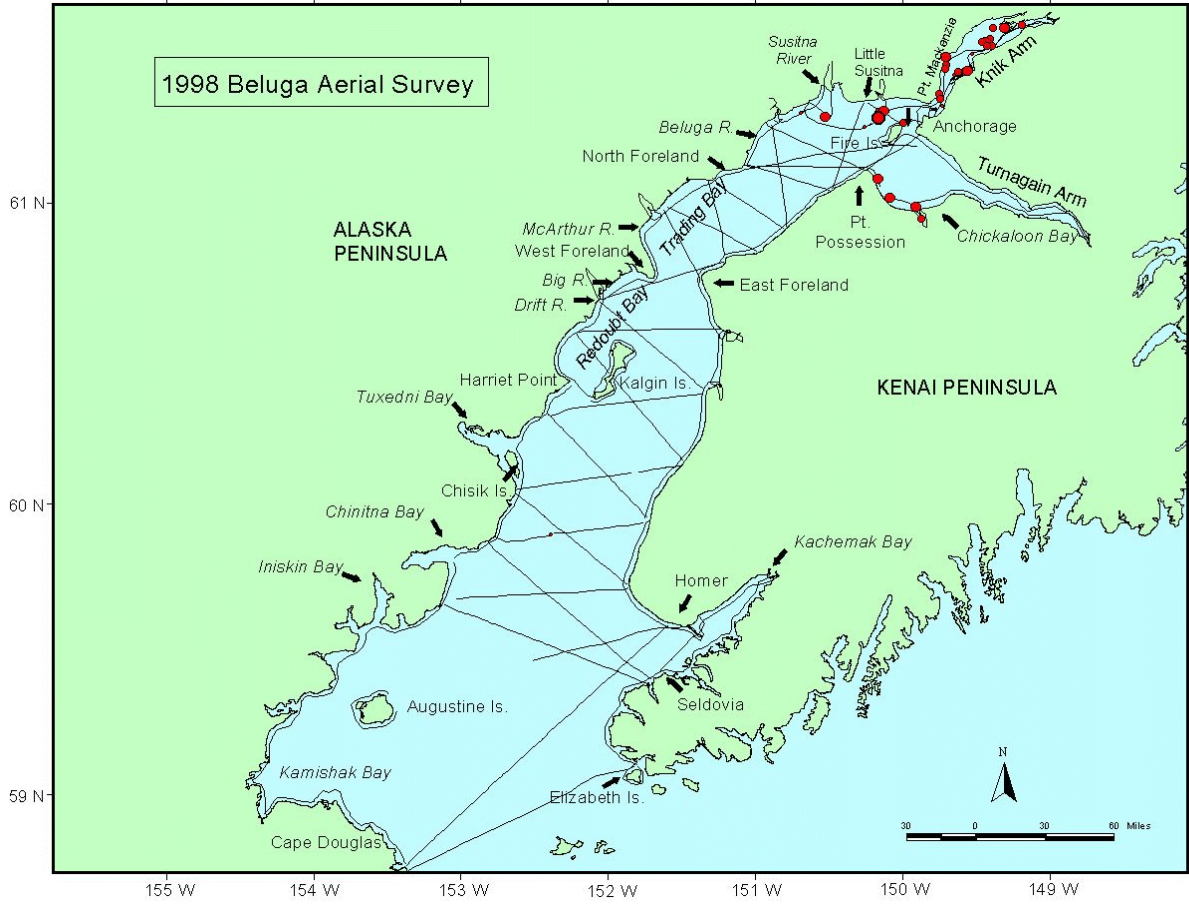


Fig. 1. Aerial survey tracklines and beluga groups seen 9-15 June 1998 during aerial surveys of Cook Inlet.