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Migration of Bowhead Whales Past Cape Lisburne, Alaska

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Introduction

Cape Lisburne is one of the most striking promontories along the east coast of the southern Chukchi Sea bordering the bowhead whale, *Balaena mysticetus*, spring migratory route. These whales are known to pass northeast along the Arctic coast from Point Hope to Point Barrow as they migrate from their wintering areas in the Bering Sea to their summer habitat in the Beaufort Sea. Presumably they follow the coastal contour to take advantage of the sea ice shear zones which are generally associated with the shoreline.

In the past, Eskimo whalers seasonally used the now extinct village of Wevok near the Cape Lisburne Air Force Station. They often watched for whales from the westernmost bluff known as Alokut or "The Jaw". This 280 m high bluff has an abrupt western face providing whalers an excellent overview of a great expanse of ocean as far south as Point Hope and an unobstructed view to the west and north (Fig. 1, 2).

A pilot study was made during 5-17 May 1977 to investigate the feasibility of a systematic bowhead whale research effort at Alokut. The wide viewing perimeter, persistently open polynyas (areas free of sea ice), and the position of the Cape relative to the migratory corridor encouraged us to take

Figure 1.—Alokut, the westernmost hill at Cape Lisburne, Alaska, drops abruptly into the Chukchi Sea. Just under the crest of the hill, an observation site was established to study bowhead whales as they passed north on their spring migration to the Beaufort Sea. Photograph by David Rugh, NMFS.

Figure 2.—Bowhead whales migrate past Cape Lisburne, Alaska, following leads or holes in the sea ice. Here, David Rugh is studying openings half way to Point Hope, which is on the horizon to the right. Photograph by Katherine Hazard, NMFS

advantage of the site as a whale observation station (Braham et al., 1979). Totals of 49 bowheads and 155 white whales, *Delphinapterus leucas*, were seen during 73 hours of good to excellent visibility. The rate of sightings steadily declined through the 13-day watch suggesting that a pulse of whales had just passed. Except for fog and high winds, the viewing platform seemed ideal. In over 40 instances bowheads were seen breaching: This was more than might be expected based on observations made elsewhere. This high incidence of breaching was worth further investigation.

The objectives of the whale watch effort in 1978 were to: 1) Delineate the onset and termination of the bowhead whale spring migration through the nearshore leads west of Cape Lisburne; 2) count the population migrating past the Cape; 3) evaluate factors that affect the ability of observers to count whales, particularly distances whales pass offshore and visibility relative to weather; and 4) maintain records of whale behavior for general biological interest.

Methods

Four researchers arrived at Cape Lisburne on 1 April 1978. During the following week, a camp was established by digging caves in snow banks of a protected vale near the westernmost bluffs of Alokut. In early May an unseasonal thaw made it imperative to use tents. Systematic watch efforts began 2 April and were maintained whenever weather and light allowed until the study was terminated on 7 June because of persistent fog.

Observations were made from four sites, depending on the height of the cloud ceiling. The sites ranged in altitude from 100 to 281 m on the west side of Alokut.

Between 2 April and 7 June, 691 hours of systematic watch were conducted, 617 during fair to excellent conditions (Fig. 3). Low clouds and high winds prevented work 32 percent of the time, and fog occluded parts of the open leads 54 percent of the time. Winds frequently rose above 80 km/hour in exposed areas. Temperatures ranged from $-26°$ to 9°C. Initially, darkness restricted the daily watch to less than 18 hours/day, but by 10 May a 24-hour watch was put into effect.

Distances to whales sighted and the edges of leads were determined with a theodolite whenever possible. Azimuth and zenith angles were converted into a coordinate system to measure whale positions relative to the ice and shore as well as vectors of whale travel. Sightings of whales were categorized as: 1) Initial sightings if the observer had reasonable confidence the whale had not been recorded yet; 2) conditional duplicates if the observer was unsure whether or not the whale had been previously recorded; 3) definite duplicates; and 4) tentative sightings if an occurrence could not be positively identified as a bowhead whale.

Results and Discussion

Census

From 2 April to 7 June, 280 bowhead whales were sighted from Cape Lisburne (Table 1). This count included 37 conditional duplicate sightings. An adequate evaluation of whale sizes and a count of calves were not possible. All sightings made during fair to excellent observation conditions were calculated on a whale-per-hour basis. These sighting rates were used to interpolate the number of whales passing during periods of unacceptable or poor conditions. By multiplying the rate of whales per hour by 24, we estimated the number that passed per day. According to these calculations, 478 bowheads migrated within 15 km of Cape Lisburne between 10 April and 7 June (Fig. 4). This estimate is considerably lower

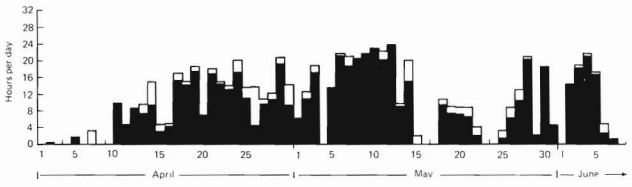

Figure 3.—Bowhead whale observation effort at Cape Lisburne, Alaska, April-June 1978. Upper box indicates number of hours spent on watch per day; shaded area shows number of hours spent in fair to excellent visibility.

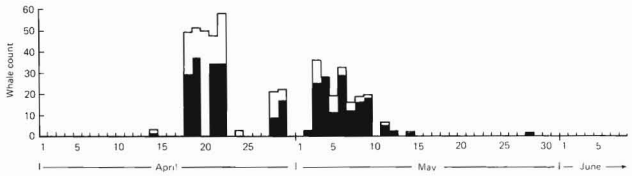

Figure 4.—Bowhead sightings from Cape Lisburne, Alaska, April-June 1978. Shaded area indicates actual counts; upper (unshaded) bars are estimated numbers based on daily rates of all sightings made during fair to excellent conditions and extrapolated to cover periods of poor visibility.

Table 1.—Summary of bowhead whale sightings at Cape Lisburne, Alaska, 1978.

Date		Observation time (hr:min)	Time in fair-exc. conditions	Counts (maximum)	Rate[1] (whales/hour)	Estimated total[2]
April	2	0:10	0	0	—	0
	3	0	0	0	—	—
	4	0	0	0	—	—
	5	1:30	1:30	0	0.0	0
	6	0	0	0	—	—
	7	3:00	0	0	—	—
	8	0	0	0	—	—
	9	0	0	0	—	—
	10	9:30	9:30	0	0.0	0
	11	4:30	4:30	0	0.0	0
	12	8:30	8:30	0	0.0	0
	13	9:25	7:34	0	0.0	0
	14	14:41	9:13	1	0.11	2.6
	15	4:27	3:03	0	0.0	0
	16	4:38	4:08	0	0.0	0
	17	16:20	15:20	0	0.0	0
	18	14:45	14:08	29	2.05	49.3
	19	18:25	17:15	37	2.14	51.5
	20	6:44	4:30	2	—	49.3
	21	17:50	17:20	34	1.96	47.1
	22	14:32	14:12	34	2.39	57.5
	23	14:00	13:30	0	0.0	0
	24	20:00	19:00	2	0.11	2.5
	25	13:15	11:05	0	0.0	0
	26	13:40	4:10	0	0.0	0
	27	10:35	9:47	0	0.0	0
	28	12:00	10:20	9	0.87	20.9
	29	20:20	18:45	17	0.91	21.8
	30	14:05	9:20	0	0.0	0
May	1	6:05	4:55	0	0.0	0
	2	12:30	11:00	1	0.09	2.2
	3	18.35	16:53	25	1.48	35.5
	4	0	0	0	—	27.4
	5	13:45	13:45	11	0.80	19.2
	6	21:45	21:30	29	1.35	32.4
	7	21:02	18:33	12	0.65	15.5
	8	20:30	20:30	16	0.78	18.7
	9	21:15	21:15	12	0.56	13.6
	10	23:20	23:20	0	0.25	0
	11	22:10	20:10	5	0.25	6.0
	12	23:30	23:30	2	0.09	2.0
	13	9:25	9:10	0	0.0	0
	14	20:00	14:30	1	0.07	1.7
	15	2:00	0	0	—	—
	16	0	0	—	—	—
	17	0	0	—	—	—
	18	10:45	9:45	0	0.0	0
	19	8:50	7:45	0	0.0	0
	20	8:20	7:45	0	0.0	0
	21	8:20	6:30	0	0.0	0
	22	4:05	2:00	0	0.0	0
	23	0	0	—	—	—
	24	0	0	—	—	—
	25	3:00	1:49	0	0.0	0
	26	8:19	6:09	0	0.0	0
	27	13:00	10:30	0	0.0	0
	28	20:41	20:36	1	0.05	1.2
	29	2:00	2:00	0	0.0	0
	30	18:25	18:25	0	0.0	0
	31	4:25	4:25	0	0.0	0
June	1	0	0	0	—	—
	2	14:07	14:07	0	0.0	0
	3	19:00	18:25	0	0.0	0
	4	21:45	20:35	0	0.0	0
	5	17:05	16:56	0	0.0	0
	6	4:50	2:45	0	0.0	0
	7	1:02	1:02	0	0.0	0
Total		690:43	617:10	280		477.9

[1]Rate of sightings is based on counts of whales seen during fair to excellent conditions divided by the respective hours. All conditional duplicates and tentative sightings are included.
[2]Estimates include interpolations for days without fair visibility.

than that made at the Point Barrow census stations (Braham et al., 1979) because: 1) The view from Alokut was frequently occluded during periods when it was assumed many whales were passing; 2) whales approached Cape Lisburne from the southwest rather than from the south or along the shore, which meant most traveled farther offshore than was expected; and 3) there was difficulty in covering the entire field of view with only one or two observers per watch.

To check the accuracy of duplicate designations, timing and position of whale blows (surfacings) were recorded as opportunity allowed. By plotting these coordinates on a chart, an evaluation of whale tracklines could be made (Fig. 5). Each trackline represents the course of a single whale as identified by the observer in the field; however, abrupt turns, back-tracking, and unrealistic speeds found in some cases suggest that the observer was actually watching more than one whale. This makes us suspect the accuracy of "duplicate" designations. Of 26 sightings considered to be duplicates during trackline studies, 35 percent appeared to have been inaccurately designated in the field.

Rate of Travel

An average swimming speed for undisturbed migrating bowhead whales was calculated at 4.7 ± 0.6 km/hour (2.9 ± 0.4 mph), based on time between nine pairs of bearings which ranged from 30 to 107 minutes. To maximize the accuracy of our calculation, we included only observations that continued

for more than 30 minutes and excluded bearings designated as approximate, as well as the aforementioned irregular tracklines.

Timing of the Migration

At 1335 hours on 14 April a tentative bowhead sighting was made at Cape Lisburne. On 18 April, at 1300 hours, the first pulse of bowheads began passing the Cape. Between 18 and 22 April 136 bowheads were recorded. Based on a calculated travel rate of 4.1 to 5.3 km/hour, the tentatively sighted whales of 14 April, traveling the 460 km between Cape Lisburne and Point Barrow in 87 to 112 hours, should have passed Point Barrow between 0400 hours on 18 April and 0600 hours on 19 April. The first whales seen on 18 April at Cape Lisburne should have passed Point Barrow between 0400 hours on 22 April and 0500 hours on 23 April.

At Point Barrow, the first bowhead whale sighting of the season was made at 0223 hours on 20 April. This was between the expected time of arrival of the bowhead whale tentatively sighted from Cape Lisburne on 14 April and the beginning of the pulse of whales seen on 18 April. Either the tentative sighting was actual, or the first whales seen at Point Barrow were not seen at Cape Lisburne.

It is evident that the migrating bowheads began passing Cape Lisburne between 14 and 18 April. On 17 April, a lead began to open between Point Hope and the Cape. Before the lead developed opposite the observation site, whales were seen traveling north surfacing in small holes and cracks. Visibility had been irregular on the preceding days—most of 15 and 16 April was lost to observation effort due to fog and heavy snowfall. Whales may have passed unobserved during such periods.

By 15 May most of the whales had passed Cape Lisburne. At Point Barrow the last pulse of whales ended on 17 May followed by a low rate of sightings until 30 May. At Cape Lisburne, 99.3 percent of the sightings occurred between 18 April and 14 May. During a comparable 27-day period at Point Barrow (22 April to 18 May), 96.8 percent of the sightings occurred. Based on travel rates established from bearings on migrating whales, bowheads can be expected to travel from Cape Lisburne to Point Barrow in 3.6 to 4.7 days, which compares well with the 4-day lag in migration dates between these two sites. The compatability in the distribution of sightings between Cape Lisburne and Point Barrow makes it evident that the bulk of the bowhead population passed during the study period.

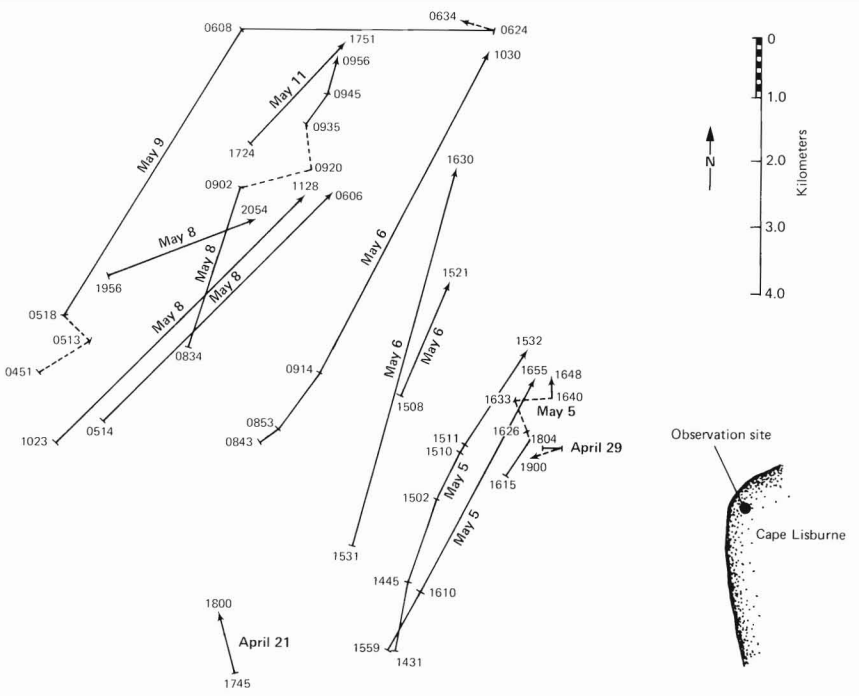

Figure 5.—Positions of bowhead whales relative to the observation station at Cape Lisburne, Alaska, April-June 1978. Time, date, and direction of travel of each sighting are recorded.

Distance Offshore

Of 170 bearings recorded, the average whale sighting distance was 4.5 km from observation sites at Cape Lisburne. The maximum recorded distance was 14.8 km, which approaches the outer limit of reliable visibility under excellent conditions. All of the sightings made at 14 to 15 km occurred on a single day, 22 April. It is unknown how often whales passed at this distance on other days when observation conditions were inferior, nor is it known how many whales traveled past Cape Lisburne beyond 15 km. Poor weather occurred during periods when aerial surveys were planned for assessing the offshore distribution.

Positions of bowheads in the leads were calculated as a ratio of the whale to the pack ice distance and the lead width with all bearings relative to a common azimuth. Of 19 ratios, all whales were sighted beyond the middle of the lead, and 11 (58 percent) were within 20 percent of the lead width from the pack ice edge. Bowheads thus appeared to prefer the farshore edge of the lead as they passed Cape Lisburne. As the season progressed, the pack ice and whale sightings tended to be farther offshore. This tendency is not an artifact of increased observer ability, as some of the greatest distances to sightings were recorded early in the season. In spite of complexities due to fog and irregular ice conditions, the above data suggest that whales passing Cape Lisburne did not follow the coast even when distinct leads were available there; They followed a course that kept them on the west side of visible leads and in offshore polynyas.

Direction Headed

Except when milling, all bowheads passed Cape Lisburne on a northeaster-

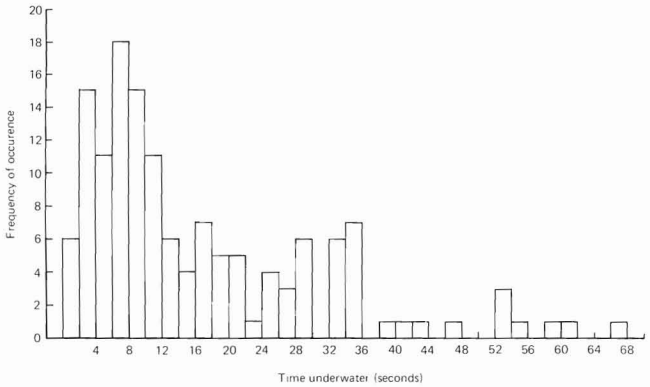

Figure 6.—Frequency of blows within bowhead whale dive series as observed at Cape Lisburne, Alaska, April-June 1978. Milling whales were not included.

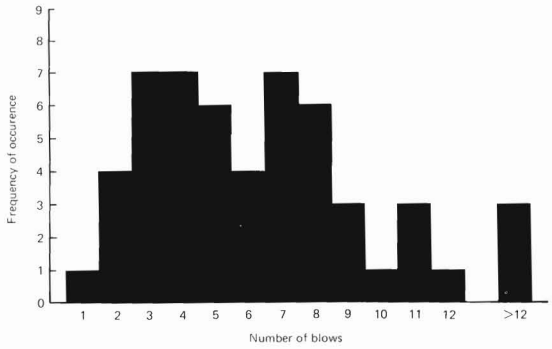

Figure 7.—Dive timings measured as bowhead whales passed Cape Lisburne, Alaska, April-June 1978.

ly course. No correlation was apparent between bearing and distance to whales offshore when compared on a common azimuth, indicating that whales were not effectively changing direction as they passed Cape Lisburne. This orientation was consistent with observations made during aerial surveys (Braham et al., 1979).

Most whales were seen along common corridors which varied according to ice conditions. There was a strong tendency for whales to follow each other even to the point of selecting common breathing sites among scattered holes and along the far shore of the open lead. There were eight recorded incidences involving 52 whales following each other. Synchronous swimming, where two or more animals surfaced and dove together, was observed on seven occasions.

Behavior

Systematic behavior notes were kept on 15 whales totaling 5.5 hours of observation time during the study period. Recorded behavior included milling (groups of whales seen turning and rolling close together), loitering (single whales making frequent turns), breaching, and fluke slapping.

On three occasions whales deviated from their migratory course to mill or loiter. Milling episodes involved two or three animals and may have been associated with courtship or mating. Usually rolling, contact, and flippers were visible in such sequences.

Sixty-five (23 percent) of all bowheads observed from Cape Lisburne breached. As many as 39 breaches were recorded in a single unbroken series. Instances of breaching decreased through the season. On 26 occasions fluke slapping was noted with a maximum of 33 slaps in a single series. Instances of group breaching and fluke slapping were observed. On 21 April, a single bowhead was seen breaching and fluke slapping. After at least 20 breaches, two other bowheads approached the first, breaching and fluke slapping as they arrived. Approximately 45 minutes after the first whale was noticed, a fourth appeared. All four whales moved north while breaching and fluke slapping. Over 86 breaches were observed during this period. On 22 April, two bowheads were seen rolling and swimming close together as they migrated past Cape Lisburne. Approximately 1 hour after this pair was seen, a third whale arrived and two bowheads were seen fluke slapping simultaneously. On the same day, two other whales breached together and one made numerous fluke slaps. One animal appeared to be smaller than the other. The high frequency of breaching and fluke slapping in the Cape Lisburne area may be a function of an environment conducive to the courtship or other communicatory roles such behavior may play.

Visual Cues

There seemed to be little consistency in circumstances surrounding the sightings of blows by surfacing whales. Of 237 observations where the visual cue that first alerted an observer to a whale was recorded, 56 were whale blows; the others were whales' black backs or wakes caused by their motions. Some whales passed without making a visible blow, whereas others made distinct blows each time they surfaced. For example, a whale was observed to surface 6 times with no visible blow; yet within half an hour, a second whale showed a distinct blow on each of 11 surfacings. This inconsistency makes it difficult to calculate the likelihood of sighting a blow relative to the rate of surfacings.

We counted the number of surfacings whales made in 53 dive series (Fig. 6). Although the distribution was irregular, it suggests that bowheads generally blow between two and nine times in a series.

Dive Times

We defined a "series dive" to be any submergence of less than 75 seconds within a blow sequence. Dives that lasted longer were considered to be "sounding dives." This distinction was based on the distribution of dive timings (Fig. 7). Only three sounding dives were recorded, lasting 395, 437, and 524 seconds. The 145 recorded series of dives ranged in length from 1.3 to 67.8 seconds with a mean of 17.9 ± 2.3 seconds. From 50 samples of dives when no breaches occurred, time underwater ranged from 2.3 to 53.5 seconds. Mean dive length for this series was 11.6 ± 2.4 seconds.

Surface Times

The length of time a whale was visible to the observer at each blow was recorded. Of 112 recordings for nonbreaching animals, surface times ranged from 1.6 to 16.5 seconds. Mean time at the surface was 6.1 ± 0.5 seconds. Of 36 breaching animals, surface times ranged from 1.9 to 10.3 seconds with a mean of 4.1 ± 0.6 seconds.

Summary

Between 2 April and 7 June, 280 bowhead whales were counted from the Cape Lisburne research site at Alokut during 691 hours of systematic observation effort; 99.3 percent of these whales were seen between 18 April and 14 May. This compares with sightings made at Point Barrow where 96.8 percent of the whales passed between 22 April and 18 May. This 4-day lag in sightings between the two observation sites compares favorably with the estimated 3.6 to 4.7 day travel time (4.1-5.3 km/hour calculated rate of travel for bowheads passing Cape Lisburne).

Using interpolations to estimate the number of whales passing during periods of poor visibility, approximately 478 bowheads passed the Cape within 15 km during the spring migration. The average offshore recorded distance was 4.5 km. Whales were seen as far as 14.8 km, the outer limit of visibility during excellent conditions. An unknown portion of the population passed beyond the viewing range. Virtually all of the bowheads were traveling in a northeasterly direction as they passed Cape Lisburne which suggests a route less dependent on coastal features than on sea ice shear zones and direct line travel toward Point Barrow. Most whales were sighted on the far side of leads and polynyas.

Fog and storms precluded watches during critical parts of the migration, further reducing the Cape Lisburne counts relative to those made at Point Barrow. The viewing area was too large to be covered adequately by one or two observers at a time, and problems with determining duplicate sightings also may have suppressed counts.

A high frequency of breaching and fluke slapping occurred in the Cape Lisburne area relative to records from other sites. Synchronous breaching and milling suggest considerable courtship and/or copulation was taking place. The mean dive time between sounding dives for nonbreaching whales was 11.6 ± 2.4 seconds. The mean recorded time at the surface was 6.1 seconds with a range of 1.6 to 16.5 seconds.

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Howard Braham, as supervisor of the Arctic Whales Task, NMFS National Marine Mammal Laboratory, Seattle, Wash., provided guidance and support for this study at Cape Lisburne. Katherine Hazard and Andrew Taber participated in the field research at Alokut. Their ability to perform research in spite of the isolated and severe Arctic environment deserves special credit. Cary Ball, a student at the University of Washington, Seattle, volunteered considerable time to help synthesize and analyze the data. Robert Melby of the NOAA Pacific Marine Environmental Laboratories, Seattle, donated time, equipment, and assistance in developing appropriate surveying and calculator programs. Civilian and Air Force personnel at Cape Lisburne Air Force Station and Elmendorf Air Force Base, Anchorage, Alaska, generously provided us with needed support.

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Vessel Survey for Bowhead Whales in the Bering and Chukchi Seas, June-July 1978

MARILYN DAHLHEIM, TERESA BRAY, and HOWARD BRAHAM

Introduction

Prior to the advent of Yankee whaling for bowhead whales, *Balaena mysticetus*, in the Chukchi Sea in 1848, there were an estimated 6,500 bowheads in the Sea of Okhotsk population and 11,700 to 18,000 in the western Arctic population (International Whaling Commission, 1978). By the turn of the 20th century bowheads in the Sea of Okhotsk had been nearly exterminated and those in the Bering Sea and Arctic Ocean were reduced to a level that was no longer commercially important (Bockstoce[1]).

Townsend (1935) reviewed several hundred logbooks of 19th century whaleships and plotted positions of 5,114 bowhead catches in the Bering Sea and Arctic Ocean from lat. 53° to 73°N, and long. 120°W to 135°E (Fig. 1a, b, c). Catches were recorded from much of the Bering Sea, the majority on the western side, and showed a clear

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[1]Bockstoce, J. 1978. A preliminary estimate of the reduction of the western Arctic bowhead whale (*Balaena mysticetus*) population by the pelagic whaling industry: 1848-1915. Unpubl. manuscr., 32 p. Prepared for the Marine Mammal Commission, Washington, D.C.