

Passive Acoustic Surveys for BCB Bowhead Whales in the Beaufort Sea, 2003-2005

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ABSTRACT

Passive acoustic surveys were conducted in support of a comprehensive effort to investigate stock structure in the Bering-Chukchi-Beaufort (BCB) population of bowhead whales (*Balaena mysticetus*). Two types of survey were conducted: (1) an over-winter survey (2003-04) northeast of Barrow, Alaska, using autonomous recorders; and (2) a dipping-hydrophone survey (2005) along a cruise track northwest of Barrow to investigate bowhead occurrence near the Chukchi Borderland in summer. Although provisional reports from both surveys were provided to the IWC Scientific Committee (SC) in 2005 and 2006, this report represents the final summary of results from both acoustic surveys. In neither survey were bowhead calls detected in areas or at times supportive of any of the putative multiple stock hypotheses.

OVER-WINTER SURVEY: AUTONOMOUS RECORDERS

Although there have been occasional summertime sightings of bowhead whales near Barrow, Alaska since the late 1970s (Moore 1992), the bulk of the herd seems to occupy Canadian Beaufort Sea waters during summer (Moore & Reeves 1993; Rugh et al. 2003). Since 1999, there have been increasing reports of bowhead whales summering in the eastern Chukchi and western Beaufort seas, with whales seen northeast and southwest of Barrow during opportunistic surveys in July 1999 and July 2003, respectively (Moore unpublished data). The increase in sighting frequency could be because of an expanding BCB bowhead population (George et al. 2004), climate-induced changes in habitat (e.g., Moore et al. 2003; Moore and Laidre 2006; Noongwook et al., 2007), or both. To investigate the seasonal occurrence of bowheads near Barrow, three hydrophones were deployed in October 2003 for one year to record bowhead whale calls. Details of this survey were provided in (SC/58/BRG8) and are summarized below.

Three autonomous Acoustic Recording Packages (ARPs, Wiggins 2003) were deployed in the western Beaufort Sea in early October 2003 to provide continuous year-round sampling for cetacean calls. The recorders were placed near a mooring line focused on fine-scale sampling of physical oceanographic parameters along the Beaufort Sea slope (part of the NSF/SBI study: www.sbi.ut.edu), and in the vicinity of bowhead whale summertime sightings (Fig. 1). The ARPs continuously sampled an effective bandwidth of 10-500 Hz. Unfortunately, instrument malfunction resulted in only two of the three recorders being recovered and both recorded only part of the year.

Instrument A was deployed at 71° 28.3 N latitude, 151° 56 W longitude in water 316 m deep, and instrument B was deployed at 71° 39.3 N latitude, 151° 48 W longitude in water 1,258 m deep. Upon recovery, the internal hard drives were removed and the data downloaded for processing. Because of a battery malfunction, instrument A only recorded data from 4 October 2003 to 29 December 2003, whereas instrument B recorded from 3 October 2003 until 12 May 2004. Because of the focus on seasonal occurrence of bowhead whale calls, only data from instrument B were analysed in detail. The available data files were split into 2-hour segments to facilitate processing, and 20 s spectrogram equalization was applied to remove long-term noise produced from sources such as sea ice and ships. Data files were scanned visually for the presence of bowhead whale calls.

Bowhead whale calls were recorded from 3 October (the day of deployment) through 23 October 2003, intermittently on 6-7 and 22-23 November 2003, then not until 25 March 2004 (Fig. 2). During the last 3 weeks of recording, bowhead whale calls were detected almost every hour. Call types included up- and down-swept and inflected signals generally in the 50-200Hz frequency band (e.g. Fig. 3), as described by previous authors (Cummings & Holliday 1987; Clark & Johnson 1984; Ljungblad et al. 1982). A few instances of “song” or “patterned calling” were found in early May 2004 (Fig. 4). Songs consisted of patterned repetitions of frequency modulated sweeps and ‘grunts’ that continued for several minutes, resulting in spectrograms that look much like those shown for ‘song’ recorded during the spring migration in the 1980s (Wursig and Clark 1995: Fig 5.9).

Finally, of note, gray whale (*Eschrichtius robustus*) calls were recorded throughout the winter (Stafford et al. in press), but bowhead calls were not. Although recorder malfunction limited sampling to only 7.5 months at site B, BCB bowhead calls were detected only during periods when whales would be expected to be migrating past Barrow on autumn and spring migrations.

DIPPING HYDROPHONE SURVEY ALONG NOAA's 2005 OCEAN EXPLORATION (OE) CRUISE TRACK

The track for the 2005 NOAA Ocean Exploration (OE) cruise extended north and east from Barrow, Alaska (Fig. 5), then northwest to the Chukchi Borderland (i.e., Northwind Ridge and Chukchi Plateau), an area recently identified as potential summering habitat for bowhead whales¹. Extant literature indicates the Borderland may contain adequate prey (i.e. large copepods) to support foraging bowheads (e.g. Ashjian et al. 2003; Hopecroft et al. 2005), and it could be a terminus for prey advected to the Arctic (i.e. euphausiids) from the northern Bering Sea (Maslowski et al. 2000; Shimada et al. 2004). Thus, the primary goal of the marine mammal component of the 2005 OE cruise was to conduct acoustic sampling and visual surveys to investigate the summertime occurrence of bowhead whales in the western Beaufort and northeastern Chukchi seas. Specifically, three objectives were to: (1) record underwater sounds via dipping hydrophone and DAT recorder at sea-ice stations where productivity (and other) components of the ecosystem were sampled; (2) conduct visual surveys for marine mammals and sea birds while the ship was underway; and (3) conduct visual surveys from the ship's helicopter, as possible.

Acoustic sampling was conducted from the sea ice at 16 stations (total = 30.5 hours) where productivity, benthic sampling and ROV dives were undertaken. Beluga calls were recorded at three stations, but no bowhead calls were detected (Table 1). Based on local observations of bowheads near Barrow and catches of bowhead whales northwest of Point Barrow (albeit later in the year) during the Yankee commercial whaling period (Bockstoce and Botkin 1983), it seemed plausible that some whales would have been seen on this survey. Visual surveys for all marine mammals and seabirds were conducted from the ship's bridge (60 ft height) and aloftcon (90 ft height) by eye and with handheld binoculars. Observations were made when the ship was on station (usually 0.5 to 1-hour morning and afternoon watches) and during transit between stations (usually 1-2 hours per watch) for a total of 64 hours of shipboard visual survey. This effort was augmented by sightings made by the ship's crew, especially bridge personnel trained in marine mammal identification and familiar with NOAA Platform of Opportunity Program (POP) forms. Aerial surveys were conducted opportunistically using the ship's helicopter (6 flights, total = 8.3 hours) when weather and other ship operations permitted. Ringed seals were the predominant marine mammal seen during ship and helicopter visual surveys.

No bowheads were seen during the surveys; however a small group (3-5 whales) was seen near Barrow on 25 June 2005, just prior to the start of the cruise.

REFERENCES

- Ashjian, C.J., Campbell, R.G., Welch, H.E., Butler, M. Van Keuren, D. 2003. Annual cycle in abundance, distribution, and size in relation to hydrography of important copepod species in the western Arctic Ocean. *Deep Sea Research* 50: 1235-1261.
- Bockstoce, J.R. and Botkin, D.B. 1983. The historical status and reduction of the western arctic bowhead whale (*Balaena mysticetus*) population by the pelagic whaling industry, 1848-1914. Report of the International Whaling Commission (Special Issue 5): 107-141.
- Clark, C.W. and Johnson, J.H. 1984. The sounds of the bowhead whale, *Balaena mysticetus*, during the spring migrations of 1979 and 1980. *Can. J. Zool.* 62, 1436-1441.
- Cummings, W.C. and Holliday, D.V. 1987. Sounds and source levels from bowhead whales off Pt. Barrow, Alaska. *J. Acoust. Soc. Am.* 82:814-821
- George, J.C., J. Zeh, R. Suydam and C. Clark. 2004. Abundance and population trend (1978-2001) of western Arctic bowhead whales surveyed near Barrow, Alaska. *Mar. Mamm. Sci.* 20(4): 755-773.
- Hopecroft, R.R., Clarke, Nelson, R.J. and Raskoff, K.A. 2005. Zooplankton communities of the Arctic's Canada Basin: the contribution by smaller taxa. *Polar Biology* 28: 198-206.
- Ljungblad, D. K., Thompson, P. O., and Moore, S. E. 1982. Underwater sounds recorded from migrating bowhead whales, *Balaena mysticetus*, in 1979. *J. Acoust. Soc. Am.* 71, 477-482.
- Maslowski, W., Newton, P. Schlosser, A. Semtner, A. and Martinson, D. 2000. Modeling recent climate variability in the Arctic Ocean. *Geophysical Research Letters (GRL)* 27 (23) doi: 9.1031/2000.

¹ see Chukchi Circuit scenario SC/59/BRG3

- Moore, S.E. 1992. Summer records of bowhead whales in the northeastern Chukchi Sea. *Arctic* 45: 398-400.
- Moore, S.E. and Laidre, K.L. 2006. Trends in sea ice cover within habitats used by bowhead whales in the western Arctic. *Ecological Applications* 16 (4): 932-944.
- Moore, S.E. and Reeves, R.R.. 1993. Distribution and movement. Pp. 313-386 in *The Bowhead Whale*, J.J. Burns, J.J. Montague and C.J. Cowles (eds.), Special Publication No. 2, the Society for Marine Mammalogy, Allen Press, Lawrence, KS.
- Noongwook, G., The Native Village of Savoonga, The Native Village of Gambell, Huntington, H.P., and George, J.C. 2007. Traditional knowledge of the bowhead whale (*Balaena Mysticetus*) around St. Lawrence Island, Alaska. *Arctic* 60 (1): 47-54.
- Rugh, D., Demaster, D., Rooney, A., Breiwick, J., Shelden, K. and Moore, S. 2003. Bowhead whale (*Balaena mysticetus*) stock identity. *J. Cetacean Res. Manage* 5(3): 267-280.
- Shimada, K., McLoughlin, F., Carmack, E., Proshutinsky, A. Nishino, S. and Itoh, M. 2004. Penetration of the 1990s warm temperature anomaly of Atlantic Water in the Canadian Basin. *GRL* 31 (20): doi: 10.1029/2004GL020860
- Stafford, K.M., Moore, S.E., Spillane, M., Wiggins, S. In press. Gray whale calls recorded near Barrow, Alaska throughout the winter of 2003-04. *Arctic*.
- Wiggins, S. 2003. Autonomous Acoustic Recording Packages (ARPs) for long-term monitoring of whale sounds. *Mar. Tech. Soc. J.* 37:13 -22.
- Wursig, B. and Clark, C. 1993. Behavior. pp. 157-199 in *The Bowhead Whale*, J.J. Burns, J.J. Montague and C.J. Cowles (eds.), Special Publication No. 2, The Society for Marine Mammalogy.

Table 1. Summary of acoustic recording effort, marine mammal (MM) detections and other sounds during the 2005 NOAA OE cruises.

Total = 16 deployments; 30.5 hours (H) recording; three detections of beluga (BE) calls.

Date	H	from HEALY	MM	Other Sounds
28 June	2.0	200m/port side	none	fathometer, deck machinery, ice coring
29 June	1.5	300m/port side	none	fathometer, diver bubbles, deck machinery
30 June	2.0	300m/port side	BE	very,very faint ~2" ;deck noise & ice coring
01 July	1.5	400m/off stern	none	walking & diver bubbles + ship sounds
02 July	1.0	300m/stern-brash ice	none	walking, ice auger, ice 'gulps', fathometer
03 July	2.0	250m/stern-brash ice	BE	very faint ~ 5" ; ship sounds
05 July	1.0	250m/stern	none	scraping/knocking of h-phone on ice
07 July	1.5	100m/bow	none	ship's engine, fathometer tick, diver bubbles
09 July	2.0	100m/port-stern	BE	very faint ~ 7" ; fathometer, diver bubbles
11 July	2.5	300m/off stern	none	fathometer, deck crane, HEALY3,walking
13 July	2.0	200m/off bow	none	fathometer, deck noise, ice squeals, bubbles
14 July	2.0	200m/off bow	none	fathometer, ice dragging, bear-watch walk
15 July	3.5	300m/off stbd stern	none	fathometer, ice gulps, ship's crane
16 July	2.0	200m/off port stern	none	fathometer; ship's engine; crane & drill/deck
20 July	2.0	300m/off port stern	none	fathometer; diver bubbles; deck noise
21 July	2.0	100m/off mid-port	none	fathometer; deck crane, ship's engine

FIGURES

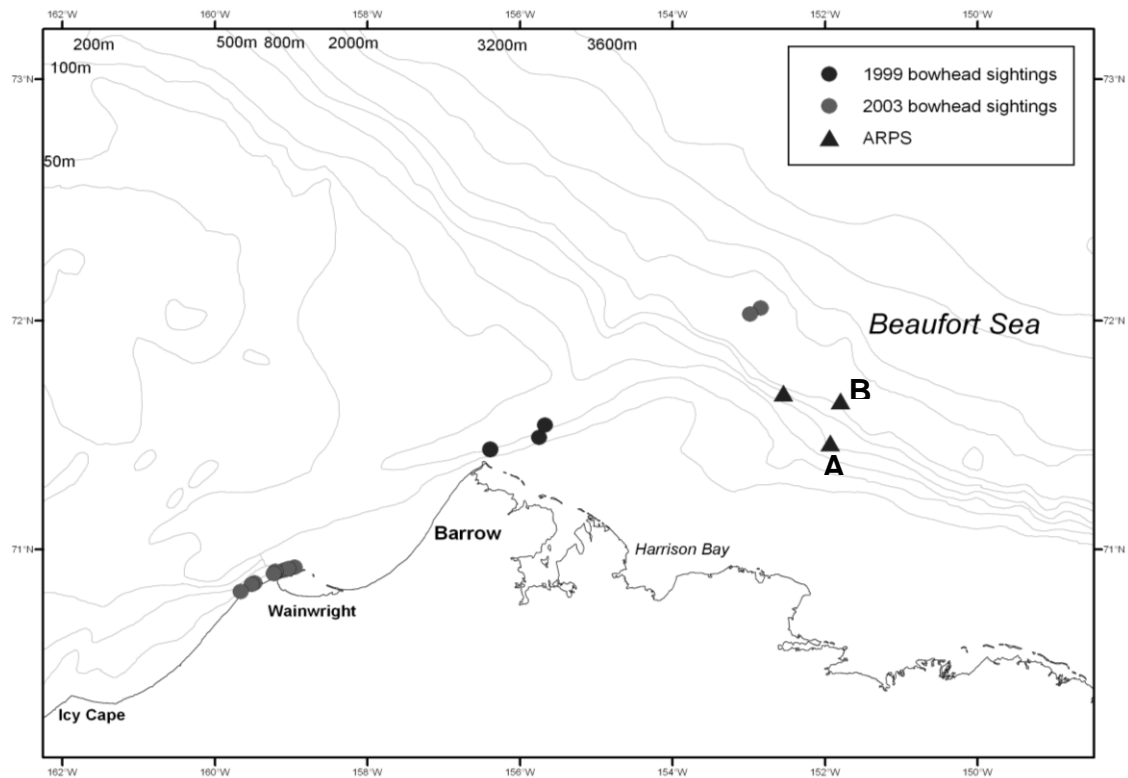


Figure 1. Locations of the ARPs (▲) in the Beaufort Sea. Instruments A and B were deployed in early October 2003 and recovered in September 2004. Locations of bowhead whale sightings from July 1999 and 2003 are also shown (●).

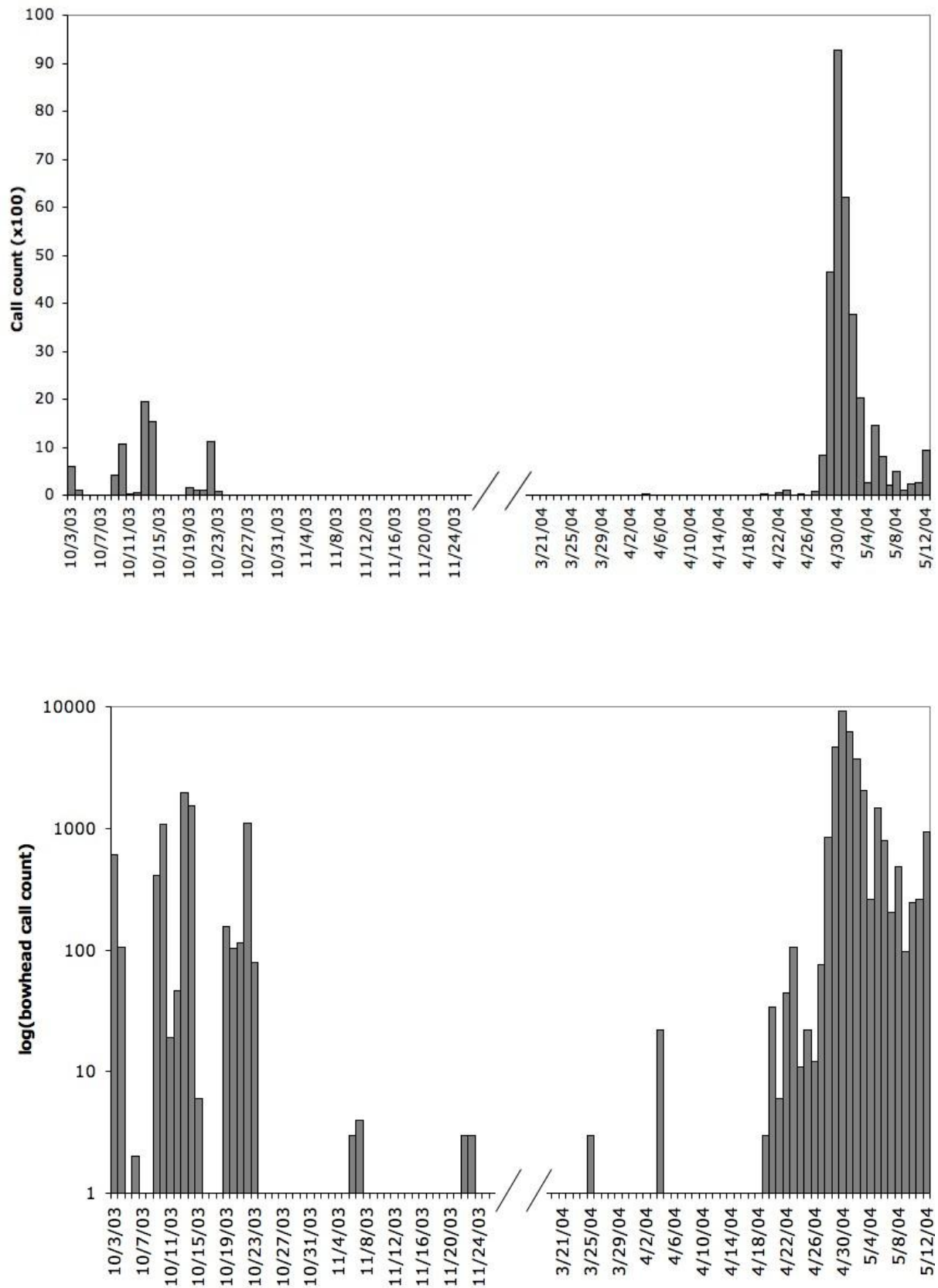


Figure 2. Bowhead whale call occurrence at site B: 3 October 2003 – 12 May 2004. Date on the X-axis and number of calls x 100 on the Y-axis (top); log (number of calls) on the Y-axis (bottom) to show few calls detected in November 2003 and March 2004.

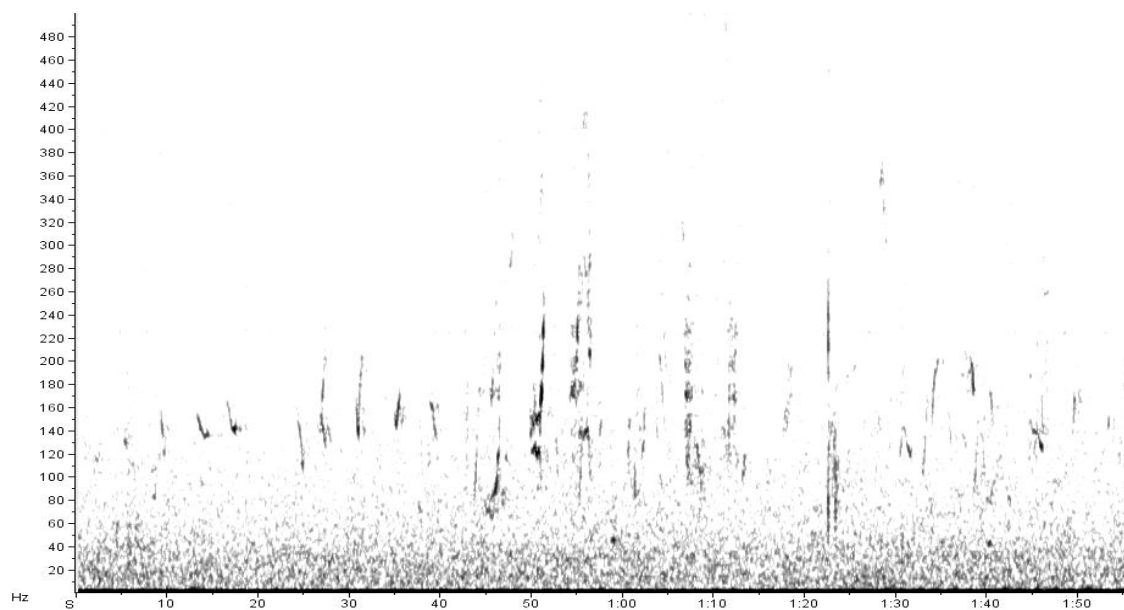


Figure 3. 2 Bowhead whale calls recorded at site B on 1 May 2004. (256 pt FFT, 25% overlap, Hanning window).

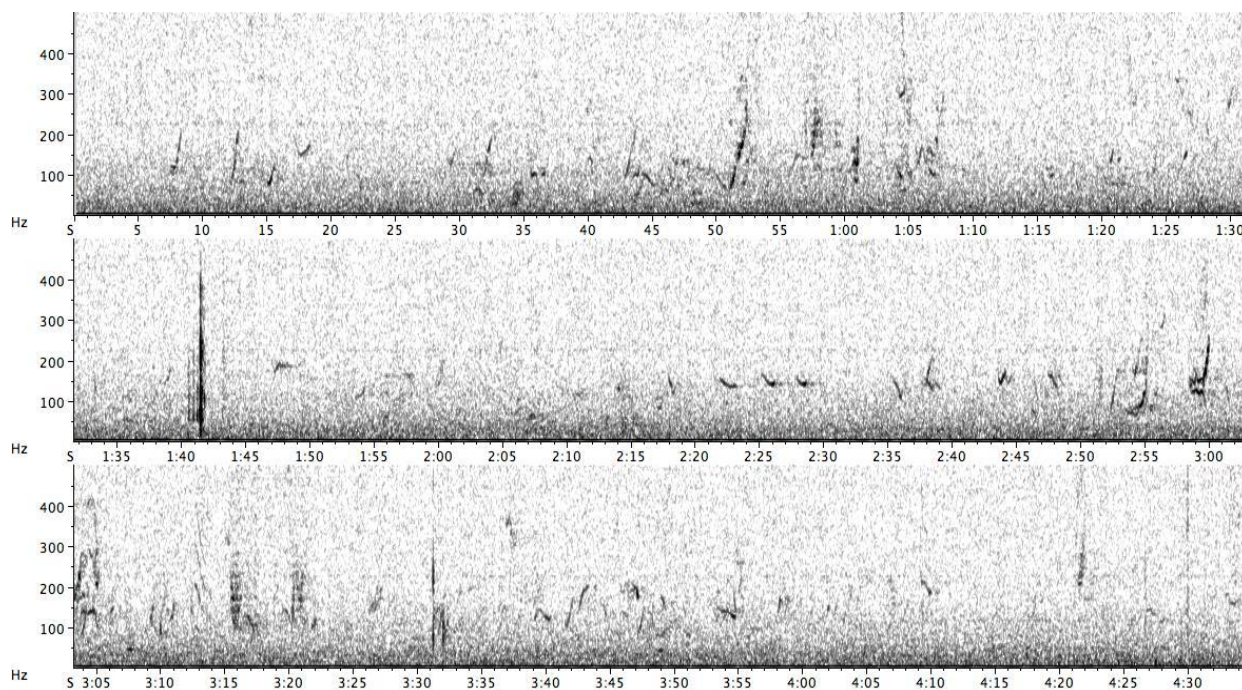


Figure 4. Bowhead call series that had repetitive elements reminiscent of 'song' as described in Wursig and Clark (1993).

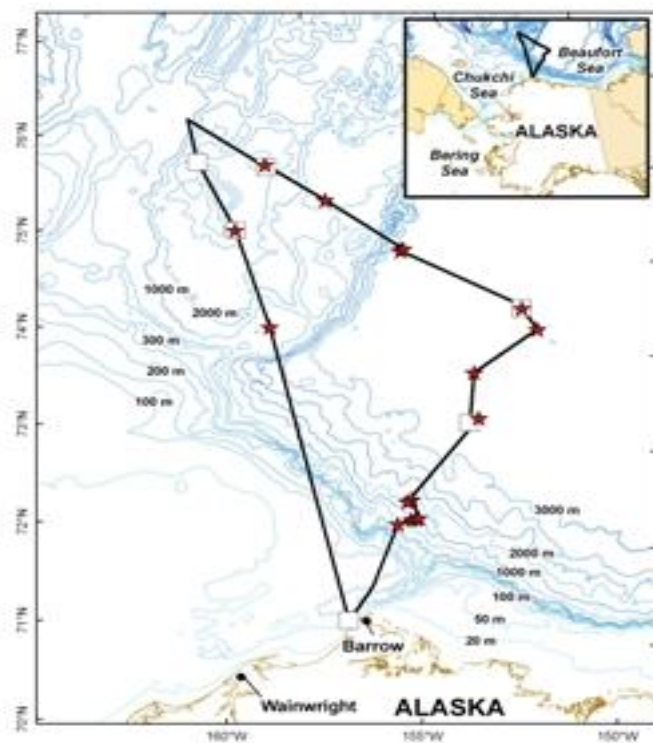


Figure 5. Track of 2005 Ocean Exploration (OE) cruise to the Chukchi Borderland. Stars = recording locations; boxes = helicopter surveys.