SOCIO-SEXUAL AND PROBABLE MATING BEHAVIOR OF COOK INLET BELUGA WHALES OBSERVED FROM AN AIRCRAFT

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ABSTRACT

Socio-sexual and mating behaviors, to our knowledge, have not been previously documented among free-ranging beluga whales (*Delphinapterus leucas*) but have been described in detail for captive belugas. We report on the first photo-documented interaction and display of socio-sexual and apparent mating behavior of non-captive endangered beluga whales in Upper Cook Inlet, Alaska. This behavior was seen on two different days in the same river mouth in uncharacteristically clear waters of Cook Inlet. On 24 April 2014, social and possibly sexual behaviors were observed and photographed for approximately 12 minutes within a group of nine adult beluga whales in the Middle

River mouth on the west central side of Cook Inlet. A total of 136 photographs were taken using a Canon® EOS 7D Digital SLR camera with a Canon 100-400 mm IS telephoto lens while circling the whales at altitude >305 m and radial distance > 500 m. On 7 May 2014, similar behavioral displays were observed among four adult beluga whales in the same location for approximately 7 minutes. The second group was observed for a shorter duration and not photo documented due to flight limitations. In both events, affiliative behavioral events such as echelon and contact swimming, and socio-sexual behaviors such as ventrum-to-ventrum contact, ventral presentations, pelvic thrusting, nodding, and rubbing were observed. These behaviors resemble those previously reported for captive beluga mating behaviors and copulation. Similarities between these observations with captive mating behaviors, and the timing of ovulation and peak calving periods from other wild beluga populations, provide strong evidence that mating occurs during spring months in Cook Inlet.

Key words: *Cook Inlet beluga whale, socio-sexual behavior, mating behavior* aerial survey

INTRODUCTION

Socio-sexual behavioral interactions among free-ranging beluga whales have not been previously documented, to our knowledge, and are poorly understood. Although mating and social behaviors have been described for captive beluga whales, it is logistically difficult to observe among free-ranging beluga whales. They inhabit remote, cold, and in

the case of the Cook Inlet beluga whale (CIBW), typically muddy waters. Observations of socio-sexual behaviors of free-ranging CIBW are needed to address critical information gaps on the natural history, mating behavior, and potential behavioral habitat preference of this declining insular population.

Reproductive Background

Little is known about the mating behavior or mating season of beluga whales in the wild. Reported age of sexual maturity varies from 4 to 10 years for females and 8 to 15 years for males (Nowak 1991; Suydam et al 1999). Gestation is 14-14.5 months, with a single calf born in late spring or early summer (Sergeant 1973). In autumn, Arctic beluga whale populations migrate towards a few common wintering grounds in offshore waters characterized by unconsolidated pack ice where mating is believed to occur during late winter or early spring (Brown & Gladden et al 1997; Brodie 1971; Sergeant 1973).

Unlike the Arctic stocks, the Cook Inlet beluga population is not thought to undertake seasonal migrations outside of Cook Inlet (reference?). Their breeding ground locations are unknown or possibly non-existent (i.e. mating can occur anywhere throughout their range). Similar to Arctic beluga populations, CIBW calving is believed to occur from mid-May to mid-July (Calkins 1983) although native hunters have observed newborn CIBW cables from April through August (Huntington 2000). Alaska natives described CIBW calving areas as the northern side of Kachemak Bay in April and May, off the Beluga and Susitna River mouths in May, and in Chickaloon Bay and Turnagain Arm during summer (Huntington 2000). Vessel-based surveys of the upper of Cook Inlet in 2005 – 2007 did

not document any specific calving locations or a definitive calving season (McGuire et al 2008). Calves were encountered in all surveyed locations and months (April – October) (McGuire et al 2008). Thus CIBW are reported to continue to calve later in the season than the Arctic stocks, although their calving season is unclear and it is possible they possibly calve year-round.

Global observations of both wild and captive beluga whales indicate that breeding is seasonal. Among captive beluga whales Robeck et al (2005) reported that both testosterone in males and progesterone peaks in females were elevated during late winter/early spring, peaking in March (Robeck et al 2005). These combined studies suggest that breeding should peak seasonally among CIBW as well, although there are no reported behavioral, hormonal, or reproductive data to support this.

Among captive belugas and bottlenose dolphins (Tursiops turncatus) ethograms for social behavior have been successfully developed and applied to link descriptive behavioral events with social (e.g., affiliative, sexual) relationships (Ostman 1991, Recchia 1994). Recchia (1994) applied a set of social behaviors specific to captive beluga whales by defining an actor and recipient and their dyadic interactions to quantitatively assess dominance among five animals of both sexes. Behaviors included ventrum-to-ventrum contact, thrusting, ventral presents, rubbing and nodding (Table 1; Recchia 1994). A clear correlation between size of animal and dominance was found, with larger animals most often in an actor role and more dominant to smaller animals in the group, regardless of sex (Recchia 1994). Another study on captive beluga whales involving

juveniles born in captivity interacting with wild-caught animals from the Chukchi Sea showed that male-to-female thrusting varied significantly across months (Glabiky et al 2010). However, a clear peak in activity was found during March - May, suggesting seasonality in sexual behaviors (Glabiky et al 2010).

Herein, we describe the first documented interaction and display of socio-sexual behavior among free ranging, U.S. federally endangered CIBW during late spring. This behavior was observed on two different days in the same river mouth, one time documented with photographs. These data support the hypothesis that CIBW mating occurs during spring months, similar to other regions.

METHODS

Aerial surveys were conducted by Smultea Environmental Sciences (SES) in Cook Inlet, Alaska from 1 April – 27 June 2014. The surveys were part of a marine mammal monitoring program during seismic operations funded by Apache Alaska Corporation. The aerial surveys were designed to monitor the distribution and habitat-use patterns of CIBW in upper Cook Inlet. Aerial surveys were flown from a high-wing, single-engine Cessna 172. The general aerial route lasted about 2.5-3 hours (hr), departing Anchorage, transiting west across Knik Arm, then flying ~1.6 km offshore along western Cook Inlet through the Susitna River Delta south to West Foreland. The route continued to the eastern side of Cook Inlet by crossing to East Foreland, then transiting along the eastern coastline through Chickaloon Bay and returned to Anchorage (Figure 1). The survey was flown at an altitude of 305 m and speed of ~95 kt. Whales were circled to document

group size and composition at a radial distance of > 457 m to remain outside the aircraft's air-to-water sound transmission range relative to the sighting location (Urick 1972; Richardson 1995). While circling, sightings were documented with a high-definition (HD) Canon EOS 7D Digital SLR camera with a Canon 100-400 mm internally stabilized (IS) telephoto lens. Systematic behavioral protocol and descriptive notes were recorded on a laptop computer using real-time *Mysticetus* observational software (Smultea and Bacon 2012). Recorded data including photographs were used to later categorize behaviors following definitions of affiliative and socio-sexual behavioral events for captive beluga whales described by Recchia 1994 (Table 1).

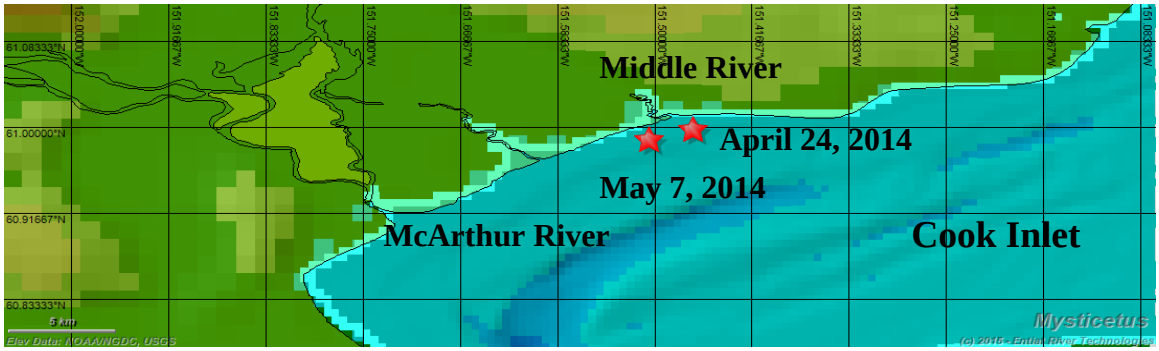

Figure 1. K. Lomac-Macnair

Figure 1. Map of Upper Cook Inlet showing locations of the two beluga whale sightings involving socio-sexual behavior on 24 April and 7 May 2014.

Table 1. Definitions of affiliative and socio-sexual behavioral events observed, adapted from Recchia (1994).

Behavioral	Abbreviation	Definition

Event		
Affiliative		
Contact	C	Actor contacted recipient and did not rub. Contacts could involve virtually any part of actor's and recipient's bodies.
Contact Swim	CS	Actor contacted recipient and contact was maintained for >3 seconds (s).
Echelon swim	ES	Actor altered his/her swim pattern to swim in parallel with recipient, maintaining relative position to recipient for >3 s, within 3 m [1 Body Length (BL)].
Socio-sexual		
Ventrum-to-Ventrum Contact	VVC	Contact in which the actor brought his/her genital region into contact with recipient's genital region.
Ventral Present	VP	Actor rolled his/her body towards recipient, so the ventral region pointed at recipient.
Thrust	Th	Actor formed an "S" shape with his/her body, with head and genital region moved ventrally and tail moved dorsally, and moved genital region towards recipient, <3 m (1 BL) of each other. Usually

		occurred when two animals were swimming in parallel. A mutual thrust was scored when two animals directed this behavior at each other simultaneously.
Ventral Swim	VS	Type of echelon swim in which actor maintained a ventral present towards recipient for >3 s. A mutual ventral swim was scored when two animals swam in parallel with their genital regions pointed at each other for >3 s.
Nodding	Nd	Actor, while facing recipient, repeatedly and rapidly moved his/her head up and down slightly.
Rub	Rb	Extended form of contact in which actor rubbed part of his/her body against recipient. Often took form of actor approaching recipient, and rubbing most of body length against the back or side of recipient. Recipient sometimes facilitated rub, e.g. by arching back slightly.

RESULTS

First Observed Mating Encounter

On 24 April, 2014, we observed and took 136 photographs of an interaction between a

group of nine adult beluga whales approximately 15 km northeast of the McArthur River, and ~0.5 km offshore of western Cook Inlet, over waters ~10 m deep relative to the mid-tide at the time (by authors KLM and MC) (Figure 1). The plane circled the group for ~12 min as the whales slowly traveled southeast and parallel to shore. Individual whales were intermittently visible at the surface between surfacing bouts within the brown-colored, silt-filled water that limited visibility below the water surface. Water clarity, and thus visibility of whales below the water surface improved as the whales neared the Middle River mouth. During this encounter, three animals remained on the periphery ~10 Body Lengths (BL) from the other six whales in the group. The latter six whales were paired into three groups of two animals, and all three pairs displayed socio-sexual behavioral events described for captive mating belugas by Recchia (1994). Aspects of these inter-animal interactions most relevant to the behaviors identified in Table 1 are detailed chronologically in Table 2.

Table 2. Chronological description of socio-sexual behavior observed among a group of nine beluga whales on 24 April 2014 and associated figure references.

Time	Description of Observations	Affiliative and Socio-sexual Behavioral Events Observed[1]	Figure
13:20	Nine adult (white) beluga whales sighted in 3 distinct pairs exhibiting affiliative behavioral events; 3 other solo individuals were ~50 m away but were not seen to interact with any other whales.	CS, ES, C	Figures 2 & 3* *only one pair is exhibited in these Figures
13:22	Two animals seen swimming in separate silt trails ~10 Body Length (BL) apart.		Fig 2 & 3
13:23	Pair 1 – one animal performed multiple rostro-genital contacts, or "goosing" of the other animal.		Figure 3
13:24	Pair 2 - slowly rolled around each other in physical contact, created large plumes of silt. Presented ventral sides.	C, VP	Figure 4

Time	Description of Observations	Affiliative and Socio-sexual Behavioral Events Observed[1]	Figure
13:25	Pair 3 - contact swimming seen with necks and heads both cocked inwards facing each other, nodding and almost touching. One animal rotated onto its side, ventral facing towards the other beluga. Two pelvic thrusts observed, followed by returning to side-by-side contact swimming and head touching.	CS, Nd, VP, Th	Figures 5, 6 & 7
13:26	Pair 1 observed engaging in similar pelvic thrusting by one animal to the other, and ventral-ventral contact followed by close-contact swimming with the thrusting animal maintaining contact with one pectoral fin.	Th, VVC, VS, VP, C, Rb	Figure 8
13:27 - 13:28	Pair 3 continued pelvic thrusting multiple times, followed by both animals diving straight down and out of sight.	Th, VP, VVC, VS	Figure 9
13:31	Observations ended.		

1 See Table 1 for event definitions

Second Observed Mating Encounter

On 7 May 2014, similar socio-sexual behavioral events were observed among four adult beluga whales (by author MAS) approximately 1 km north of the McArthur River, and ~1 km offshore of western Cook Inlet near the Middle River mouth (Figure 1). The group was circled for ~7 min, a shorter duration due to flight and survey limitations. The socio-sexual behaviors observed and documented in field notes included repeated ventral-to-ventral contact, ventral presents, thrusting, nodding, and touching. In addition, two whales chased and appeared to maneuver for proximity to a third central animal. No photographs were taken during this encounter, as an HD camera and zoom lens were not available.

DISCUSSION

Sexual activity has not previously been described for CIBW in the wild despite extensive aerial surveys conducted in the region since 1994 (e.g. Rugh et al 1995, 1996, 1997, 1999, 2000, 2001,2002, 2003, 2004) and additional vessel- and shore-based marine mammal monitoring programs in Cook Inlet (e.g., McGuire et al. 2008). Underwater observations of beluga behavior and direct observations of inter-individual behavior are difficult to do and typically limited given the challenges inherent with remote, cold, and typically silty waters characterizing Cook Inlet. Observations reported herein are exceptional in that the beluga whales were in a freshwater confluence area, unusually allowing sub-surface identification of behavioral events, including relative inter-

individual spacing and positioning from the “bird’s eye”, three-dimensional view of the whales afforded by the aerial observation platform.

The socio-sexual behavioral events we observed in Cook Inlet on 24 April and 7 May 2014 closely resemble the specific behavioral events of previously observed beluga whales courting and mating in captivity. To our knowledge, these behaviors have never been photo-documented among free ranging beluga whales and specifically the CIBW endangered population. The seasonality of these apparent courting and mating behaviors correspond with reported spring mating seasons for the Arctic and St. Lawrence beluga populations as well as captive belugas. Correlation of our observations with timing of ovulation, peak testes size, and peak calving periods from both captive and other wild beluga populations provide strong evidence that mating occurs during spring months in Cook Inlet. This suggests that the CIBW population exhibits seasonal fluctuations in behavioral ecology.

The distribution, habitat use, and grouping behavior patterns of mammals have been linked with ecological parameters such as food and mate availability/distribution and predator avoidance (e.g. Davies et al. 2002, Kappeler et al. 2013). Both of our reported beluga whale sightings occurred in the same general area, possibly suggesting geographic preference and/or behavior-based habitat use by this species during the breeding season, though further research is needed.

All the beluga whales we observed in the two groups described herein were white and of similar body size. Coloration in beluga whales is apparently related to physical maturity. Adults are thought to become white at sexual maturity, however Burns and Seaman (1986) reported females may retain gray coloration upwards of 21 years and McGuire et al. (2008) reported ten photo-identified mothers that retained gray coloration, suggesting that coloration is not definitive of maturity. Although all the belugas we observed were white and appeared to be adults based on body size, we were not able to determine their sex from our aerial observations. It is possible that this socio-sexual activity represents play and or social behaviors of males on males or non-reproductive animals, possibly sexually immature or out of estrus. It is also possible that socio-sexual activity occurs year-round and was only coincidentally observed during the spring season at the same geographic location. Further observations of this behavior are necessary to confirm if it is seasonally related and/or occurs in certain areas of Cook Inlet. However, the exceptionally observed and photo-documented rarity of such behavior is important to both note and report for ecological management and conservation purposes.

Unlike other beluga populations in Alaska, the endangered CIBW stock is believed to be confined to the Cook Inlet estuary, representing a relatively small genetically and geographically isolated population. Accordingly, the CIBW population is potentially more susceptible to physical, ecological, and anthropogenic stresses (Moore et al. 2000). NMFS aerial survey results indicated nearly a 50 percent decline in the CIBW population between 1994 and 1998 (NMFS 2008). Specific reasons for this decline are unknown. In

2008, the CIBW was listed as endangered under the U.S. Endangered Species Act and a CIBW Recovery Plan was developed, followed by identification of critical habitat in 2011 (73 FR 62919; NMFS 2008). The Recovery Plan specifically identified the need to characterize CIBW life history traits and improve knowledge in mating systems (NMFS 2008). Identifying temporal and spatial habitat-use patterns, as well as confirming the peak period of mating, are critical to ensure protection of potentially important behavioral regions and seasons sensitive to population recovery, further mitigating potential decline of this already depleted population.

SUMMARY AND CONCLUSION

Our observations represent a unique contribution lending insight into the little-known social-sexual behavior of free-swimming beluga whales, including temporal and geographical aspects. Documenting and understanding mating systems and related behavior is critical for effective management and conservation of this endangered population. Such information also begins to address critical data gaps for this species identified in the NMFS 2008 CIBW Conservation Plan (NMFS 2008), providing some insight on the natural history, mating behavior, seasonality and potential behavioral-based habitat preference of this declining population.

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Figure 2. M. Cotter

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Figure 9. M. Cotter