

**FEDERAL AID
FINAL PERFORMANCE REPORT**

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
Juneau, AK 99811-5526

**Alaska Department of Fish and Game
State Wildlife Grant**

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PROJECT TITLE: Bowhead Whale Diet Investigation: St. Lawrence Island, Bering Sea

PARTNERS: North Slope Borough Department of Wildlife Management (NSB-DWM) and Alaska Department of Fish and Game (ADF&G)

PRINCIPAL INVESTIGATORS: John "Craig" George (NSB-DWM) and Gay Sheffield (ADF&G)

PROJECT DURATION: May 20, 2005 – December 31, 2008

REPORT PERIOD: May 21, 2008 – December 31, 2008

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

The bowhead whale (*Balaena mysticetus*) is a large baleen whale that feeds on zooplankton and spends its entire life in cold northern waters. Although recent studies indicate that the bowhead whale population is recovering from commercial exploitation (George et al. 2004) it remains federally listed as an Endangered Species.

We proposed to collect stomach contents and other biological tissues from bowhead whales harvested in spring and late fall from the northern Bering Sea to document bowhead feeding, provide quantitative diet data, and determine prey composition.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Our knowledge of bowhead feeding ecology is incomplete and perplexing. It is reasonable to surmise that bowheads might migrate to a zooplankton-rich feeding area for the summer. Yet, in Alaska, bowheads leave their Bering Sea wintering grounds each spring, just prior to the most productive period (Coyle et al. 1996), and travel to the less productive Beaufort Sea. They return to the Bering Sea each fall just before the productivity decreases for the winter. At the onset of 19th century commercial whaling, however, a segment of the population remained in the Bering and Chukchi seas throughout the summer (Bockstoce and Bodkin 1983). Why this pattern had now changed is unclear.

Diet studies by the North Slope Borough, Department of Wildlife Management (NSB-DWM), the Alaska Eskimo Whaling Commission (AEWC), and the Alaska Department of Fish and Game (ADF&G) in the Chukchi and Beaufort seas have examined stomach contents of bowheads harvested for subsistence (Carroll et al. 1987, Lowry 1993, Lowry

et al. 2004). Zooplankton, especially, copepods and euphausiids, were the most important food items found, and more than 75% of the whales harvested in the fall were actively feeding. The Alaskan Beaufort Sea is considered a major feeding area during the summer and early fall (Lowry et al. 2004).

There are no comparable data for bowhead whales feeding activities in the Bering Sea. The stomachs of six whales harvested from 1978 to 1982 have been examined; however the contents of only one stomach are available in the published literature (Hazard and Lowry 1984; Lowry 1993). This stomach contained mostly epibenthic organisms (gammarid amphipods) in contrast to the stomachs from the Beaufort Sea, which contained more planktonic organisms (copepods and euphausiids). Isotope studies from bowhead baleen and muscle have indicated that the Bering Sea is a greater contributor of energy to adult bowheads (Schell et al. 1989) than the Beaufort Sea; however the Beaufort may be more important to subadult whales (Hoekstra et al. 2002; Lee et al. 2005).

In the Bering Sea, bowhead whales are harvested by two Siberian Yupik communities, Gambell and Savoonga, on St. Lawrence Island. These communities typically harvest bowheads during both the spring (April–May) and fall (October–November) migrations. St. Lawrence Island has a harvest quota of 16 strikes per year for both villages; however, the quota has not been reached in recent years due to poor weather and ice conditions. Whalers from St. Lawrence Island report that whales are commonly seen milling in the spring, a behavior associated with feeding (Wursig et al. 1985), and reports of food in stomachs are apparently not unusual (Hazard and Lowry 1984). This annual harvest allows an opportunity for the study of bowhead diet in the Bering Sea by examining stomach contents.

The Scientific Review Board of a multidisciplinary study entitled “Bowhead whale feeding in the eastern Alaskan Beaufort Sea” conducted from 1997 to 2000 identified the need for diet data from the Bering Sea (Richardson and Thomson 2002) and included a recommendation for “the continued collection of stomach contents from harvested whales, particularly from areas where no such data have been collected, to provide a broader base of the range of prey species, times, and locations at which bowhead whales feed.”

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

OBJECTIVE 1: Collect stomach contents, harvest data, and other biological tissues from bowhead whales harvested on St. Lawrence Island in 2005, 2006, 2007, and 2008 in cooperation with the Gambell Whale Captains Association, Savoonga Boat Captains Association, NSB-DWM, Alaska Eskimo Whaling Commission (AEWC), and ADF&G.

Gay Sheffield traveled to St. Lawrence Island during fall 2005 to spring 2008 whaling seasons and collected harvest data and/or biological tissues from 13 bowhead whales harvested for subsistence purposes during this period (Appendix 1).

Biological sampling occurred concurrently with the butchering process. Digestive tract contents (from stomachs or intestines) were obtained from eight of the harvested whales examined. The internal organs remained inaccessible for two whales (07S4, 07G2) that

were butchered while floating in the ocean. In the laboratory, aliquots of stomach or intestine samples were thawed, rinsed, and sorted into major taxonomic groups, and examined microscopically at the University of Alaska's Institute of Marine Science for identification.

A suite of other biological samples (ex. Muscle, eye, skin, etc.) were provided to the NSB-DWM from 12 harvested whales for ongoing studies and/or archived at the University of Alaska Museum for future studies (Appendix 2).

OBJECTIVE 2: Analyze the stomach contents of bowhead whales collected during this study and from previous collections to determine the composition of the bowhead diet in the Bering Sea by season, sex, and whale size class.

Harvest records (1972-2008) provided by the NSB-DWM were reviewed for information on feeding status during the spring. Six whales (30%) harvested during the spring had evidence of feeding. Three whales (100%) harvested during the fall had been feeding shortly before death. The sample sizes for feeding status between seasons is small and we recommend caution when interpreting these results. However, there are indications there may be a seasonal difference in the proportion of whales feeding as has been determined in bowhead whale diet studies in the Beaufort Sea.

We compared the proportion of whales feeding during the spring migration between those in the Bering Sea (30%; n=20) with the proportion of bowhead whales feeding during the spring migration in the Beaufort Sea (34%; n=91; Lowry et al. 2004) and there was no difference ($P=0.73$). During the spring, bowhead whales apparently feed with some regularity throughout the range of their spring migration in Alaskan waters.

We identified prey from eight whales harvested during the monitored period (n=5 spring; n=3 fall). We recommend caution when interpreting these results from this small sample; however, over nine types of prey taxa were identified from the diet samples collected during this project (Appendix 3). Copepods occurred most frequently and were identified in 87% of the five whales sampled during the spring. These data provided the first spring prey data from bowhead whales in the northern Bering Sea since 1982. Due to sampling conditions, quantitative data were typically not available. There was evidence of epibenthic feeding with amphipods, cumaceans, polychaetes, and clams identified, though less frequently, as prey items. Euphausiids were not present in any whales sampled during the spring.

The three adult female whales harvested during late November 2005 had been feeding recently prior to death and euphausiids dominated each diet sample. These are the first prey data from the fall migration of bowhead whales into the northern Bering Sea. The sample sizes for fall diet are small and we recommend caution when interpreting these results.

IV. MANAGEMENT IMPLICATIONS

Results of this study further our understanding of the feeding ecology of bowhead whales in several ways. First, we have provided documentation that during the fall migration bowhead whales feed as they move through the Bering Strait and enter the northern Bering Sea. While the sample size is small, it is interesting that all three whales examined in the fall had been feeding. Second, feeding near Saint Lawrence Island during the

spring is a relatively regular event with a third of the animals examined had been feeding. Of note, our data indicate that this rate of feeding activity is similar to that of bowhead whales traveling past Barrow in the Beaufort Sea during the latter part of the spring. Our sample sizes for Bering Sea diet are small and we recommend caution when interpreting these results. However, there are indications there may be a seasonal difference in the proportion of whales feeding as has been determined in bowhead whale diet studies in the Beaufort Sea. Also, our data indicate there are seasonal differences in the prey composition consumed with euphausiids dominate in the fall diet but not present in the spring. Lastly, the data we document are consistent with bowhead whale feeding behavior observed by Alaska Native whalers from Saint Lawrence Island.

We have provided a new but still incomplete description of seasonal bowhead feeding activities and diet in this region. We recommend future collections of bowhead diet samples, harvest data, and other biological tissues from bowhead whales harvested on St. Lawrence Island in cooperation with the Gambell Whale Captains Association, Savoonga Boat Captains Association, NSB-DWM, Alaska Eskimo Whaling Commission (AEWC), and ADF&G to further understand the health, status, and feeding ecology of bowheads in the northern Bering Sea / Bering Strait region.

With diminishing ice predicted in the Bering Sea, the northern Bering Sea / Bering Strait region is expected to become the central transportation corridor between Asian nations and Atlantic markets and all ship traffic will transit this area. Concerns exist over the potential effects of increased ship traffic associated with oil/gas development, commercial shipping, commercial fisheries, as well as ecotourism the availability and quality of all marine resources in the region due to increased pollution, underwater noise, and human interactions. Additionally, Alaska Native communities in this region are highly reliant on the bowhead whale for nutritional and cultural needs. This project has developed, and will strive to continue building, a good working relationship amongst subsistence users and biologists. It has also increased in our collective Native and scientific knowledge of the bowhead whale.

V. **SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY (May 21, 2008 – December 31, 2008)**

JOB/ACTIVITY 1: Collect stomach contents, harvest data, and other biological tissues from bowhead whales harvested on St. Lawrence Island in 2005, 2006, and 2007 in cooperation with the Gambell Whale Captains Association, Savoonga Boat Captains Association, NSB-DWM, Alaska Eskimo Whaling Commission (AEWC), and ADF&G.

Gay Sheffield traveled to St. Lawrence Island during the spring 2008 whaling season and collected harvest data and/or biological tissues from two bowhead whales harvested for subsistence purposes during April.

JOB/ACTIVITY 2: Analyze the stomach contents of bowhead whales collected during this study and from previous collections to determine the composition of the bowhead diet in the Bering Sea by season, sex, and whale size class.

Data from the diet samples as well as archived harvest records from previous collections provided by the NSB-DWM were compiled and analyzed as reported in Section III.

Objectives and preliminary results of the bowhead sampling and diet project were discussed with whaling captains, residents, as well as St. Lawrence Island IRA council members and Alaska Eskimo Whaling Commission representatives.

VI. PUBLICATIONS

- Sheffield, G. 2008. St. Lawrence Island – 2008 Season. Report to Captains, Alaska Dept. of Fish and Game, Nome, AK.
- Sheffield, G. 2007. St. Lawrence Island – 2007 Season. Report to Captains, Alaska Dept. of Fish and Game, Fairbanks, AK.
- Sheffield, G. 2006a. St. Lawrence Island – 2006 Season (Gambell). Report to Captains, Alaska Dept. of Fish and Game, Fairbanks, AK.
- Sheffield, G. 2006b. St. Lawrence Island – 2006 Season (Savoonga). Report to Captains, Alaska Dept. of Fish and Game, Fairbanks, AK.
- Sheffield, G. 2005. St. Lawrence Island – 2005 Season. Report to Captains, Alaska Dept. of Fish and Game, Fairbanks, AK.
- Sheffield, G. and J. C. George. 2009. Bowhead whale feeding in the northern Bering Sea near Saint Lawrence Island, Alaska. Alaska Marine Science Symposium 19-23, 2009, Anchorage, AK. Abstract.
- Suydam, R.S., J. C. George, C. Hanns, and G. Sheffield. 2006. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaska Eskimos during 2005. Annual Report to the Scientific Committee of the International Whaling Commission. Paper SC/58/BRG21, Department of Wildlife Management, North Slope Borough, Barrow, Alaska.
- Suydam, R.S., J. C. George, C. Rosa, B. Person, C. Hanns, G. Sheffield, and J. Bacon. 2007. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaska Eskimos during 2006. Annual Report to the Scientific Committee of the International Whaling Commission. Paper SC/59/BRG4, Department of Wildlife Management, North Slope Borough, Barrow, Alaska.
- Suydam, R.S., J. C. George, C. Rosa, B. Person, C. Hanns, G. Sheffield, and J. Bacon. 2008. Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaska Eskimos during 2007. Annual Report to the Scientific Committee of the International Whaling Commission. Paper SC/60/BRG10, Department of Wildlife Management, North Slope Borough, Barrow, Alaska. 7 pp.

ABSTRACT: ALASKA MARINE SCIENCE SYMPOSIUM, JANUARY 19-23, 2009,
ANCHORAGE, ALASKA

**BOWHEAD WHALE FEEDING IN THE NORTHERN BERING SEA NEAR SAINT
LAWRENCE ISLAND, ALASKA**

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We studied feeding of bowhead whales taken by Alaska Natives at Saint Lawrence Island in the northern Bering Sea during the spring (April-May) and fall (November) migrations from 1972-2008. Our objectives were to: 1) identify the proportion of harvested whales that had been feeding based on historical harvest records and 2) describe the prey identified from the stomach and/or intestinal contents of eight whales harvested during 2005-2008.

Harvest records (1972-2008) were reviewed for information on feeding status during the spring. Six whales (30%) harvested during the spring had evidence of feeding. Three whales (100%) harvested during the fall had been feeding shortly before death. The sample sizes for feeding status between seasons is small and we recommend caution when interpreting these results. However, there are indications there may be a seasonal difference in the proportion of whales feeding as has been determined in bowhead whale diet studies in the Beaufort Sea.

Of note, there was no difference ($P=0.73$) in the proportion of bowhead whales feeding in the Bering Sea (30%; $n=20$) and the Beaufort Sea (34%; $n=91$; Lowry et al. 2004) during the spring migration.

Five whales harvested during spring (2007-2008) provided the first spring prey data from the northern Bering Sea since 1982. Copepods occurred most frequently and were identified in 87% of the whales sampled.

The three whales harvested during late November 2005 provided the first prey data from bowhead whales during their fall migration into the northern Bering Sea. Euphausiids dominated the diet samples of whales sampled during late November. Euphausiids were not present in any whales sampled during the spring. The sample sizes for diet samples are small and we recommend caution when interpreting these results.

The data we document is consistent with bowhead whale feeding behavior observed by Alaska Native whalers from Saint Lawrence Island. Bowhead whales feed near Saint Lawrence Island during spring and fall migrations.

VII. LITERATURE CITED

- Bockstoce, J.R. and D.B. Bodkin. 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.
- Carroll, G.M., J.C. George, L.F. Lowry, and K.O. Coyle. 1987. Bowhead whale (*Balaena mysticetus*) feeding near Point Barrow, Alaska, during the 1985 migration. *Arctic* 40(2):105–110.

- Coyle, K.O., V.G. Chavtur, and A.I. Pinchuk. 1996. Zooplankton of the Bering Sea: a review of the Russian language literature. Pages 97–133 in O.A. Mathisen and K.O. Coyle eds. Ecology of the Bering Sea: a review of the Russian literature. Alaska Sea Grant College program Report No. 96-01, University of Alaska, Fairbanks, AK.
- 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. *Marine Mammal Science* 20(4):755–773.
- Hazard, K.W., and L.F. Lowry. 1984. Benthic prey in a bowhead whale from the northern Bering Sea. *Arctic* 37:166–168.
- Hoekstra, P.F., L.A. Dehn, J.C. George, K.R. Solomon, D.C.G. Muir, and T.M. O'Hara. 2002. Trophic ecology of bowhead whales (*Balaena mysticetus*) compared with that of other arctic marine biota as interpreted from carbon-, nitrogen-, and sulfur-isotope signatures. *Canadian Journal of Zoology* 80:223–231.
- Lee S.H., D.M. Schell, T.L. McDonald, and W.J. Richardson. 2005. Regional and seasonal feeding by bowhead whales *Balaena mysticetus* as indicated by stable isotope ratios. *Marine Ecology Progress Series* 285(19 Jan.): 271–287
- Lowry, L.F. 1993. Foods and feeding ecology. Pages 201–38 in: J.J. Burns, J.J. Montague and C.J. Cowles eds. *The Bowhead Whale*. Special Publication No. 2, Society for Marine Mammalogy, Lawrence, KS.
- Lowry, L.F., G. Sheffield, and J.C. George. 2004. Bowhead whale feeding in the Alaskan Beaufort Sea, based on stomach content analysis. *Journal of Cetacean Research and Management*, 6(3):215-223.
- Richardson, W.J., and D.H. Thomson, (eds.). 2002. Bowhead whale feeding in the eastern Alaskan Beaufort Sea: update of scientific and traditional information. OCS Study MMS 2002-012; LGL Rep. TA2196-7. Report from LGL Ltd., King City, Ontario, Canada, to U.S. Minerals Management Service, Anchorage, AK and Herndon, VA, USA. Vol. 1, xlv + 420pp.; Vol. 2, 277 pp. [Available from National Technical Information Service, Springfield, Virginia, USA, Rep. No. NTIS PB2004-101568]
- Schell, D.M., S.M. Saupe, and N. Haubenstock. 1989. Bowhead whale, *Balaena mysticetus*, growth and feeding as estimated by $\delta^{13}\text{C}$ techniques. *Marine Biology* 103:433–443.
- Wursig, B., E.M. Dorsey, M.A. Fraker, R.S. Payne, and W.J. Richardson. 1985. Behavior of bowhead whales, *Balaena mysticetus*, summering in the Beaufort Sea: a description. *Fishery Bulletin* 83:357–377.

VIII. APPENDICES

Appendix 1. Summary information for bowhead whales harvested near St. Lawrence Island during the 2005-2008 monitored whaling seasons. Pregnant animals indicated by *. Estimated total lengths are indicated by **. Whales not sampled are indicated by italic font. No whales were harvested during 2006.

ID Number	Village	Date	Sex	Total length (meters)
05S5 *	Savoonga	29-Nov-2005	Female	16.5 m
05S6 *	Savoonga	29-Nov-2005	Female	17.1 m
05S7 *	Savoonga	29-Nov-2005	Female	18.3 m
<i>07G1</i>	<i>Gambell</i>	<i>3-Apr-2007</i>	<i>Female</i>	<i>8.8 m</i>
07S1	Savoonga	13-Apr-2007	Male	10.0 m
07S2	Savoonga	15-Apr-2007	Female	8.3 m
07S3	Savoonga	16-Apr-2007	Male	10.7 m
07S4	Savoonga	27-Apr-2007	Female	15.2 m
07G2	Gambell	1-May-2007	Female	16.3 m
07G3	Gambell	1-May-2007	Female	15.3 m
07G4	Gambell	1-May-2007	Female	15.2 m
08S1	Savoonga	7-Apr-2008	Female	7.6 m **
08S2	Savoonga	27-Apr-2008	Male	13.7 m **

T-1-16-3 Bowhead Diet
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Appendix 2. Tissue samples collected from bowhead whales harvested near St. Lawrence Island during 2005-2008 and the recipient of those tissues.

	Stomach	Intestine	Eyeball	Skin	Muscle	Kidney	Liver	Spleen	Blubber	Ovaries	Testis	Baleen
05S5	ADF&G	ADF&G	NSB	NSB / UAM	-	-	-	-	-	-	-	NSB
05S6	ADF&G	-	-	NSB / UAM	-	-	-	-	-	NSB	-	NSB
05S7	-	ADF&G	NSB	NSB / UAM	-	-	-	-	-	-	-	NSB
07S1	ADF&G	ADF&G	NSB	NSB	NSB / UAM	-	-	-	NSB	-	-	-
07S2	ADF&G	-	NSB	NSB	NSB / UAM	NSB / UAM	NSB / UAM	NSB / UAM	NSB	NSB	-	-
07S3	-	ADF&G	NSB	NSB	NSB / UAM	NSB / UAM	NSB / UAM	NSB / UAM	NSB	-	-	-
07S4	-	-	NSB	NSB	NSB / UAM	-	-	-	-	-	-	-
07G2	-	-	-	NSB	NSB / UAM	-	-	-	-	-	-	-
07G3	-	ADF&G	NSB	NSB	NSB / UAM	-	-	-	NSB	-	-	-
07G4	-	ADF&G	NSB	NSB	NSB / UAM	-	-	-	NSB	-	-	-
08S1	-	ADF&G	NSB	NSB	-	-	-	-	NSB	-	-	NSB
08S2	-	ADF&G	NSB	NSB	-	NSB	-	-	NSB	-	NSB	NSB

ADF&G = Alaska Department of Fish and Game (Nome)

NSB = North Slope Borough, Department of Wildlife Management (Barrow)

UAM = University of Alaska Museum (Fairbanks)

Appendix 3. Prey items identified from diet samples of bowhead whales harvested near St. Lawrence Island during 2005-2008.

Prey Items	05S5	05S6	05S7	07S2	07G3	07G4	08S1	08S2
Crustaceans	-	-	-	-	X	-	-	-
Euphausiids	-	X	-	-	-	-	-	-
<i>Thysanoessa raschii</i>	X	-	X	-	-	-	-	-
Mysids								
<i>Mysis oculata</i>	-	-	-	X	-	-	-	-
Amphipods	-	-	-	X	-	-	-	-
Copepods (calanoid)	-	-	-	-	X	X	X	X
<i>c.f. Calanus marshallae</i>	X	X	X	-	-	-	-	-
Shrimp	-	X	X	X	X	-	-	-
Pandalidae	-	-	X	-	-	-	-	-
Crangonidae	-	-	X	-	-	-	-	-
Fish (vertebra)	-	-	X	-	-	-	-	-
Bivalve (shell)	-	-	-	X	-	-	-	-
Polychaete (Spintheridae)	X	X	X	-	-	-	-	-