Interactions between beluga whales (*Delphinapterus leucas*) and boats in Lower Knik Arm, Alaska: Behavior and Bioacoustics

(1 August – 14 September 2008)

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Behavioral observations Lower Knik Arm (LKA)

General Objectives

1) Document patterns of movement, associations with particular habitats, and behavior of belugas

2) Document small boat movements

3) Document interactions between small boats and beluga whales

Observation Sites

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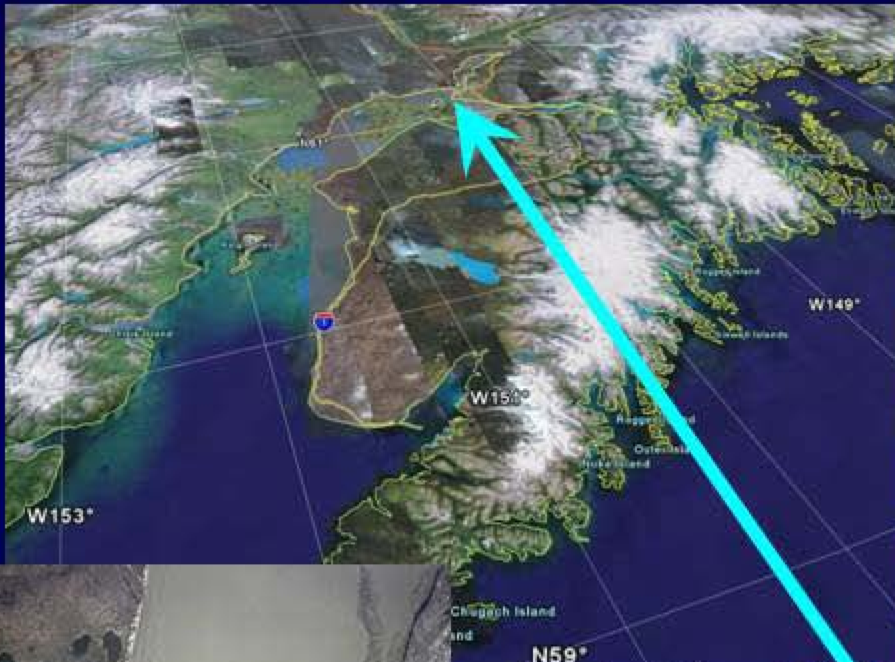

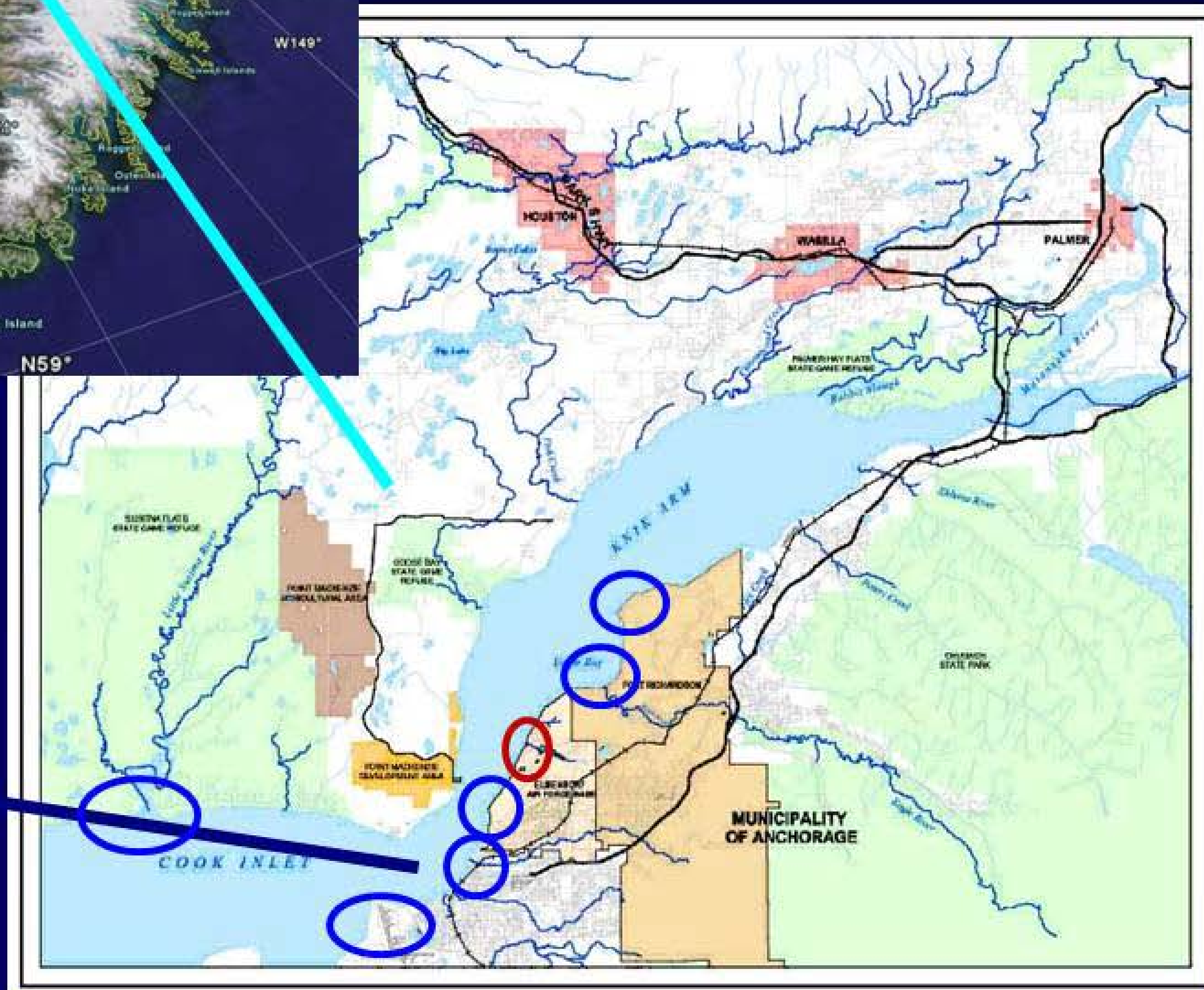

Methods

- Focal animal and group observations of beluga whales from land sites

- Passive recording of behavior and acoustics from NOAA inflatable

- Focal animal and group observations of interactions between beluga whales and boats

LKA Effort

- **Land sites: 29 July – 14 Sept**
  - 183 hours of observations on 31 days
  - whales present on 15 days
- **NOAA inflatable: 4 Aug – 9 Sept**
  - 41 hours of observations on 10 days
  - whales present on 5 days
- **Boat-Whale interactions: 15 Aug – 14 Sept**
  - 1 boat observed on each of 10 days
  - Whales present on 8 of the 10 days

Results

- **Beluga occurrence in (LKA)**
  - **13 August : First whales observed**
  - **4 September: Last observations of whales**
  - **Whales present on 15 of 31 days of observations**

- **Beluga net movements in LKA: 21 groups observed**

  - **1 group moving *UP* LKA on *rising tide***
  - **13 groups moving *UP* LKA on *falling tide***
  - **7 groups moving *DOWN* LKA on *falling tide***

- **Transit primarily along east side of LKA**

- **Milling, feeding, socializing at Six Mile Creek, north Eagle Bay, Eagle River, Point McKenzie**

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Key activities of beluga whales in lower Knik Arm July - September

- Calving and protection of young calves during early development

- Foraging

- Socializing, reunions, and group realignments at particular sites

Functional use of habitats in Knik Arm and Turnagain Arm mid-August to mid-September

Socializing, staging, Re-establishment of groups

Foraging

Transit

Small Boats & Beluga in LKA

Inflatable

-- 1 pursuing slowly ca 150-200m: whales dive & increase speed same course, reverse course

-- 1 transiting =>400 m, no response

Skiff

-- 1 pursuing slowly at 50-100m: whales dive, increase speed, maintain course

-- 2 transiting > 400m, no response

-- 1 transiting ca 200 m, whales change course & dive

Hovercraft

- 2 transiting ca 200 m, whales dive & continue course

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Conclusions

- Movement patterns and focal areas of whales varied daily
- Distinct use of particular areas for transit, foraging, and socializing and group realignments
- Group realignment areas likely important because of complete impairment of vision and correlative dependence on sound for group & social cohesion
- Small boats in LKA infrequent, but whales will respond behaviorally depending on proximity of boat, its tenure, and activity

Supplemental Pilot Study: Acoustic Assessment of Group Size

General Objectives

Explore passive towed arrays for detecting and estimating abundance of beluga whales

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biology letters

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Marine biology

First human-caused extinction of a cetacean species?

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1. INTRODUCTION

The Yangtze River dolphin or baiji (*Lipotes vexillifer*), an obligate freshwater odontocete known only from the middle-lower Yangtze River system and neighbouring Qiantang River in eastern China (figure 1), has long been recognized as one of the world's rarest and most threatened mammal species (e.g. Chen et al. 1980; Chen & Hua 1989; Lin et al. 1985; Zhou & Li 1989; Zhou et al. 1998; Würsig et al. 2000; Zhang et al. 2003). Baiji have not been seen in the Qiantang River since the 1950s (Smith et al. 2000), and Chinese scientists reported a steady rapid decline in the Yangtze through the 1980s and 1990s from an estimated 400 individuals in 1979–1981 (table 1). Surveys during 1997–1999 provided a minimum estimate of only 13 animals (Zhang et al. 2003). The last authenticated baiji records were of a stranded pregnant female found in 2001 and a live animal photographed in 2002, although a few more recent unverifiable sightings have been reported by fishermen to reserve managers in National and Provincial Baiji Reserves along the Yangtze (see electronic supplementary material).

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Abundance and conservation status of the Yangtze finless porpoise in the Yangtze River, China

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ABSTRACT

The Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*) is endemic to the middle and lower reaches of the Yangtze River, China. It is the only freshwater population of porpoises in the world and is currently listed as Endangered by IUCN. In November and December 2006 we used two boats and line transect methods to survey the entire current range of the population, except for two lakes (Poyang and Dongting). Sighting results were similar for both boats, so we pooled all data and analyzed them using two line transect models and a strip transect model. All models produced similar estimates of abundance (1111, 1225 and 1000). We then added independent estimates of the number of porpoises from the two lakes for a total estimate of approximately 1800 porpoises. Our findings indicate that the population continues to decline and that its distribution is becoming more fragmented. Our current estimate in the main river is slightly less than half the estimate from surveys between 1984 and 1991 (which was probably an underestimate). We also found an apparent gap in the distribution of porpoises between Yueyang and Shishou (~150 km), where sightings had previously been common. Continued threats to Yangtze finless porpoises include bycatch in unregulated and unselective fishing, habitat degradation through dredging, pollution and noise, vessel strikes and water development. Immediate protective measures are urgently needed to ensure the persistence of finless porpoises in the Yangtze River. The survey design and analytical methods developed in this study might be appropriate for surveys of cetaceans in other river systems.

INDIRECT EVIDENCE OF BOAT AVOIDANCE BEHAVIOR OF YANGTZE FINLESS PORPOISES

SONGHAI LI, TOMONARI AKAMATSU, DING WANG, KEXIONG WANG, SHOUYUE DONG, XIUJIANG ZHAO, ZHUO WEI, XIANFENG ZHANG, BARBARA TAYLOR, LEIGH A. BARRETT, SAMUEL T. TURVEY, RANDALL R. REEVES, BRENT S. STEWART, MICHAEL RICHLEN, AND JOHN R. BRANDON

Estimation of the detection probability for Yangtze finless porpoises (*Neophocaena phocaenoides asiaeorientalis*) with a passive acoustic method

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Yangtze finless porpoises were surveyed by using simultaneous visual and acoustical methods from 6 November to 13 December 2006. Two research vessels towed stereo acoustic data loggers, which were used to store the intensity and sound source direction of the high frequency sonar signals produced by finless porpoises at detection ranges up to 300 m on each side of the vessel. Simple stereo beam forming allowed the separation of distinct biosonar sound source, which enabled us to count the number of vocalizing porpoises. Acoustically, 204 porpoises were detected from one vessel and 199 from the other vessel in the same section of the Yangtze River. Visually, 163 and 162 porpoises were detected from two vessels within 300 m of the vessel track. The calculated detection probability using acoustic method was approximately twice that for visual detection for each vessel. The difference in detection probabilities between the two methods was caused by the large number of single individuals that were missed by visual observers. However, the sizes of large groups were underestimated by using the acoustic methods. Acoustic and visual observations complemented each other in the accurate detection of porpoises. The use of simple, relatively inexpensive acoustic monitoring systems should enhance population surveys of free-ranging, echolocating odontocetes. © 2008 *Acoustical Society of America*. [DOI: 10.1121/1.2912449]

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I. INTRODUCTION

Estimating abundance of marine mammals is essential for their conservation and management. Visual observation is the most commonly used method to estimate abundance of aquatic mammals. These animals must surface to breathe and then are visible to ship-based or airborne observers. However, on ship or aerial surveys, not all aquatic mammals surface within the visual range of observers due to relatively long dive times for some species (e.g., Okamura et al., 2006) and avoidance of ships (Richardson et al., 1995). Consequently, an unknown proportion of animals near or on the survey track line are not detected.

Strip or line transect survey methods allow the estimation of total population size based on the incomplete detection of local abundance (Buckland et al., 1993). A key assumption of this method is that all animals within the strip width or on the transect line are detected. This condition is generally not satisfied. However, the detection probability can be calculated by using independent visual observers, which is often based on the same observation platform. Observation events of an individual animal, or a group of animals, by two independent observers are then matched. Based on an assumption of independent sampling, the detection probability of the primary observer can be calculated as the number of matched events over the total number of events observed by the secondary observer (Buckland et al., 1993). In the present study, we employed the strip transect method to compare independent visual and acoustical detections of finless porpoises.

Detection probability is the key to estimate the number of animals. Once the detection probability within a specific distance of the survey track line has been determined, the total number of animals can be estimated from this probability (Buckland et al., 1993). This simple but well established method has been widely applied to assess abundance of marine mammals including blue whales (Calambokidis and Barlow, 2004), humpback whales (Calambokidis et al., 2004), sperm whales (Lewis et al., 2007; Barlow and Taylor, 2005), killer whales (Zerbini et al., 2007), dugongs (Shirakihara et al., 2007), spotted seals (Mizuno et al., 2002), and several species of dolphins and porpoises (de Segura et al., 2006;

Methods

110 m towed hydrophone array

- Two acoustic data loggers (A-tags) used for passive recording of high frequency echolocation signals (120kHz - 160 kHz)
  - 2 hydrophones in each data logger @ 11 cm apart
  - Data loggers at +80 m and +100 m
- Aquafeeler array for passive recording of low frequency sounds (100Hz - 90 kHz)
  - 2 hydrophones 2m apart at distal end of array

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Click sound file at recording location

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Results

Sound emission varied among whales and with location and behavioral context

- Low frequency whistles
- High frequency sonar signals
- Buzz-like sound characterized by broad band spectrum caused by very shot inter-click interval or very short period of sound repetition

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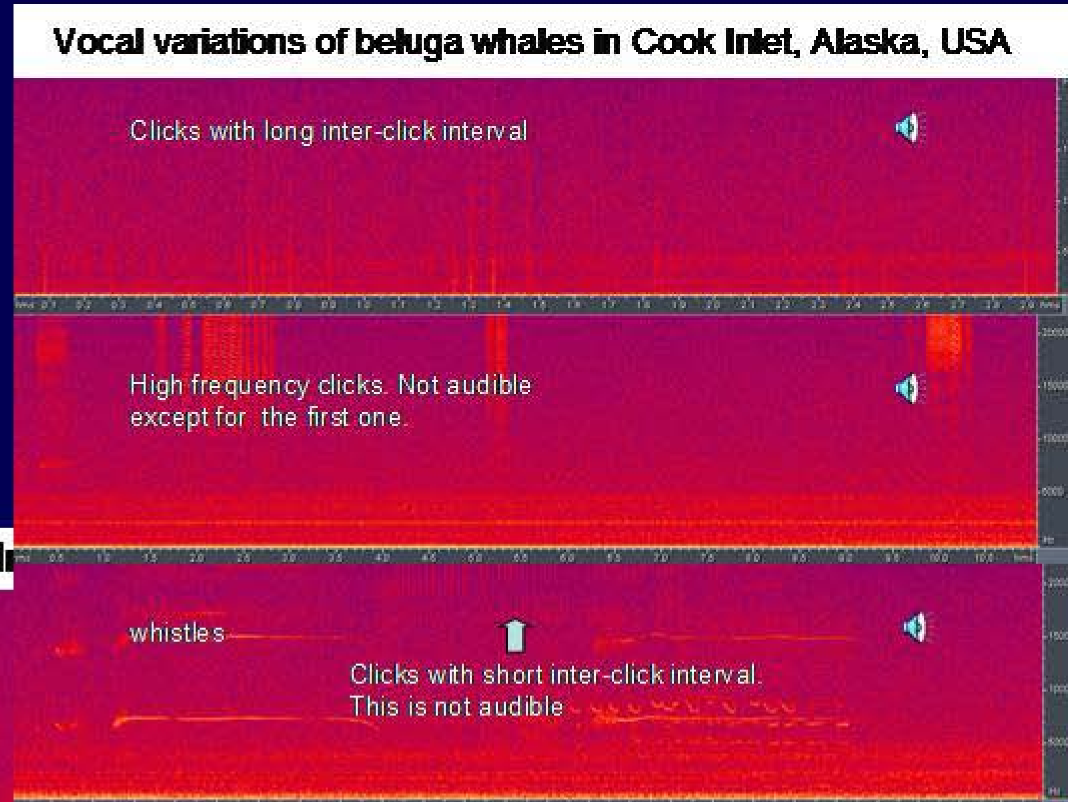
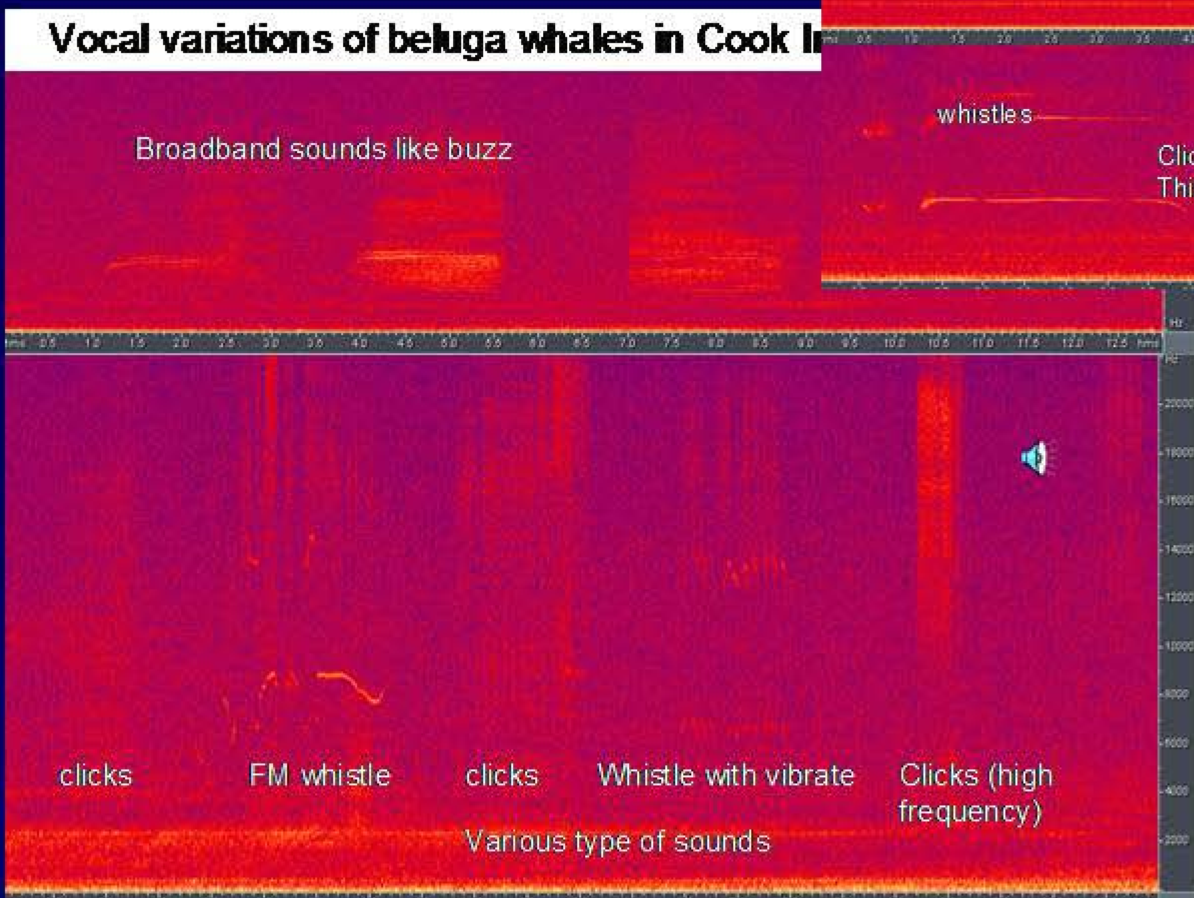
Preliminary Results





Results

- Distance to sound source calculated from geometric solution using difference in arrival time of sound at two hydrophones on single A-tag

  -- greatest calculated distance = 471 m

- Largest estimated sub-group size group size = 2

  -- whales closer than 1 body length not easily distinguishable
  --whales farther apart than 2 body lengths distinguished as distinct sub-group

- Total group size = sum of sub-groups passed during recording session

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Results

Calculated distances to whales. Sound durations were too brief to calculate distances in some cases (###). The sub-group size estimated from distinct bearing sources

Detection time	Sub-group size	Calculated distance (m)
11:38:26	1	288
11:41:00	2	164
11:42:03	1	####
11:42:25	1	376
11:44:00	1	471
11:44:25	1	329
11:45:43	1	133
11:47:06	1	105
11:47:27	1	92.1
11:47:56	1	177
11:48:16	1	102
11:49:05	1	####
11:50:37	1	400
11:50:55	1	####
11:51:35	1	####
11:52:05	1	####

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