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APPENDIX

BELUGA WHALES (DELPHINAPTERUS LEUCAS) IN COOK INLET – A REVIEW

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A comprehensive literature review was conducted to aid in evaluating different methods of data collection and analysis prior to the 1993 aerial surveys for beluga whales in Cook Inlet. In the compiling of this review it wad revealed how little is known about belugas residing in the Gulf of Alaska. Stock boundaries are assumed due to the lack of sightings along the Aleutian Island chain though genetic isolation has not been determined. Behaviors such as feeding, breeding, and calving are inferred from studies of beluga populations in the Canadian and Alaskan Arctic, and Russia. Abundance estimates and seasonal distribution of belugas have been based on a small number of surveys conducted sporadically between 1963 and 1983. Beluga mortality from entanglement in fishing gear and from Native subsistence harvest is not well documented. To assess the fraction of the population currently removed annually by subsistence users and incidental to commercial fisheries an empirical estimate of the size of the beluga whale population in Cook Inlet and an evaluation of stock separation are necessary. Currently there are insufficient data to determine safe levels of take, a requirement that will need to be met to authorize incidental take in commercial fisheries.

LITERATURE REVIEW

Distribution

Beluga whales are distributed throughout seasonally ice-covered arctic and sub-arctic waters of the Northern Hemisphere (Hazard 1988). The seasonal movements of these whales are substantial, with many making annual migrations covering thousands of kilometers (Reeves 1990). In the absence of permanent barriers to their migration, there is uncertainty as to where stock boundaries should be drawn (see Dizon et al. 1992). Studies comparing body size, declines in highly exploited versus unexploited populations, and segregated summering grounds provide preliminary guidelines for distinguishing stocks based on morphological and seasonal differences (Sergeant and Brodie 1969; Mitchell and Reeves 1981; Finley et al. 1982; Reeves and Mitchell 1987). To date, however, beluga "stock" boundaries are distinguished primarily for management purposes and do not imply that the groups are genetically isolated (Reeves 1990). Preliminary tests of DNA taken from beluga at five separate locations along the coast of northwestern

Canada and Alaska (not including Cook Inlet) did not show genetic discreetness between the management stocks (O'Corry-Crowe 1993).

In Alaskan and northwestern Canadian waters, concentrations occur seasonally in the Mackenzie River estuary, Kasegaluk Lagoon, Kotzebue Sound, Norton Sound, Bristol Bay, and Cook Inlet. It is presumed that most belugas from these summering areas overwinter in the Bering Sea, excluding those belugas found in the northern Gulf of Alaska (Lensink 1961; Kleinenberg et al. 1964; Harrison and Hall 1978; Leatherwood et al. 1983; Seaman et al. 1985).

Due to the absence of sightings along the Aleutian Island chain (Braham et al. 1977; Harrison and Hall 1978; Frost et al. 1983; Leatherwood et al. 1983; Braham et al. 1984), the consistency of population estimates from year to year, and their presence year-round in Cook Inlet (Calkins 1979), belugas found in Cook Inlet are recognized as a population separate from those in the western Arctic. However, genetic isolation has not yet been proven. This population is centered in Cook Inlet but may range from Yakutat Bay to Shelikof Strait (Klinkhart 1966; Calkins and Pitcher 1977; Harrison and Hall 1978; Calkins 1979, 1987; Consiglieri and Braham 1982; Leatherwood et al. 1983). Sightings at the extremes of the range are infrequent, though this may be due in part to a lack of survey effort. Extra-limital sightings have been made as far south as the Washington Coast (Scheffer and Slipp 1948). As many as 21 belugas have been documented in Yakutat Bay in late May 1976 and 200 in Prince William Sound in July 1983, times of the year that belugas are usually most abundant in Cook Inlet (Calkins and Pitcher 1977; Calkins 1987). Consiglieri and Braham (1982) also reported observations made by local fishermen of belugas frequenting Yakutat Bay. It is not known whether these incidents are isolated or recurrent. Though it is suspected that a resident population of approximately 20 animals inhabits Yakutat Bay (Morris et al. 1983), Calkins (1987) believes that there is not enough evidence to conclude that a resident population exists, Some areas outside of Cook Inlet may have had large numbers of belugas in the past, at least seasonally (Calkins 1984).

Beluga whales occupy different parts of Cook Inlet in different seasons. In winter, access to the upper inlet may be restricted during heavy ice years. As the ice recedes in early spring, belugas move into the upper inlet where they form dense aggregations around the river mouths, particularly between West Foreland and Knik Arm. By August, beluga concentrations begin to disperse along the coastline of the upper and central inlet. With the return of ice in late fall, the belugas move into the lower inlet (Calkins 1984; Fall et al. 1984).

Habitat

Beluga whales are sighted most often in coastal and continental shelf waters and are known to frequent bays, estuaries and river mouths (Calkins 1987). In Cook Inlet, belugas are rarely found outside of the 50 fm contour line (Calkins et al. 1975). Cook Inlet is a tidal estuary that flows into the Gulf of Alaska and is approximately 200 km long and ranges in width from 16 km between East Foreland and West Foreland to 120 km across its mouth. The Forelands constrict the flow of water into and out of the upper inlet effectively breaking up the inlet's currents. In this narrow region, the tidal flow may reach speeds over 15 km/hr (8 knots) (Alaska Geographic 1983).

In the shallow upper inlet, particularly where fresh and salt water meet, bays and coves may be covered with ice in the winter. As the ice builds and moves south into the warmer water

beyond the Forelands, it melts. Only extremely low temperatures for extended periods create conditions suitable for large sea ice build-up in the lower inlet. Tidal swirls and rips are common throughout the inlet and contribute to the lack of ice in the lower inlet. The complex water circulation patterns within the inlet are influenced by large tidal ranges (Trasky et al. 1977), the seasonal runoff of fresh water, and wind. Cook Inlet tides have a normal maximum range of 10 m at Anchorage and 5 m at Homer. Extensive descriptions of climatic conditions are provided in Evans et al. (1972) and Selkregg (1974). Tidal patterns are described in Burbank (1977) and ADF&G (1978).

Silt from upstream glaciers is continually deposited into the inlet. Channels north of the Forelands, particularly 74-kilometer-long Knik Arm and 89-kilometer-long Turnagain Arm are at risk of being closed off by this siltation (Alaska Geographic 1983). In the upper inlet the middle channel averages 45 to 55 meters in depth and is dredged annually to keep shipping lanes open. Despite these unstable environmental conditions, large spawning runs of anadromous fish return every year to the inlet (Rearden 1983).

Lowry (1985) lists four factors that are crucial in determining habitat suitability: 1) access to air, 2) water quality, 3) availability of prey, and 4) freedom from disturbance. Beluga habitats have been broken down into four types: 1) breeding grounds, 2) calving/nursing grounds, 3) feeding grounds, and 4) migration routes (Calkins 1979). Cook Inlet, at least during ice-free seasons, is suitable in terms of access to air and availability of a number of prey items. Movement of food and ice appear to play a large part in beluga whale migration. The lack of food availability or cold water temperatures with ice cover might shift the distribution of belugas in Cook Inlet to the south during the winter. The arrival of prey species and reduction of ice in the spring leads to their northward return (Morris 1988). Warm rivers feeding into the inlet could provide a thermal advantage to newborns (Sergeant and Brodie 1969; Fraker et al. 1979) as well as accelerate the breakdown of old cells and promote new cell growth during the molt (Finley 1982; St. Aubin et al. 1990; Watts et al. 1991). However, fisheries activities and oil development within the inlet have contributed to increased noise and traffic in the region. Subsistence takes, mortality incidental to fishing operations, and contamination of habitats by hydrocarbons are potential threats to belugas spending extended time in this area (Hazard 1988). Although shallow, muddy waters may deter predation by killer whales (Orcinus orca), attacks on belugas do occur (R. Morris, pers. comm.) and might play a role in the beluga distribution in the area.

Behavior

Beluga whales in Cook Inlet appear to have acclimated to the heavy vessel and air traffic around Anchorage. They have been seen within the immediate vicinity of active oil platforms; even females with calves have passed as close as 10 m (Hazard 1988). Belugas do not appear to be affected by constant noise but tend to avoid sudden changes in noise level (McCarty 1981). Much of the description of beluga whales in Cook Inlet is inferred from studies of belugas in other regions. Breeding and calving grounds are unknown, and the timing of these activities can only be hypothesized.

Calving along the northwest coast of Alaska is believed to extend from April to September (Braham 1984). Calving is thought to occur in coastal estuaries (Sergeant and Brodie 1975) but has also been observed in colder offshore waters (Fraker 1977; Davis and Finley 1979;

Davis and Evans 1982; Watts et al. 1991). Calves may be born outside the estuaries (Fraker 1977) and then enter the areas with their mothers (Hay and McClung 1976), using the inlet as a nursery area. In Cook Inlet, calves have been observed at the Beluga River, Trading Bay, and Redoubt Bay in mid-July, in the central inlet between Kalgin Island and the Kasilof River in mid-August, and in Tuxedni Bay in mid-October (Calkins 1979). Along with its potential benefits as a calving and nursing ground, Cook Inlet may be beneficial to older belugas for molting.

Molting beaches were first described by Finley (1982) for belugas in eastern Canada. Frost et al. (1992) described belugas churning the gravel/sandy bottom of Kasegaluk Lagoon into muddy plumes and believed the animals were displaying molting behaviors similar to those observed in the Canadian Arctic. The dense muddy substrate that is predominant in Cook Inlet probably would not be abrasive enough to remove sloughing epidermis; however, the warm, fresh water in combination with rubbing on the bottom could further stimulate molting and "promote energy efficient epidermal growth" (Watts et al. 1991). Milling close to river mouths may be related to molting, feeding, or both behaviors.

There is only circumstantial evidence that belugas are feeding while in upper Cook Inlet. Large concentrations (150+) have been observed in the river mouths over a period of days, coinciding with spawning runs of anadromous fish. Whales were seen aligned on the same directional heading with lead animals breaking off from the front of the main group. Calkins (1979) believed that this group formation represented a feeding aggregation though no food source was observed. Large herd formations have been shown to be associated with heavy concentrations of food organisms in a small feeding area (Bel'kovich 1960).

Prey Preference

According to Rearden (1983), Cook Inlet has a stable salmon fishery. Spawning streams and lakes surround the entire inlet, ensuring high salmon returns even if adverse environmental conditions should occur in one part of the inlet. Kings (Oncorhynchus tshawytscha) are the first to arrive with spawners appearing in the Susitna River around May 25. By mid-June they have completed spawning. A second run arrives in June and continues through July bound for the Kenai-Kasilof rivers. The Kenai and Susitna Rivers are the largest producers of sockeye salmon (Oncorhynchus nerka). The peak of the sockeye fishery is usually between July 15 and 20. The annual average catch between 1973-82 was 1.6 million. The Susitna is also an important producer of pinks (Oncorhynchus gorbuscha) which are commonly fished after the sockeye have completed their run. There are as many as one million spawning fish in some years. Fish incidentally taken in these fisheries include chum (Oncorhynchus keta) and coho (Oncorhynchus kisutch) salmon. Chum runs peak about one week after sockeye, and the largest numbers again are produced in the Susitna basin. Coho, on the other hand, are found in every spawning system of the inlet, arriving from mid-July well into October. Other fishes common to Cook Inlet include eulachon (Thaleichthys pacificus) which spawn in the lower Susitna River in late May and early June, tomcod (Microgadus proximus), herring (Clupea harengus), grayling (Thymallus arcticus), Dolly Varden (Salvelinus malma), rainbow trout (Salmo gairdneri), whitefish (Coregonus sp.), and burbot (Lota lota) (Rearden 1983; Calkins 1984).

Movements of beluga whales inshore during summer to river estuaries appears to be associated with concentrations of fish (Klinkhart 1966; Sergeant 1962; Tarasevich 1960). The

beluga diet is diverse, including over 100 recognized prey species (Kleinenberg et al. 1964). Beluga prey items can be expected to vary seasonally and with location. Stomachs from beluga caught in the lower inlet contained salmon, smelt (Osmerus dentax), flounder (Pleuronectidae sp.), sole (Pleuronectidae sp.), sculpin (Cottidae sp.), and shrimp (Pandalus sp.) (Calkins 1979). Based on interviews with residents in Tyonek, Fall et al. (1984) state that belugas commonly prey on salmon, eulachon, and tomcod during the spring and summer in upper Cook Inlet. Calkins (1984) observed a large group of whales near the Susitna River mouth, coinciding with the arrival of over several million eulachon. Both smolts and adult salmon may be important prey items. In 1986, tags from at least 10 salmon were found in the stomach of a beluga stranded in Turnagain Arm (L. Lowry, pers. comm. to B. Morris).

Historical Abundance Records

Research in the northern Gulf of Alaska, particularly in Cook Inlet, began in 1963 (Klinkhart 1966). Most surveys have concentrated on shoreline aggregation areas and have not included intensive surveys of the open water areas of the inlet. In some cases, descriptions of survey methods are lacking (Hazard 1988). Klinkhart (1966) estimated 300-400 beluga during aerial surveys in 1963 and 1964. Harrison and Hall (1978) flew systematic surveys throughout Alaska from 1975-77. This included one trackline into upper Cook Inlet, and 2-3 tracklines in the lower inlet. However, they did not survey river mouths, and group sizes were small (<3). On three consecutive days in August 1978, visual counts were made "of the main concentration of animals in the central part of the Inlet" (Murray and Fay 1979). Counts on each day came to 150 animals; however, they believe that three times that number (450) may have been present but were not counted due to water turbidity. Calkins (1984) estimated 200-300 belugas in a concentration area between the Beluga River and the Susitna River during aerial surveys conducted in 1982 and 1983. Again, surveys were only conducted in the upper Inlet and along the shoreline. He concluded that the population likely exceeded 400 animals. Opportunistic surveys of the north shore of Cook Inlet, in particular the Susitna Rivers and Knik Arm, were conducted 8 and 10 June 1991 and 11 June 1992. An estimated 200 belugas were observed in the Big/Little Susitna area in 1991; 240 at the Little Susitna River in 1992 (NMML unpubl. data). Systematic strip and neashore transects covering 4,000 nautical miles and 40 hours of aerial observation were conducted 18-21 June 1991 (NMFS-AKR 1992). Transects were flown as far south as Anchor Point in the lower inlet, however, all beluga observations occurred in upper inlet estuaries. The highest count recorded was 242 belugas. An estimate of 500 belugas in Cook Inlet was given by the Interagency Task Group (1978), but a source for this number was not cited. In general, estimates of abundance for Cook Inlet have ranged from 300 to 500.

Correction factors have been applied to surveys conducted in Bristol Bay and elsewhere to correct for animals that were missed because they were submerged (Brodie 1971; Sergeant 1973; Fraker and Fraker 1979, 1981, 1983; Fraker 1980, 1983; Frost et al. 1985). However, unless thorough documentation of the methods used during past surveys is provided, a correction factor should not be arbitrarily applied to population estimates in Cook Inlet.

Interaction with Commercial Fisheries and Subsistence Harvest

In Alaska, beluga whales are taken for subsistence and incidentally in commercial and Native coastal fisheries. However, beluga mortality from entanglement in fishing gear is not well documented. In 1980, 5 to 7 belugas were taken in Cook Inlet, most incidental to commercial salmon fishing. An estimated 3 to 6 belugas were taken by entanglement each year in 1981, 1982, and 1983 (Burns and Seaman 1986).

Annual average landed harvest of beluga based on the eight year period from 1977 to 1984 is 220 animals for western and northern Alaska. Estimates of whales killed but not landed vary from 33% (Fraker 1980) to 40% (Hunt 1976, 1979) to 57% (Finley et al. 1983). In Cook Inlet the average annual retrieved kill is 5 (Burns and Seaman 1986), though the estimated total annual kill is 10 (Interagency Task Group 1978), and preliminary studies by the Alaska Department of Fish and Game indicate harvests may be as high as 20-40 annually (Hazard 1988). Belugas apparently have a strong site tenacity despite being hunted, as demonstrated by the Nastapoka herd in Eastern Hudson Bay (Caron and Smith 1990). This is of concern since hundreds of belugas concentrate annually in river mouths of upper Cook Inlet, in particular the Susitna region where whaling is known to take place (NMFS-AKR, pers. comm.).

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