

Socio-sexual and Probable Mating Behavior of Cook Inlet Beluga Whales, *Delphinapterus leucas*, Observed From an Aircraft

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Introduction

Socio-sexual behavioral interactions among free-ranging beluga whales, *Delphinapterus leucas*, have not been previously documented, to our knowledge, and are thus poorly understood. Although mating and social behaviors have been described for captive beluga whales (Hill et al., 2015), it is logistically difficult to observe undisturbed behavior among free-ranging beluga. They inhabit remote, 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.

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.¹). Gestation is 14.0–14.5 months, with a single calf born in late spring or early summer (Sergeant, 1973). This would suggest mating occurs in early spring. In autumn, beluga whale populations migrate toward a few common wintering grounds in Bering Sea offshore waters characterized by unconsolidated pack ice where mating is believed to occur during late winter or early spring (Brodie, 1971; Sergeant, 1973; Brown Gladden et al., 1997).

Unlike the Arctic stocks, the Cook Inlet beluga population is not thought

to undertake seasonal migrations outside of Cook Inlet (Laidre et al., 2000; Rugh et al., 2000). Specific breeding areas are unknown or possibly non-existent (i.e. mating might occur anywhere throughout their range). Similar to Arctic beluga populations, CIBW calving is believed to occur in early summer (Hobbs et al., 2015a) although Native hunters have observed newborn CIBW calves 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). McGuire et al.², during vessel-based surveys of the upper reaches of Cook Inlet in 2005–07, did not document any specific calving locations or a definitive calving season and calves were encountered in all surveyed location and months (April–October). Thus CIBW are reported to continue to calve later in the season than the Arctic stocks, although their calving season is unclear. In part, some confusion on calving dates may be a function of sightings of calves well into the summer that were actually born weeks or months earlier.

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 in females were elevated during late winter/ear-

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¹Suydam, R., J. J. Burns, and G. Carroll. 1999. Age, growth, and reproduction of beluga whales from the eastern Chukchi Sea, Alaska. Paper presented to the Alaska Beluga Whale Committee workshop, March 30–April 1, 1999. 5 p.

ABSTRACT—Socio-sexual and mating behaviors, to our knowledge, have not been previously documented among free-ranging beluga whales, *Delphinapterus leucas*, but they 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 noncaptive beluga whales in Cook Inlet, Alaska. This behavior was seen on two different days in the same river mouth in uncharacteristically clear waters of upper Cook Inlet. On 24 April 2014, social and possible mating behaviors were observed and photographed for approximately 12 min within a group of nine adult beluga whales in the mouth of Middle River on the west central side of Cook Inlet. A total of 136 photographs were taken at a radial distance

> 500 m. On 7 May 2014, similar behaviors were observed among four adult beluga whales in the same location for about 7 min. The second group was not photo-documented due to flight limitations. In both circumstances, 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 early spring months in Cook Inlet.

²McGuire, T. L., C. C. Kaplan, M. K. Blees, and M. R. Link. 2008. Photo-identification of beluga whales in upper Cook Inlet, Alaska. 2007 Annu. Rep. Prep. LGL Alaska Res. Assoc., Inc., Anchorage, AK, for Chevron, Natl. Fish Wildl. Found., and ConocoPhillips Alaska, Inc., 52 p.

ly 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, in part because aerial surveys and sampling of whales rarely occur in March in Cook Inlet (Shelden et al., 2015).

Among captive belugas and bottlenose dolphins, *Tursiops truncatus*, ethograms for social behavior have been successfully developed and applied to link descriptive behavioral events with social (e.g., affiliative, sexual) relationships (Östman, 1991; Recchia³). Recchia³ applied a set of social behaviors specific to captive beluga whales by defining an actor and recipient and their dyadic (i.e., pair) interactions to quantitatively assess dominance among five animals of both sexes. Behaviors included ventrum-to-ventrum contact, thrusting, ventral presenting, rubbing, and nodding (Table 1; Recchia³). 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 (Recchia³).

Glabiky et al., (2010) found that male-to-female thrusting between captive-born juvenile beluga whales and wild-caught animals from the Chukchi Sea varied significantly across months. 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 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 early spring months, similar to other regions.

³Recchia, C. A. Social behaviour of captive belugas, *Delphinapterus leucas*. Rep. no. WHOI-94-03. Woods Hole Oceanographic Institute, MA, 1994, 206 p.

Table 1.—Definitions of affiliative and socio-sexual behavioral events observed, adapted from Recchia (text footnote 3) and Hill et al. (2015).

Behavioral Event	Abbreviation	Definition
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).
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 body length) 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.

Methods

Apache Alaska Corporation funded aerial surveys, conducted by Smultea Environmental Sciences⁴ in Cook Inlet, Alaska, from 1 Apr–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 2.5–3 h, departing Anchorage, transiting west across Knik Arm, then flying about 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.

The survey was flown at an altitude of 305 m and speed of about 95 kn. 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 (Urlick, 1972; Richardson et al., 1995). While circling, sightings were documented with a high-definition (HD) Canon EOS 7D Digital SLR camera with a Canon 100–400 mm image stabilized (IS) telephoto lens.

Systematic behavioral protocol and descriptive notes were recorded on a laptop computer using real-time *Mysticetus* observational software (Smultea and Bacon⁵). Recorded data,

⁴Mention of the trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA

⁵Smultea, M. A., and C. M. Bacon. 2012. A comprehensive report of aerial marine mammal monitoring in the Southern California Range Complex: 2008–2012. Prep. for Commander, U.S. Pacific Fleet, Pearl Harbor, Hawaii. Submitted to Naval Facilities Engineering Command Southwest (NAVFAC SW), EV5



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

including photographs, were used to later categorize behaviors following definitions of affiliative and socio-sexual behavioral events for captive beluga whales described by Recchia³ (Table 1).

Results

Mating Encounter First Observed

On 24 April 2014, we (KLM and MC) 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 about 0.5 km offshore of western Cook Inlet, over waters about 10 m deep relative to the mid-tide at the time (Fig. 1). The plane circled the group for about 12 min

as the whales slowly traveled south-east 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 about 10 body lengths from the other six whales in the group. The latter six whales were paired into three groups of two animals (Figs. 2–9), and all three pairs displayed socio-sexual behavioral events described for captive mating belugas by Recchia³. Aspects of these inter-animal interactions most relevant to the behaviors identified in Table 1 are detailed chronologically in Table 2.

Mating Encounter Second Observed

On 7 May 2014, similar socio-sexual behavioral events were observed among four adult beluga whales (by MAS) approximately 1 km north of the McArthur River and about 1 km offshore of western Cook Inlet near the Middle River mouth (Fig. 1). The group was circled for about 7 min, a relatively short 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, because an HD camera and zoom lens were not available.

Environmental, San Diego, under Contr. No. N62470-10-D-3011 issued to HDR, Inc., San Diego, Calif., 68 p.

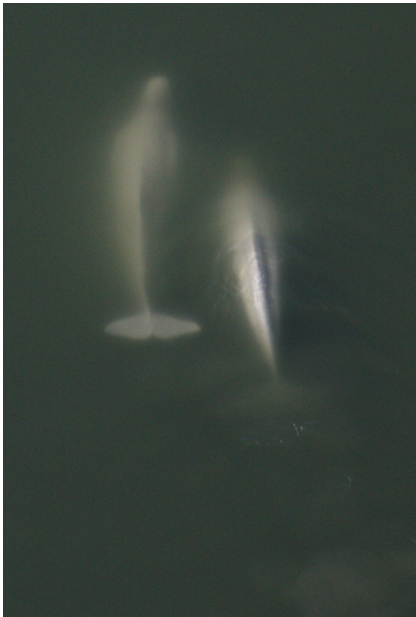


Figure 2.—Pair 1, two animals observed swimming within one body length of each other through silty water. Photo by Mark Cotter.

Discussion

Sexual activity has not previously been described for CIBW in the wild despite extensive aerial surveys conducted in the region since 1994 (Rugh et al., 2000, 2004, 2005; Shelden et al., 2013, 2015) and additional vessel- and shore-based marine mammal monitoring programs in Cook Inlet (McGuire et al.²). The lack of recorded observations during these surveys indicating sexual activity among belugas may in part be due to timing—almost no surveys were conducted during early spring when the CIBW are likely mating (Shelden et al., 2015). Underwater observations of beluga behavior and direct observations of inter-individual behavior are difficult to obtain and limited given the challenges inherent with remote, and typically silty waters characterizing Cook Inlet. Observations reported herein are exceptional in that the beluga whales were in a freshwater confluence area, allowing unusually clear identification of subsurface behavioral events, including relative

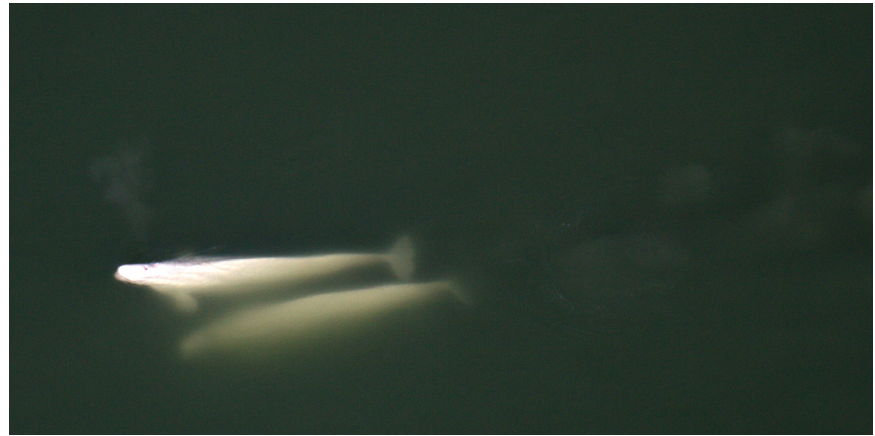


Figure 3.—Pair 1, exhibiting contact swimming. Photo by Mark Cotter.

inter-individual spacing and positioning from the aerial, three-dimensional view of the whales.

To our knowledge, the socio-sexual behavioral events we observed in Cook Inlet on 24 April and 7 May 2014 have never been photo-documented among free-ranging beluga whales and specifically the CIBW population. However, these behaviors closely resemble the specific behavioral events of previously observed beluga whales courting and mating in captivity (Hill et al., 2015). The seasonality of these apparent courting and mating behaviors in CIBW correspond with reported spring mating seasons for the Arctic populations (Burns and Seaman⁶) as well as captive belugas (Robeck et al., 2005).

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 early 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 ecologi-

cal parameters such as food and mate availability or distribution and predator avoidance (Davies et al., 2012; Kappeler et al., 2013). Both of our reported beluga whale sightings occurred in the same general area, suggesting importance of this area.

All the beluga whales we observed in the two groups described herein were white and of similar body size. Coloration in beluga whales is related to physical maturity; however, Burns and Seaman⁶ reported females may retain some degree of gray coloration upwards of 21 years and McGuire et al.² reported 10 photo-identified mothers that retained gray coloration, suggesting that coloration is not definitive of maturity. It is estimated that female belugas reach sexual maturity when they are 4–9 years old and males when they are 4–7 years old (Suydam, 2009). Therefore, it is likely that belugas may become sexually mature before they have turned completely white.

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 indifferent gender or non-reproductive animals, or out of estrus. It is also possible that socio-sexual activity occurs year-round and was only coincidental-

⁶Burns, J. J., and G. A. Seaman. 1986. Investigations of belukha whales in coastal waters of western and northern Alaska. II. Biology and ecology. U.S. Dep. Commer., NOAA, OCSEAP Final Rep. 56(1988): 221–357.



Figure 4.—Pair 2 slowly rolling around each other in physical contact, creating large plumes of silt and presented ventral sides. Photo by Mark Cotter.

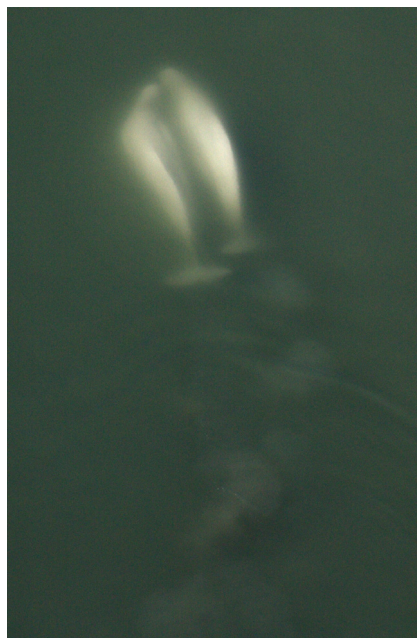


Figure 5.—Pair 3 exhibiting contact swimming necks and heads both cocked inwards facing each other, nodding and almost touching. Photo by Mark Cotter.



Figure 6.—Pair 3 exhibiting contact swimming and nodding, one animal rotated onto its side with ventral facing towards the other beluga. Photo by Mark Cotter.



Figure 7.—Pair 3 exhibiting ventral presenting and pelvic thrusting. Photo by Mark Cotter.



Figure 8.—Pair 1 exhibiting ventral presenting, pelvic thrusting, and contact swimming. Photo by Mark Cotter.

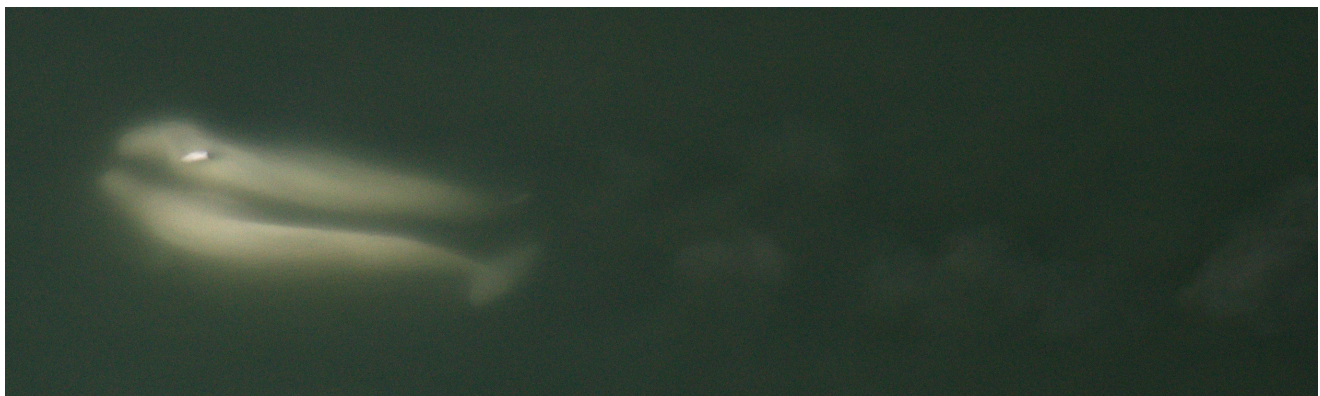


Figure 9.—Pair 3 continuing pelvic thrusting, ventral presents, nodding, and contact swimming. Photo by Mark Cotter.

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 no.
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	2, 3 ²
13:22	Two animals seen swimming in separate silt trails ~10 body lengths apart.		2, 3
13:23	Pair 1 – one animal performed multiple rostro-genital contacts or “goosing” of the other animal.		3
13:24	Pair 2 – slowly rolled around each other in physical contact, created large plumes of silt and presented ventral sides.	C, VP	4
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	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	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	9
13:31	Observations ended.		

¹ See Table 1 for event definitions

² Only one pair is exhibited in these figures.

ly observed during the spring season at the same geographic location where water was unusually clear.

Further observations of this behavior are necessary to confirm if it is seasonally related or occurs in only 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 (O’Corry-Crowe et al., 1997; Laidre et al., 2000). Accordingly, the CIBW population is potentially more susceptible to physical, ecological, and anthropogenic stresses (Moore et al., 2000; Norman et al., 2015). NMFS aerial survey results indicated nearly a 50% decline in the CIBW population between 1994 and 1998 (Hobbs et al., 2015b). This acute decline was attributed to unregulated hunting. However, even after the hunt virtually ceased, no appreciable increase in abundance has been documented (Hobbs et al., 2015b).

In 2008, the CIBW was listed as endangered under the U.S. Endangered Species Act, and a CIBW Conservation Plan was developed (NMFS, 2008), followed by identification of critical habitat in 2011 (NOAA, 2008). The Conservation Plan specifically identified the need to characterize CIBW life history traits and improve knowledge of 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) and draft Recovery Plan (NMFS⁷), providing some insight on the natural history, mating behavior, seasonality, and potential behavioral-based habitat preference of this declining population.

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⁷NMFS. 2015. Draft recovery plan for Cook Inlet beluga whale (*Delphinapterus leucas*). U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Alaska Region. Off., Protected Resour. Div., Juneau, AK, 274 p.

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