AERIAL SURVEYS OF BELUGA WHALES IN COOK INLET, ALASKA, JUNE 1999

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ABSTRACT

The National Marine Fisheries Service (NMFS) conducted an aerial survey of the beluga whale population in Cook Inlet, Alaska, during 8-14 June 1999. The 41.5 hr survey was flown in a twin-engine, high-wing aircraft at an altitude of 244 m (800 ft) and speed of 185 km/hr (100 kt) along a trackline 1.4 km from shore, consistent with annual surveys flown each year since 1993. The flights in 1999 included one or more surveys of coastal areas around nearly the entire Inlet and 1,790 km of transects across the Inlet. Paired, independent observers searched on the coastal (left) side of the plane, where virtually all sightings occur, while a single observer and a computer operator/data recorder were on the right side. In addition, each day a different visitor observed from the left side. After finding beluga groups, a series of aerial passes were made to allow at least two pairs of primary observers to make 4 or more counts of each group. Inter-day counts ranged from 75 to160 belugas near the Susitna River (between the Beluga and Little Susitna Rivers), 13 to 43 in Knik Arm, and 17 to 30 in Chickaloon Bay, but no belugas were found in lower Cook Inlet. The sum of the aerial estimates (using median counts from each site, not corrected for missed whales) ranged from 197 to 221 whales, depending on observer. The index count for 1999 is 217, which is slightly higher than the index counts for 1998 (193) but lower than all index counts by NMFS observers between 1993-97.

INTRODUCTION

Beluga whales (*Delphinapterus leucas*) are distributed around most of Alaska from Yakutat Bay 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 (Laidre *et al.* In prep.). Beluga whales in Cook Inlet are very concentrated in a few river mouths during parts of the year

(Rugh *et al.* In prep.). 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.

NMFS's National Marine Mammal Laboratory (NMML) and the Alaska Regional Office have conducted annual aerial surveys to study the distribution and abundance of beluga whales in Cook Inlet each June/July since 1993 (Withrow *et al*. 1994; Rugh *et al*. 1995, 1996, 1997a, 1997b, 1999) in cooperation with the Alaska Beluga Whale Commission (ABWC) and the Cook Inlet Marine Mammal Council (CIMMC). A letter from the Alaska Regional Scientific Review Group (ASRG) to S. Pennoyer, NMFS, dated 13 May 1997, strongly urged NMFS to continue these surveys every year. Aerial surveys are proven to be the most efficient method for collecting distribution and abundance data for beluga whales in Cook Inlet (Klinkhart 1966; Calkins *et al*. 1975; Murray and Fay 1979; Calkins 1984). The most recent studies have been some of the most thorough and intensive (Rugh *et al.* In prep.).

METHODS

The survey aircraft, an Aero Commander 680 FL (*N7UP*), has twin-engines, high-wings, 10-hr flying capability, is equipped with seating for five passengers and one pilot. There are bubble windows at each of the four 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 a portable 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.

There was an attempt to synchronize flight timings with low tides in the upper Inlet. This was primarily to minimize the effective survey area (at low tide, large areas of mudflats are exposed that would otherwise have to be surveyed). However, 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.

Coastal surveys were conducted on a trackline approximately 1.4 km offshore. The objective was to search nearshore, shallow waters where beluga whales are typically seen in summer (Rugh *et al.* In prep.). The trackline distance from shore was monitored with an inclinometer such that the waterline was generally 10^{o} 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, systematic 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). In 1999, this sawtooth pattern was offset from the previous years to reduce resampling among years.

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 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 survey protocol was the independence of the observers on the left (i.e., 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 counting passes by flying a criss-cross pattern over the group, recording starts and stops of group perimeters.

The flight pattern used to count a whale group involved an extended oval around the longitudinal axis of the group with turns made well beyond the ends of the group. 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 counting opportunities per whale 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. Count records 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.

A digital video camera was operated on each counting pass. Both the digital video and the Hi8 mm video used in previous seasons were run simultaneously in one test to allow for comparisons of the two cameras. Later, the images will be studied in the laboratory, and counts of whales will be compared to the infield counts (Hobbs and Waite In prep). Analysis of both the aerial counts and counts from the video tapes are detailed in Hobbs et al. (In prep.) for 1994-98 data.

RESULTS

A total of 41.5 hr of aerial surveys were flown around Cook Inlet 8-14 June 1999. All of these surveys (12 flights ranging from 1.6 to 5.3 hr) were based out of Anchorage, with refueling stops in Kenai and Homer. Systematic search effort was conducted for 22.1 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

1.5 hr (6.6% of the total flight time) when the left-front observer considered the visibility poor or worse. All of the primary observers who flew with this project in 1998 returned in 1999.

On 8 June, a test flight was conducted to be sure all onboard systems were operational. In addition, the group of whales at the Little Susitna River was circled for aerial photography (to collect images that will provide ratios of dark to light animals) and tests with dual video cameras (to compare a new digital video camera to the Hi-8mm camera used during the past several years).

On 9, 12, and 13 June, surveys were made around upper Cook Inlet, north of the East and West Forelands. High winds prevented surveys in Turnagain Arm except on 12 June. Excellent sighting conditions and thorough coverage made 12 June the primary survey day for upper Cook Inlet in 1999. On 10, 11, and 14 June, the lower Inlet and offshore waters were surveyed. Although the lower Inlet is usually surveyed in two days, unforecasted high winds in the lower Inlet on 11 June required an additional survey flight on 14 June. The composite of these aerial surveys provided a thorough coverage of most of the coast of Cook Inlet for all waters within approximately 3 km of shore (Fig. 1). In addition, there were 1,790 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 tracklines covered roughly 6,200 sq km, which is approximately 31% of the surface area of Cook Inlet; however, these surveys covered virtually all of the coastal areas except the southwesternmost corner of the lower Inlet. Most of upper Cook Inlet was surveyed three times, in particular the Susitna Delta where large groups of beluga whales have usually been found.

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' counts on multiple passes over a group. Ideal counting conditions and thorough coverage of the upper Inlet occurred on 12 June. Therefore, only the counts made on that date are used in summary calculations (which is consistent with methods used in the past). The sum of the observers' counts ranged from 197 to 221, depending on observer, with a median index count of 217. 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 (Hobbs et al. In prep.). The median index of counts in 1999 (217) is higher than in 1998 (193) but lower than in previous years (Table 2).

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, described here as the Susitna Delta, or in Knik Arm and Chickaloon Bay (Fig. 1). 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 July or later and are very likely associated with the migration of anadromous fish, particularly eulachon (*Thaleichthys pacificus*) (Calkins 1984; 1989) and several species of salmon. Only 0-4% of the annual sightings of belugas have occurred in lower Cook Inlet since 1993 (Table 2), but historically many whales were seen in the lower Inlet (Rugh *et al.* In prep.). Prior to 1996, small groups of belugas were observed in the lower Inlet (such as in

Kachemak and Redoubt Bays), but only single or dead whales have been seen south of North Foreland since then, and none were seen in the lower Inlet in 1999. Although the southwesternmost part of the lower Inlet was not surveyed in 1999 due to high winds or fog and rain, this area has never had beluga whales during any surveys in the past. Many sea otters, harbor porpoise, harbor seals, and some other cetaceans (eg., humpback, gray, and minke whales) were seen in the lower Inlet, so the lack of beluga sightings was not a function of visibility. In fact, on virtually every day of this survey a sighting was made of a beluga group near the Little Susitna River, even in windy conditions while the aircraft was doing an approach into Anchorage International Airport.

The uncorrected sum of median estimates made from the June 1999 aerial observations in Cook Inlet was 217 beluga whales. Using the same procedure of summarizing median estimates from the highest seasonal counts at each site 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. The average abundance estimate for the period 1994-98 is 505 beluga whales (SE = 81, CV =0.16; Hobbs et al. In prep.), including corrections for whales missed within the viewing range of observers and whales missed because they were beneath the surface. Although there appears to be a decline in abundance estimates through this five year period, the trend is not statistically significant.

The rise in the abundance index in 1999 might at first be interpreted as a rise in the true abundance (perhaps as a function of the moratorium on the hunt in 1999); however, the precision of the index is not good enough to be a true reflection of such a small change (24 whales). The abundance estimate for 1998 (347 beluga whales) had a CV of 0.29 (Hobbs et al. In prep.); therefore, a large change in counts would be necessary to show a statistically significant difference. Note that as beluga group density decreases, aerial counts become more accurate, reducing the sensitivity to a downward trend in abundance. As of yet there is no clear evidence that the Cook Inlet beluga population has changed in size when compared to the 1998 abundance estimate of 347 whales (Hobbs et al. In prep.).

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Table 1. Summary of counts of beluga whales made during aerial surveys of Cook Inlet in June 1999. Medians from primary 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		10-11 June		12 June		13-14 June		1999
	median	high	median	high	median	high	median	high	Highest medians
Turnagain Arm (East of Chickaloon Bay)	---	---	---	---	0	0	---	---	0
Chickaloon Bay/ Pt. Possession	17	30	---	---	**29**	39	---	---	29
Pt. Possession to East Foreland	0	0	0	0	**1**	1	0	0	1
Mid-Inlet east of Trading Bay	---	---	0	0	---	---	0	0	0
East Foreland to Homer	---	---	0	0	---	---	---	---	0
Kachemak Bay	---	---	0	0	---	---	---	---	0
W side of lower Cook Inlet	---	---	0	0	---	---	0	0	0
Redoubt Bay	---	---	0	0	---	---	0	0	0
Trading Bay	0	0	---	---	0	0	0	0	0
Susitna Delta (N Foreland to Pt. Mackenzie	89	105	75	96	**160**	221	109	181	160
Fire Island	---	---	---	---	0	0	---	---	0
Knik Arm	43	51	---	---	**27**	39	14	27	27*

Total = 217

*Use high count of Knik Arm plus Susitna counts, allowing that whales may move between these two areas.

Table 2. Summary of beluga whale sightings made during aerial surveys of Cook Inlet in June or July 1993-99. Medians were used when multiple counts occurred within a day, and the high counts among days were entered here.

			Percent Sightings		
Year	Dates	Counts	Lower Cook Inlet	Susitna Delta	Elsewhere in upper Cook Inlet
1993	June 2-5	**305**	0	56	44
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
1999	June 8-14	**217**	0	74	26

FIGURE CAPTION

Fig. 1. Aerial survey tracklines and beluga groups seen 8-14 June 1999 during aerial surveys of Cook Inlet.

1999 Beluga Aerial Survey