Table 4. Summary of sightings (number of sightings/number of animals), summer 1985.

Flight	Date	Gray Whale	Belukha	Bearded Seal	Ringed Seal	Walrus	Unidentified Pinniped
1	17 July	67/478	0	0	0	1/1	5/10
2	18 July	3/16	0	0	1/2	0	2/3
3	19 July	17/57	1/3	313	1/1	0	0
4	20 July	7/12	1/30	2/2	0	4/155	0
5	21 July	0	0	0	0	0	0
6	22 July	1/1	0	1/1	0	2/580	0
7	23 July	1/2	0	4/6	1/1	64/4166	4/4
8	24 July	24/76	0	13/19	9/13	22/1417	23/56
9	25 July	19/63	1/1	4/5	2/2	3/33	7/9
10	26 July	0	0	0	0	0	4/4
11	28 July	0	0	0	0	0	0
12	29 July	0	0	0	0	0	0
13	30 July	0	1/3	1/1	0	0	0
TOTAL		139/705	4/37	28/37	14/19	96/6352	46/86

Gray Whale (Eschrichtius robustus)

Distribution, Relative Abundance, and Density

One hundred thirty-nine sightings of seven hundred and five gray whales were made in the northern Bering and northeastern Chukchi Seas in July (Table 4, Figure 5). Four hundred seventy-seven whales, including two calves, were seen in the northern Bering Sea on one flight (Figure 5A). Two hundred twenty-eight whales, including fifteen calves, were seen in the Chukchi Sea on eight flights (Figure 5B). The distribution of gray whales in both seas was very similar to past years.

Areas of greatest relative abundance in the Bering Sea were blocks 25 and 26 where WPUE was 46.34 and 164.25 respectively (Table 5). In the Chukchi Sea, areas of greatest abundance were blocks 13, 17, 20 and 22 where WPUE were 14.23, 12.34, 2.81, and 7.73 respectively (Table 5). Whales in block 22 were approximately 7 to 26 km south of Pt. Hope. Those seen in blocks 13 and 17 were

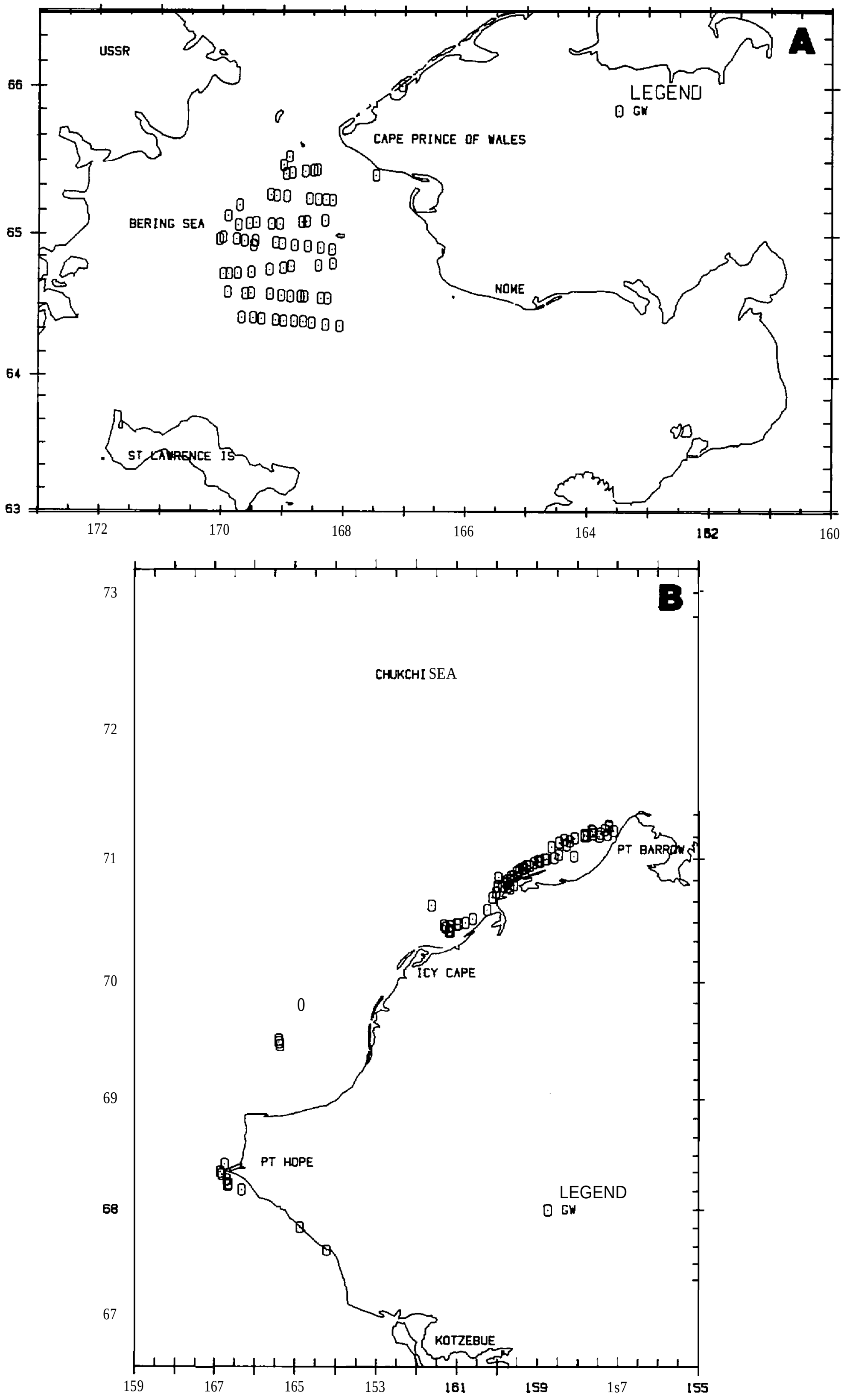


Figure 5. Distribution of 139 sightings of 705 gray whales, summer 1985: 66 sightings of 477 whales, Bering Sea (A); 73 sightings of 228 whales, Chukchi Sea (B).

Table 5. Relative abundance (WPUE) of gray whales by survey block, summer 1985. WPUE = no. whales/hours of survey effort

Block	Flights*	Hours	Gray Whales	WPUE
1	4	1.19	0	0.00
2	2	0.71	0	0.00
3	1	0.52	0	0.00
4	1	0.64	0	0.00
5	1	1.61	0	0.00
6	1	0.49	0	0.00
7	1	1.20	0	0.00
9	2	1.64	0	0.00
12	6	0.51	0	0.00
13	8	9.77	139	14.23
14	5	3.25	0	0.00
15	2	3.22	0	0.00
17	6	3.81	47	12.34
18	3	2.90	0	0.00
19	1	0.33	0	0.00
20	3	2.85	8	2.81
21	1	1.91	0	0.00
22	3	3.88	30	7.73
24	1	0.17	1	5.88
25	1	2.46	114	46.34
26	1	2.21	363	164.25
28	1	0.16	0	0.00
Unblocked	8	1.92	3	1.56
Total/Average	63	47.35	705	14.89

*Flight is any traverse of a block.

generally within 30 km off shore between Icy Cape and Pt. Barrow, and those seen in block 20 were north of Cape Lisburne, within 90 km of shore. One whale was seen in block 24 less than one kilometer from shore.

Estimates of gray whale density/block ranged from 0.0936 whales/km ^{2} in block 26 to 0.0008 whales/km^2 in block 20 (Figure 6). Density estimates for blocks 25, 13 and 17 were 0.0394 whales/km^2, 0.0018 whales/km^2 and 0.0034 whales/km^2 respectively. These estimates represent densities of whales at the surface only and were not corrected for submerged whales.

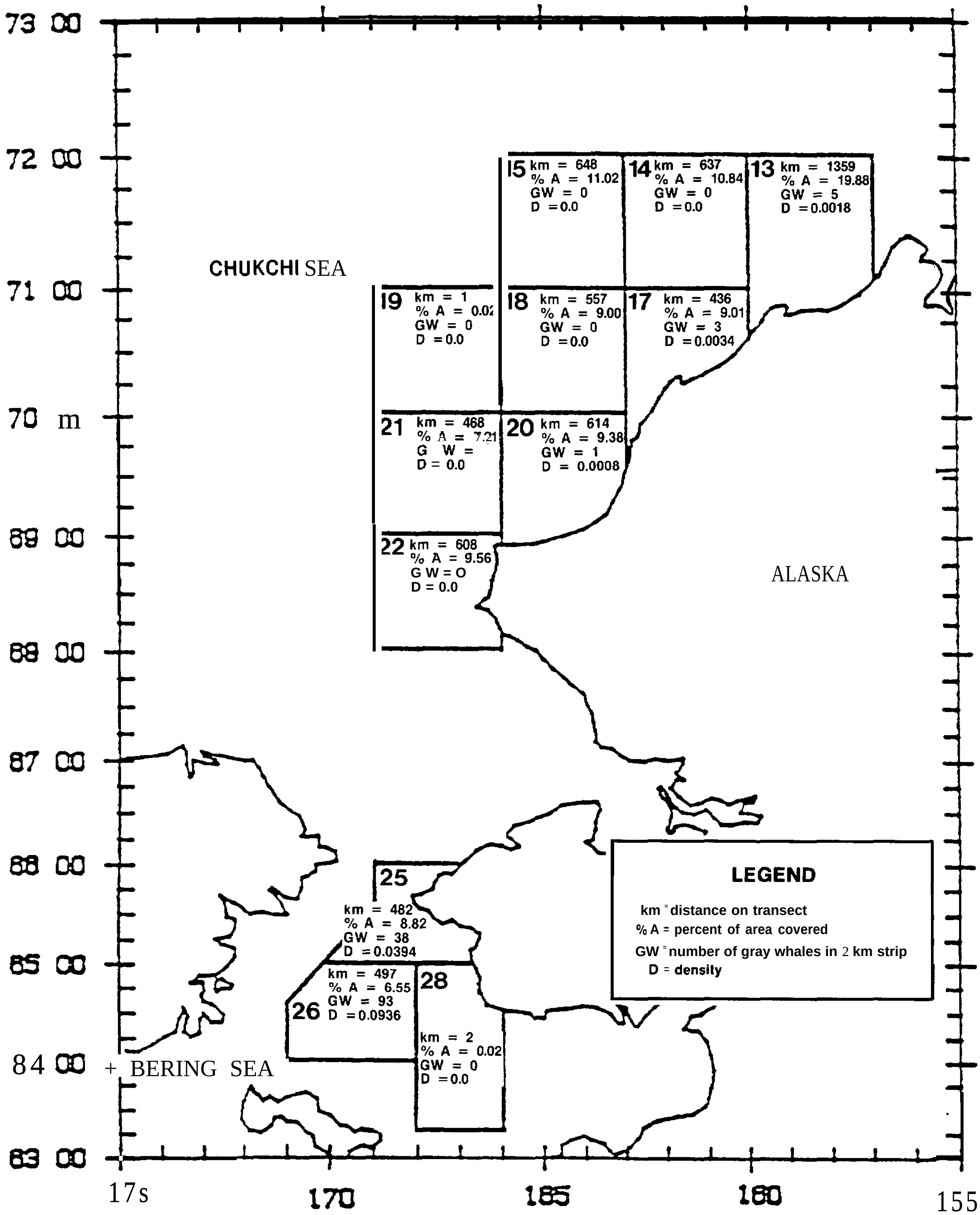


Figure 6. Gray whale density by block, summer 1985.

Although high gray whale relative abundance indices (WPUE) were calculated for blocks 22 and 24, density estimates could not be derived for these blocks because whale sightings were never made while surveying a random transect leg (see Figure 2).

Gray whale density estimates and relative abundance indices reflect the importance of the northern Bering Sea, and secondarily the coastal Chukchi Sea as summering habitat for gray whales. In 1985, the Chirikov Basin in the northern Bering Sea supported a summering aggregation of gray whales whose density was at least an order of magnitude greater than the densest area in the Chukchi Sea. Similar differences in abundance by sea have been noted for past years, although the magnitude of difference has varied annually (Appendix B: see Table B-2).

Habitat Relationships

Gray whales in the Bering Sea were seen approximately 0.5 to 140 km from shore in water 18 to 60 m deep ($\bar{x}$ = 45.1, s.d. = 7.56, n = 66). All gray whales (n = 477) seen in the Bering Sea were in open water. Grays seen in the Chukchi Sea were approximately 0.5 to 90 km from shore in water 5 to 42 m deep ($\bar{x}$ = 21.5, s.d. = 8.63, n = 73). Eighty-seven percent (n = 199) of gray whales seen in the Chukchi Sea were in open water, twelve percent (n = 27) were in 1 to 10 percent ice coverage, and less than 1 percent (n = 2) were seen in 20 to 30 percent ice coverage.

Behavior

Gray whales were usually seen either feeding (66 %, n = 466) or swimming (26 %, n =183; Table 6). Of the feeding whales seen, seventy-four percent (n = 346) were in the northern Bering Sea and 26 percent (n = 120) were in the Chukchi Sea. Feeding was inferred anytime a whale was seen with a mud plume. Mud plumes, billows of sediment brought to the surface by whales feeding on infaunal prey, are excellent sighting cues and as such may positively bias data toward “feeding” whales. Conversely, whales feeding on epibenthic prey may not create mud plumes and therefore some “feeding” whales may go unrecorded.

Three percent (n =22) of the grays seen were resting, sometimes in very shallow coastal water. Five percent (n = 34) of all gray whales seen were involved in cow-calf behaviors. The majority (n = 30) of these were seen in the Chukchi Sea south of Point Hope and along the northeastern coast between Icy Cape and Point Barrow.

Table 6. Observed gray whale behavior by sea, summer 1985.

	Bering Sea No.(%)	Chukchi Sea No.(%)	Total No.(%)
BEHAVIOR:			
Swim	118 (25)	64 (28)	182 (26)
Dive	o (o)	1 (1)	1 (o)
Rest	9 (2)	13 (5)	22 (3)
Feed	346(72)	120(53)	466 (66)
Cow-Calf	4 (1)	30 (13)	34 (5)
TOTAL	477	228	705

Gray whale calves seen south of Point Hope (35%, n = 6) exhibited avoidance or "hiding" behavior on two days (Appendix A: Flights 2 and 3) similar to that seen in 1982 (Ljungblad et al., 1983). Each calf positioned itself under an adult whale, presumably the cow, so that only the calf's flukes could be seen. Occasionally a calf was seen momentarily resting close to an adult before submerging and "hiding" in what may have been an aircraft response.

Nine calves (53%) were seen swimming adjacent to an adult that was part of a larger feeding group both in the Bering (n = 2) and northeastern Chukchi Seas (n = 7). The remaining two calves (12%) were associated with swimming adults in the northeastern Chukchi Sea. One of these was swimming and breaching ahead of the adult (Appendix A: Flight 9).

Gray whales exhibited headings in all directions, with no significant clustering about any direction in either the northern Bering Sea (Rayleigh test, $z = 1.35$, $n = 15$, $p \leq 0.20$) nor the northeastern Chukchi Sea (Rayleigh test, $z = 1.87$, $n = 29$, $p \leq 0.10$).

Average group size for all gray whales was 3.38 (s.d. = 13.45, n = 103). Feeding gray whale groups were larger ($\bar{x} = 7.88$, s.d. = 15.75, n = 60) than groups of non-feeding whales ($\bar{x} = 4.56$, s.d. = 2.99, n = 43), but this difference was not significant ($t = 1.14$, $df = 101$, $p < 0.09$).

Recruitment

Seventeen gray whale calves were seen during the summer surveys resulting in a Gross Annual Recruitment Rate (GARR) of 17/705, or 2.4 percent. Fifteen of the calves were among the 228 whales in the northeastern Chukchi Sea (GARR = 6.58%), while only two calves were among the 477 gray whales in the northern Bering Sea (GARR = 0.42%). These differences in GARR by sea are similar to those reported for past years (Moore et al., 1986 b), and may represent an example of partial segregation of cow-calf groups on the northern range. Annual estimates of GARR, and gray whale calf relative abundance for data collected in the northern Bering and eastern Chukchi Seas since 1980, further support the contention of partial cow-calf segregation on the northern range (see Table 23 and Table 24).

Other Species

Belukha Whale (Delphinapterus leucas)

Four sightings of 37 belukha whales were made in summer. One group of 30, consisting of primarily cows with calves, was seen near-shore in the northeastern Chukchi Sea on 20 July (Appendix A: Flight 4). All other sightings were of singles or small groups of adult whales. They consisted of one sighting of three belukas within 0.5 km of shore approximately 140 km southwest of Point Hope (Appendix A: Flight 3), a single whale seen about 40 km northwest of Point Barrow (Appendix A: Flight 9), and one sighting of three belukhas approximately 195 km north of Barter Island (Appendix A: Flight 13).

Pinnipeds

Thirty-seven bearded seals, 19 ringed seals, and 86 unidentified pinnipeds were seen in summer. Bearded seals and ringed seals were usually seen as singles in the Chukchi Sea. The largest loose aggregation of bearded (n . 19) and ringed (n = 13) seals was seen *on* 24 July (Appendix A: Flight 8) approximately 100 km north of Cape Lisburne. Walrus were sighted primarily along the ice edge and were usually swimming or in large (up to 600) groups resting on ice floes. Over 4000 walrus were seen northwest of Icy Cape on 23 July [Appendix A: Flight 7), and 1417 were counted on 24 July (Appendix A: Flight 8) in the same general area offshore between Cape Lisburne and Ice Cape where bearded and ringed seals were seen. Pinnipeds that reacted suddenly to the aircraft often could not be positively identified.

FALL (1 August to 23 **October)**

Survey Effort, Rationale, and Sighting Summary

Two hundred twelve and three-quarter hours of surveys were flown in the fall, with 93 percent (197.7 hrs) of this effort in the Beaufort Sea and 7 percent (15.1 hrs) in the Chukchi Sea (Table 7). Thirty-one percent (67.0 hrs) of the total flight time was flown in August (Figure 7A), 33 percent (69.8 hrs) in September (Figure 7B), and 36 percent (76.0 hrs) in October (Figure 7C; Table 8). Overall, survey effort was somewhat less extensive than that flown in 1982-84, but greater than that flown in 1979-81. Surveys were not flown on 12 days in August, 12 in September, and 6 in October due to poor weather or aircraft maintenance requirements (Table 8).

Surveys in the Beaufort Sea were scheduled to cover near-shore and offshore blocks, and to support other MMS-funded bowhead studies. Restrictive weather and lengthy transit time to some blocks altered planned coverage somewhat. In August and the first half of September, priority was given to blocks east of 1500 W. In the latter part of September, first priority was given to all coastal blocks and to offshore blocks east of 1500 W. In early October, surveys were directed toward near-shore blocks in the Beaufort Sea, and to near and offshore areas in the northern Chukchi Sea. Surveys during the latter part of October generally focused on the near-shore blocks of the eastern Alaskan Beaufort Sea to determine the status of the bowhead migration, as well as on the near-shore blocks of the western Beaufort Sea and the northern Chukchi Sea. Search surveys along the shifting ice edge or 20- to 40-m isobath were flown enroute to or from scheduled blocks.

Bowheads were seen east of 142°30'W and south of 70°35'N during August, east of 147°W near the continental shelf break and along the coastline in September, and west of 1470W along the shelf break and into the coastal Chukchi Sea in October. Although large aggregations (n = 50 to 600) of bowheads were reported between Kay Point (690 10'N, 138°20'W) and Shingle Point (68°55'N, 137°25’W), Canada, from late August through October (R. Davis, personal communication 1), bowheads were not seen in substantial numbers in the Alaskan Beaufort Sea until late September-early October. This relatively late observed movement of the major proportion of whales into the Alaskan Beaufort Sea was similar to 1979 sighting data (Ljungblad et al., 1980).

Table 7. Summary of flight effort, fall 1985.

Flight	Date	Sea	Transect Length (km)	Search Length (km)	Connect Length (km)	Total Length (km)	Time on Transect (hr:min)	Total Time (hr:min)	WPUE (Whales/hr)
14	2 Aug	Beaufort	675	191	90	956	2:26	3:28	0.00
15	6 Aug	Beaufort	111	728	14	85'3	0:23	3:05	0.00
16	7 Aug	Beaufort	571	499	88	1158	2:00	4:09	0.24
17	8 Aug	Beaufort	559	351	134	1044	2:02	3:48	1.05
18	9 Aug	Beaufort	224	505	56	785	0:50	2:52	0.00
19	11 Aug	Beaufort	289	473	84	846	1:07	3:14	0.93
20	12 hug	Beaufort	62	543	0	605	0:14	2:11	0.00
21	14 Aug	Beaufort	202	416	122	740	0:46	2:50	0.00
22	15 Aug	Beaufort	586	425	70	1081	2:04	3:51	0.26
23	17 Aug	Beaufort	330	475	89	894	1:19	3:26	0.58
24	18 Aug	Beaufort	357	503	148	1008	1:21	3:50	0.00
25	19 Aug	Beaufort	112	156	85	353	0:28	1:25	0.00
26	21 Aug	Beaufort	588	321	141	1050	2:11	4:02	0.00
27	24 Aug	Beaufort	551	488	150	1189	2:08	4:42	0.00
28	25 Aug	Beaufort	351	475	102	928	1:21	3:30	0.00
29	27 Aug	Beaufort	452	399	184	1035	1:47	3:58	0.00
30	28 Aug	Beaufort	712	316	164	1192	2:37	4:25	0.00
31	29 Aug	Beaufort	854	540	238	1632	3:11	6:07	0.16
32	30 Aug	Beaufort	264	206	81	55 I	1:01	2:08	0.00
33	1 Sep	Beaufort	319	404	66	789	1:12	2:55	0.00
34	4 Sep	Beaufort	0	318	0	318	0:00	1:14	0.00
35	5 Sep	Beaufort	271	293	134	698	1:06	250	0.00
36	9 Sep	Beaufort	0	483	0	483	0:00	2:22	10.55
37	11 Sep	Beaufort	467	384	107	958	1:47	3:38	0.83
38	12 Sep	Beaufort	686	431	75	1192	2:36	4:36	0.00
39	13 Sep	Beaufort	823	90	124	1037	3:25	4:18	1.40
40	18 Sep	Beaufort	941	235	149	1325	3:35	5:06	0.00
41	19 Sep	Beaufort	769	458	67	1294	300	5:05	0.00
42	20 Sep	Beaufort	835	60	114	1009	3:18	4:10	0.00
43	22 Sep	Beaufort	469	789	113	1371	1:58	5:44	0.35

Table 7 (contd).

Flight	Date	Sea	Transect Length (km)	Search Length (km)	Connect Length (km)	Total Length (km)	Time on Transect (hr:min)	Total Time (hr:min)	WPUE (Whales/ hr)
44	23 Sep	Beaufort	528	305	141	974	2:07	3:54	0.00
45	24 Sep	Beaufort	537	530	94	1161	2:16	4:57	0.00
46	25 Sep	Beaufort	593	518	131	1242	2:27	5:37	1.25
47	26 Sep	Beaufort	553	377	111	1041	220	4:24	0.91
48	27 Sep	Beaufort	391	514	55	960	1:33	4:17	4.44
49	29 Sep	Beaufort	442	472	96	1010	1:47	4:00	0.25
50	30 Sep	Beaufort	34	105	16	155	0:10	0:39	0.00
51	1 Ott	Beaufort	735	329	133	1197	3:13	5:16	1.71
52	3 Ott	Beaufort	708	162	91	961	2:53	4:07	0.00
53	5 Ott	Beaufort	834	22	144	1000	3:24	4:32	1.10
54	6 Ott	Beaufort	555	426	112	1093	2:10	4:58	5.23
55	7 Ott	Beaufort	895	451	86	1432	3:28	5:30	0.00
56	10 Ott	Chukchi	115	611	47	773	0:31	3:14	0.00
57	11 Ott	Beaufort	545	364	84	993	2:19	4:12	0.48
58	12 Ott	Chukchi	880	463	169	1512	3:30	6:10	0.32
		Beaufort	0	17	0	17	0:00	0:05	[2.50
59	13 Ott	Beaufort	309	553	121	983	1:18	4:21	2.99
60	14 Ott	Beaufort	480	330	148	958	1:59	3:52	0.00
61	15 Ott	Chukchi	0	544	0	544	0:00	2:06	0.48
		Beaufort	0	14	0	14	0:00	0:03	0.00
62	16 Ott	Beaufort	543	151	127	821	2:28	3:41	0.27
63	17 Ott	Beaufort	537	348	125	1010	2:13	4:13	0.00
64	19 Ott	Beaufort	67 I	167	141	979	254	4:23	0.00
65	20 Ott	Beaufort	992	740	209	1941	4:02	7:32	0.00
66	21 Ott	Beaufort	592	107	119	818	2:17	3:22	0.00
67	23 Ott	Chukchi	701	105	55	861	2:56	4:37	0.00
		Beaufort	145	4	33	182	0:35	0:46	0.00
Beaufort Sea Total			25049	18961	5306	49316	99:06	197:43	0.69
Chukchi Sea Total			1696	1723	271	3690	6:57	15:07	0.20
TOTAL			26745	20684	5577	53006	106:03	212:50	0.65

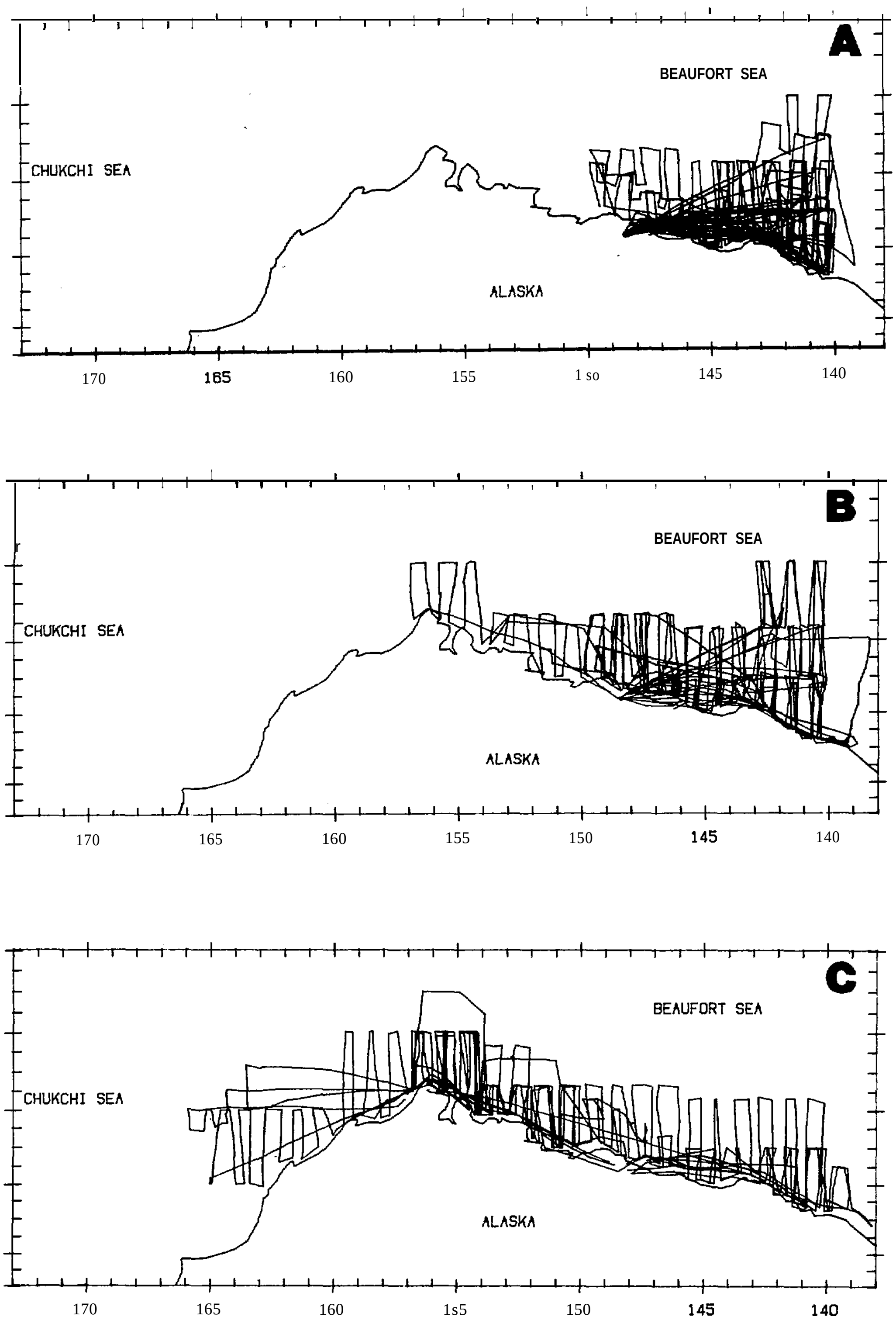


Figure7. Composite flight tracks, fall 1985: 19 flights in August (A); 18 flights in September (B); and 17 flights in October (C).

Table 8. Monthly summary of flight effort, fall 1985.

	AUG	SEP	OCT	TOTAL
FLIGHT EFFORT				
Total Transect Length (km)	7850	8658	10237	26745
Total Connect Length (km)	2040	1593	1944	5577
Total Search Length (km)	8010	6766	5908	20684
Total Time on Transect (hr:min)	29:16	34:37	42:10	106:03
Total Flight Time (hr:min)	67:01	69:46	76:03	212:50
No. Flight (days)	19	18	17	54
Unacceptable Weather (days)	12	11	5	28
Aircraft Maintenance (days)	0	1	1	2

The secondary aircraft (N545N) flew 42.8 hours of surveys in the eastern Alaskan Beaufort Sea from 9t027September to monitor the status of the bowhead migration (Appendix C: Table C-1, Figure C-1). Surveys were conducted to coastal areas near the U.S.-Canadian border where aggregations of 10 to 25 bowheads were seen over atwo week period (Appendix C: Flights C-2 to C-9).

Survey Conditions Summary

Survey conditions in early August were generally poor. During the first half of the month, low ceilings and dense fog prevented flying on six out of 15 days and caused transects to be truncated or aborted on five occasions. The weather improved slightly during the latter half of August, allowing more transect surveys to be completed. Heavy fog extending from Barrow to Canada precluded flying on six of 16 days, and low altitude search surveys were flown on four days.

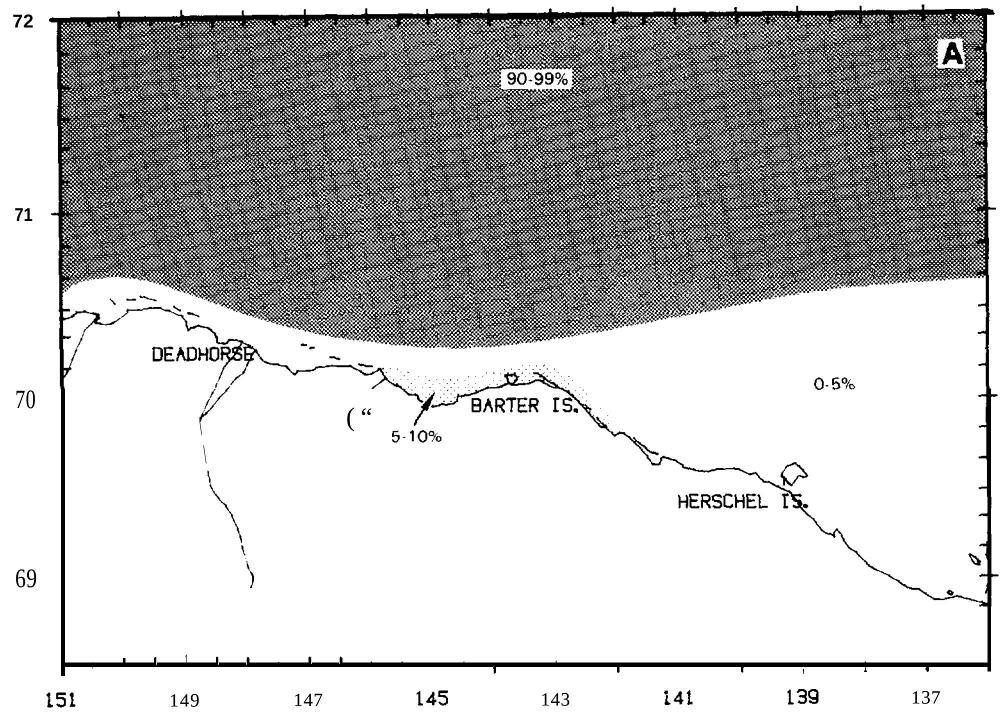
Survey conditions in early September were poor. Persistent low fog prevented flying on seven days, and caused transects to be truncated or aborted on four of the seven surveys completed. Survey conditions improved during the latter half of September, although low overcast, fog and/or high winds precluded flying on four days.

Survey conditions in October were generally good in areas with heavy ice, with the exception of persistent high winds which precluded flying on 5 days. In the ice-free areas of the Chukchi Sea, survey conditions were usually poor due to reduced visibility, fog, and high sea states (up to Beaufort 7).

Ice coverage in the Beaufort Sea in August remained heavy. In early August, there was 5 to 10 percent ice coverage in Camden Bay and waters near Barter Island (Figure 8A). There was a narrow channel (approximately 25 km) of nearly ice-free (0-5%) water between Deadhorse and Barter Island that broadened and extended from shore north to 70°40'N east of Barter Island. Ice coverage was greater than 90 percent throughout the rest of the eastern Alaskan Beaufort Sea. By mid-August, the heavy ice edge had moved farther offshore east of Barter Island (Figure 8B). Nearly ice-free (O-5%) water extended from shore to 70020'N at 141°W, broadening to 7 1°N at 1390W and east. Ice coverage varied from 10 to 50 percent due north of Deadhorse, with the heavy ice (95-99%) edge about 55 km offshore.

The heavy ice edge continued to move offshore in the northeastern Beaufort Sea during early September (Figure 9A). Except for localized near-shore bands of 5 to 20 percent and 1 to 10 percent ice north of Prudhoe Bay and east of Barter Island, the eastern Beaufort Sea was relatively ice-free to 70050'N at 150°W extending northeast to nearly 72°N at 140°W by mid-month. A four-day storm with strong winds (≥40 knots) changed Beaufort Sea ice conditions dramatically in mid-September (Figure 9B). Heavy ice was blown near shore, and ice conditions were generally heavy (80 to 99%) throughout the northeastern Beaufort Sea, with localized areas of moderate to heavy coverage (30 to 60%, 50 to 80%) and light to moderate conditions (5 to 50%) encountered near the U.S.-Canadian border. By the latter part of September, the heavy ice edge had again retreated from shore (Figure 9C). Although a region of moderate to heavy ice (40 to 90%) persisted north of Barter Island and light to moderate coverage (5 to 40%) was found east of there, the remainder of the Beaufort Sea was nearly ice-free (<10%) to about 71° 20'N.

As temperatures dropped in early October (50 to 20°F), new ice began to form rapidly in the shallow areas of the Alaskan Beaufort Sea. Ice coverage was light to moderate (20 to 30%) east of Deadhorse extending north to 70°30'N, where it increased to 50 to 99 percent (Figure 10A). There was eighty percent new ice coverage near-shore north of Deadhorse and west to Harrison Bay, with lighter ice



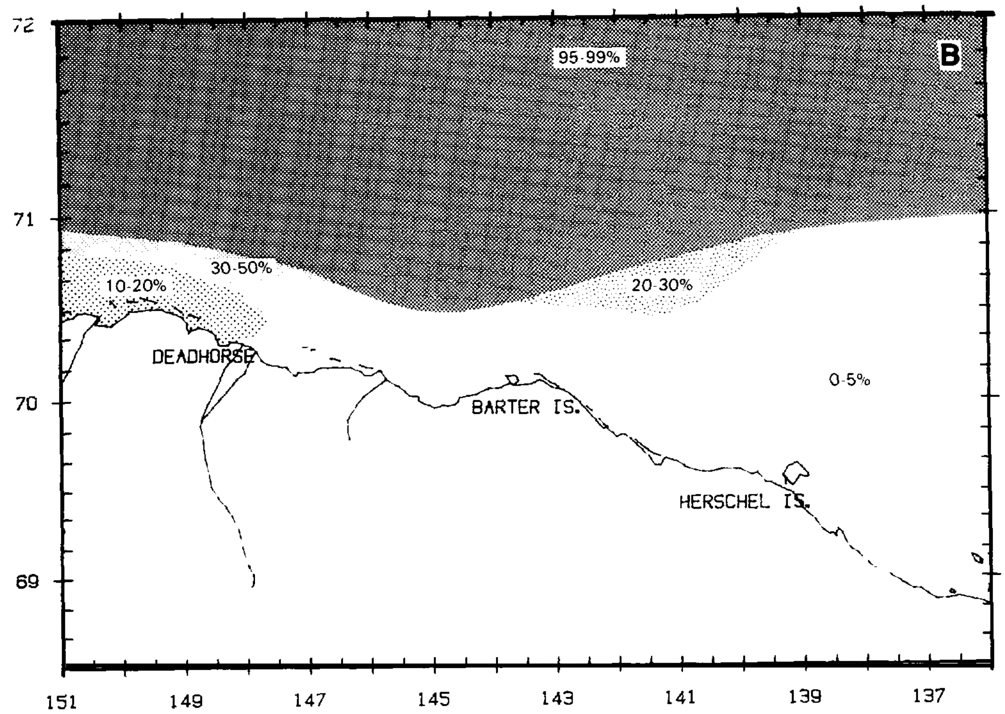


Figure 8. Schematic representation of ice conditions in the Beaufort Sea, 1-15 August (A); and 16-31 August (B).

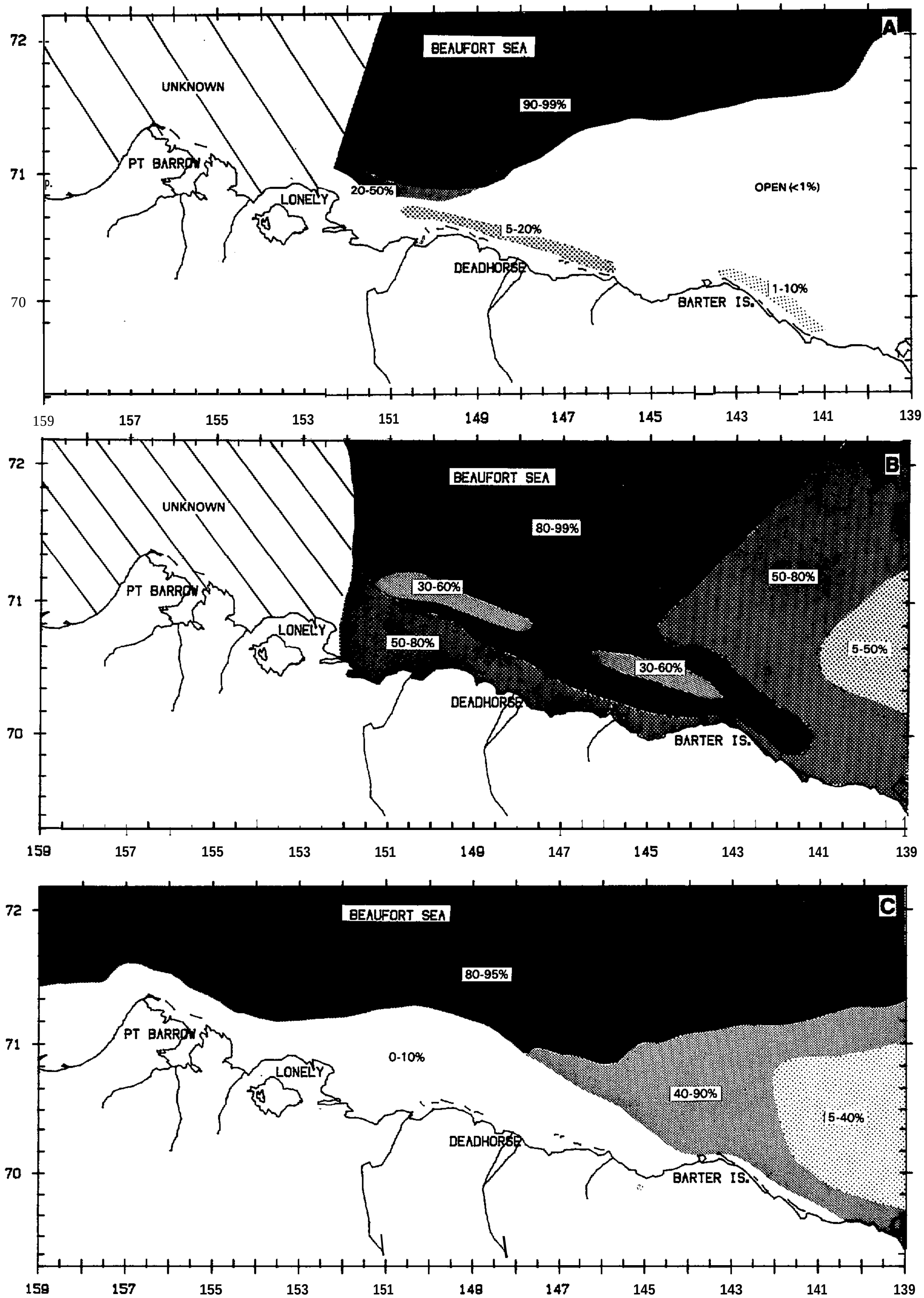


Figure 9. Schematic representation of ice conditions in the Beaufort Sea, l-15 September(A); 16-20 September (B); and 21-30 September (C).

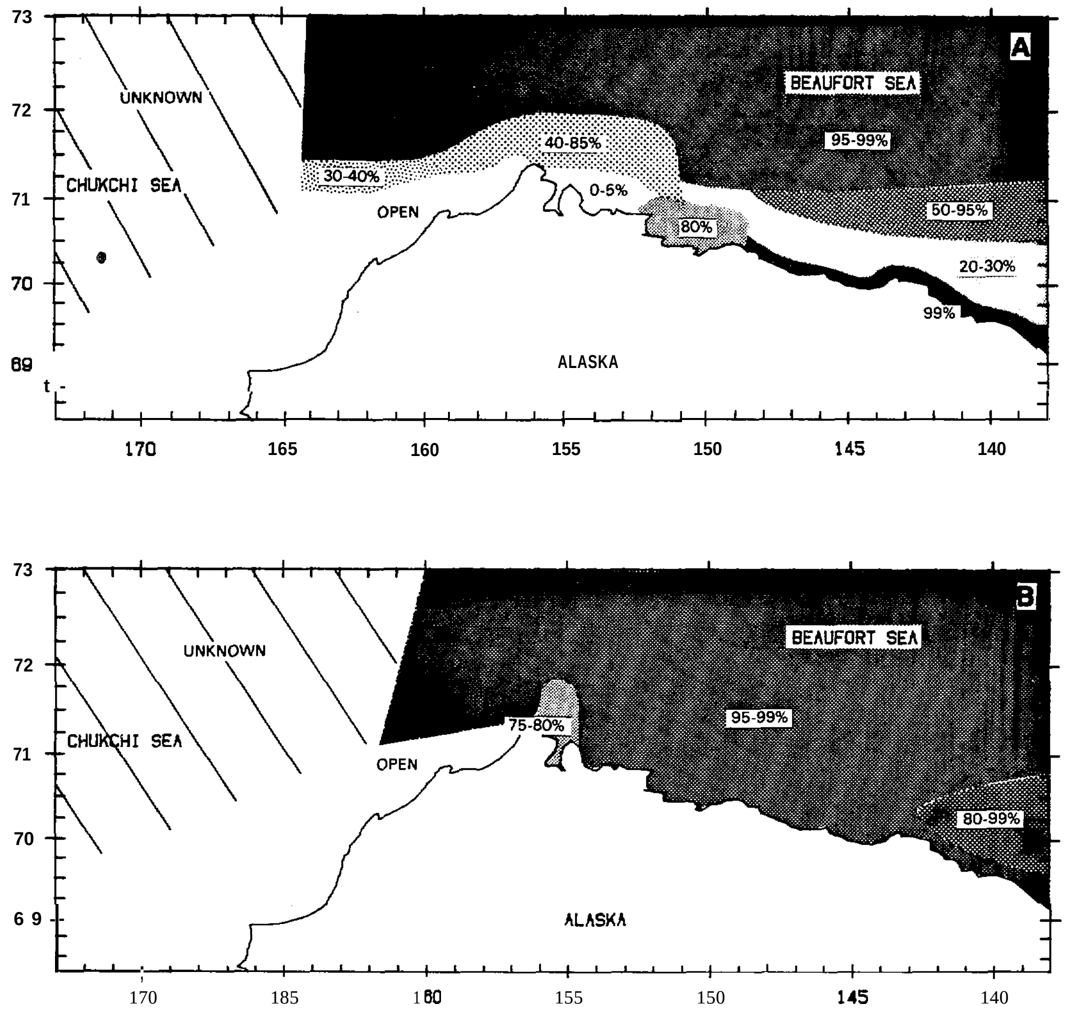


Figure 10. Schematic representation of ice conditions in the Chukchi and Beaufort Seas, 1-15 October (A);and 16-23 October (B).

coverage (0-5%) near-shore west of 152°W. North of Smith Bay (154°W) and extending west of Barrow, 40 to 85 percent ice existed north of 71°N. In mid-October, persistent low temperatures (Oo to 5oF) caused most of the Alaskan Beaufort Sea to freeze almost entirely (95 to 99%), with the exception of a near-shore area east of 143°W, where coverage was 80 to 99 percent, and a small area northeast of Barrow where numerous cracks and leads persisted resulting in 75 to 80 percent coverage (Figure 10B). By 21 October, the Alaskan Beaufort Sea was determined to have 99 percent coverage nearly everywhere.

Much of the Chukchi Sea remained ice-free through 23 October. In early October, heavy ice [95 to 99%) existed north of 71°30'N and a 25-km strip of moderate ice coverage (30 to 40%) was south of this (Figure lOA). By mid-October, areas previously covered with 40 percent ice were 95 percent covered (Figure 10B). The near-shore areas remained open through 23 October, although heavy ice had formed directly off Barrow.

Bowhead Whale (Balaena mysticetus)

Distribution, Relative Abundance, and Density

Seventy-seven sightings of 139 bowheads were made during the fall season (Table 9; Figure 11). Twelve bowheads were seen in August near the easternmost Outer Continental Shelf (OCS) oil and gas lease areas between 140°W and 1420W and offshore to 70°31'N (Figure 11A). This August distribution was similar to that of 1984 but dissimilar to that of 1982 and 1983 when whales were generally found farther offshore and farther west (to 146°30'W) along or outside the shelf break (Ljungblad et al., 1985).

Sixty-seven bowheads were seen in September (Figure 1 1B), fewer whales for this month than during all previous years except 1980 (Ljungblad, 1981). Whales were distributed in three discrete groupings: along the coast between 1390W and 141°W (n = 31); approximately 35 km north of Barter Island between 143°W and 1440W (n = 26); and about 40 km north northwest of Flaxman Island between 145°30'W and 1470W (n = 10). The distribution of bowheads in September overlapped the eastern OCS oil and gas lease areas somewhat and was similar to, but not comprehensive of, that seen in prior years (Ljungblad et al., 1985).

Fifty-seven bowheads were seen in the Beaufort Sea in October (Figure 1 1C), more whales for this month than in 1980-83, but less than in 1979 and 1984 (Ljungblad et al., 1985). All were seen eight to 110 km offshore east of 147020'W, and some were within the northwestern boundaries of OCS lease areas. Two relatively large groupings of bowheads were seen in early October; one consisting of eight whales 87 km northeast of Lonely, and one group of 20 whales north of Harrison Bay (Appendix A: Flights 51 and 54). In mid-October, two groups (n = 6 and 7) of bowheads were seen 45-55 km north of Prudhoe Bay (Appendix A: Flight 59). Three bowheads were seen in the Chukchi Sea in October, between 2 and 44 km offshore (Appendix A: Flight 58 and 61). As in September, the distribution of bowheads in October was similar to, but not comprehensive of, that seen in prior years (Ljungblad et al., 1985).

Table 9. Summary of sightings (number of sightings/number of animals), fall 1985.

Flight	Date	Bowhead	Belukha	Bearded Seal	Ringed Seal	Uniden-tified Pinniped	Polar Bear
14	2 Aug	0	1/1	0	0	0	0
15	6 Aug	0	0	0	0	0	0
16	7 Aug	1/1	0	0	0	2/2	0
17	8 Aug	4/4	3/9	1/1	0	1/1	0
18	9 Aug	0	2/2	1/1	0	0	0
19	11 Aug	2/3	5/25	1/1	0	2/2	0
20	12 Aug	0	1/2	0	0	0	0
21	14 Aug	0	0	0	0	0	0
22	15 Aug	1/1	6/9	0	0	1/1	0
23	17 Aug	2/2	1/2	0	0	0	0
24	18 Aug	0	1/11	1/1	0	5/8	0
25	19 Aug	0	0	0	0	0	0
26	21 Aug	0	0	0	0	0	0
27	24 Aug	0	0	0	0	0	0
28	25 Aug	0	1/1	0	0	0	0
29	27 Aug	0	0	0	0	5/5	0
30	28 Aug	0	11/36	0	0	2/3	0
31	29 Aug	1/1	12/24	1/1	0	0	0
32	30 Aug	0	0	0	0	0	0
33	1 Sep	0	3/4	0	0	0	0
34	4Sep	0	0	0	0	0	0
35	5 Sep	0	1/1	0	0	0	0
36	9 Sep	9/25	0	0	0	0	0
37	11 Sep	1/3	3/5	0	0	3/4	0
38	12 Sep	0	1/1	1/2	0	1/2	0
39	13 Sep	3/6	1/1	3/4	0	1/1	0
40	18 Sep	0	3/6	1/1	0	0	0
41	19 Sep	0	2/3	2/3	0	1/1	0
42	20 Sep	0	2/11	0	0	0	0

Table 9 (contd).

Flight	Date	Bowhead	Belukha	Bearded Seal	Ringed Seal	Uniden-tified Pinniped	Polar Bear
43	22 Sep	2/2	7/25	0	0	1/1	0
44	23Sep	O	o	0	0	3/3	0
45	24Sep	O	10/1'20	1/1	1/1	2/2	0
46	25 Sep	5/7	2/6	0	0	3/3	1/1
47	26Sep	3/4	1/2	0	0	5/5	0
48	27Sep	7/19	4/25	0	0	1/1	0
49	29 Sep	1/1	1/4	1/1	0	2/2	0
50	30Sep	O	o	o	0	o	0
51	1 Ott	7/9	12/49	0	0	0	0
52	3oct	o	o	0	0	0	0
53	5 Ott	4/5	0	0	0	0	0
54	60ct	8/26	3/15	0	0	1/1	0
55	7oct	o	2/2	0	0	1/1	0
56	10 Oct	o	o	1/1	0	o	2/2
57	11 Oct	2/2	4/12	1/1	0	1/1	0
58	12 Oct	3/3	1/10	o	0	o	0
59	13 Oct	9/13	1/1	0	0	0	0
60	14 Oct	o	o	0	0	0	0
61	15 Oct	1/1	0	0	0	0	0
62	160ct	1/1	7/9	0	0	0	1/3
63	17 Oct	o	o	0	0	0	o
64	19 Oct	o	0	0	0	0	0
65	2ooct	o	1/5	0	0	0	0
66	21 Oct	o	o	0	0	0	0
67	230ct	o	0	0	0	0	0
August		11/12	44/122	5/5	0/0	18/22	0/0
September		31/67	41/214	9/12	1/1	23/25	1/1
October		35/60	31/103	2/2	0/0	3/3	3/5
Total		77/139	116/439	16/19	1/1	44/50	4/6

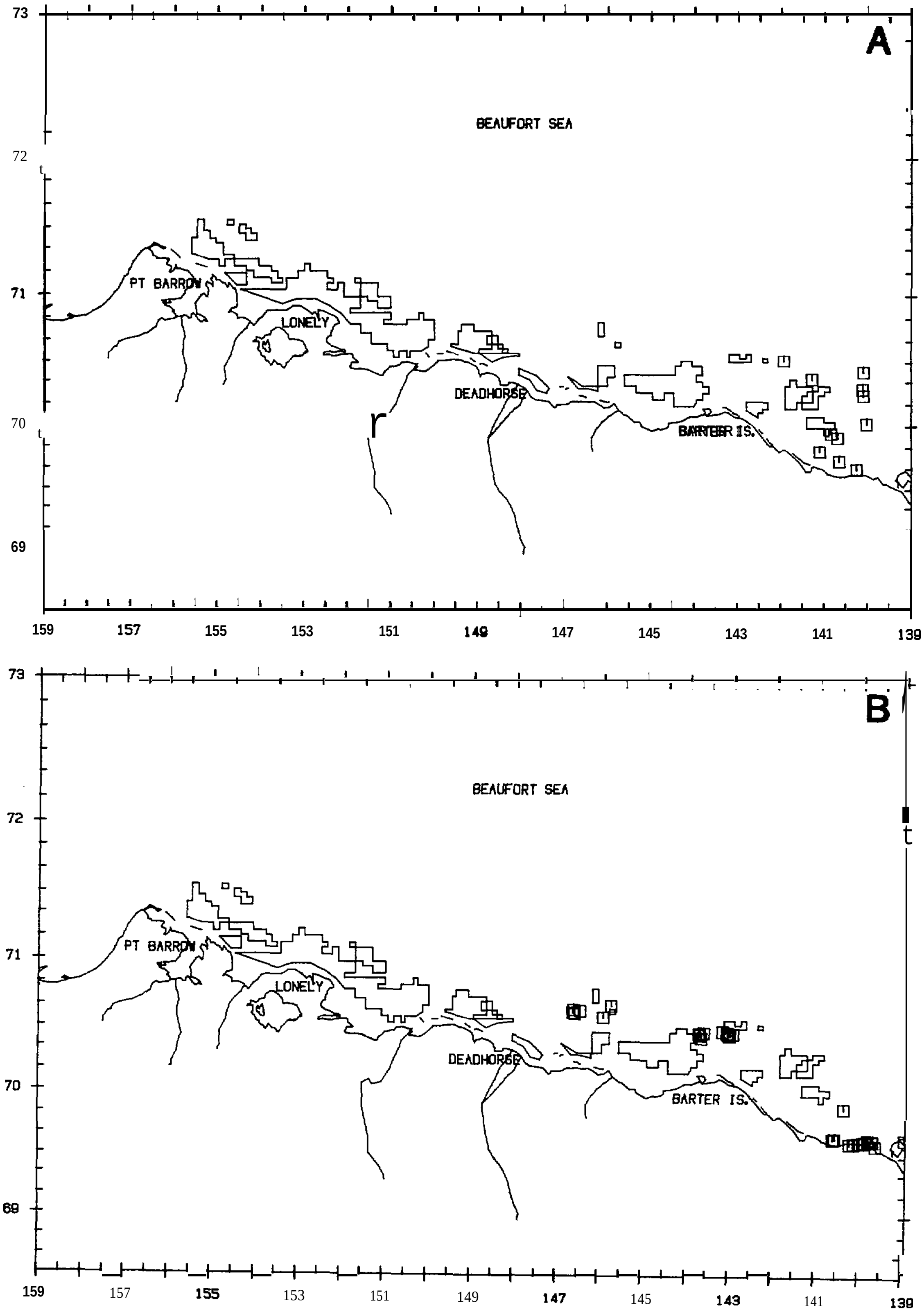
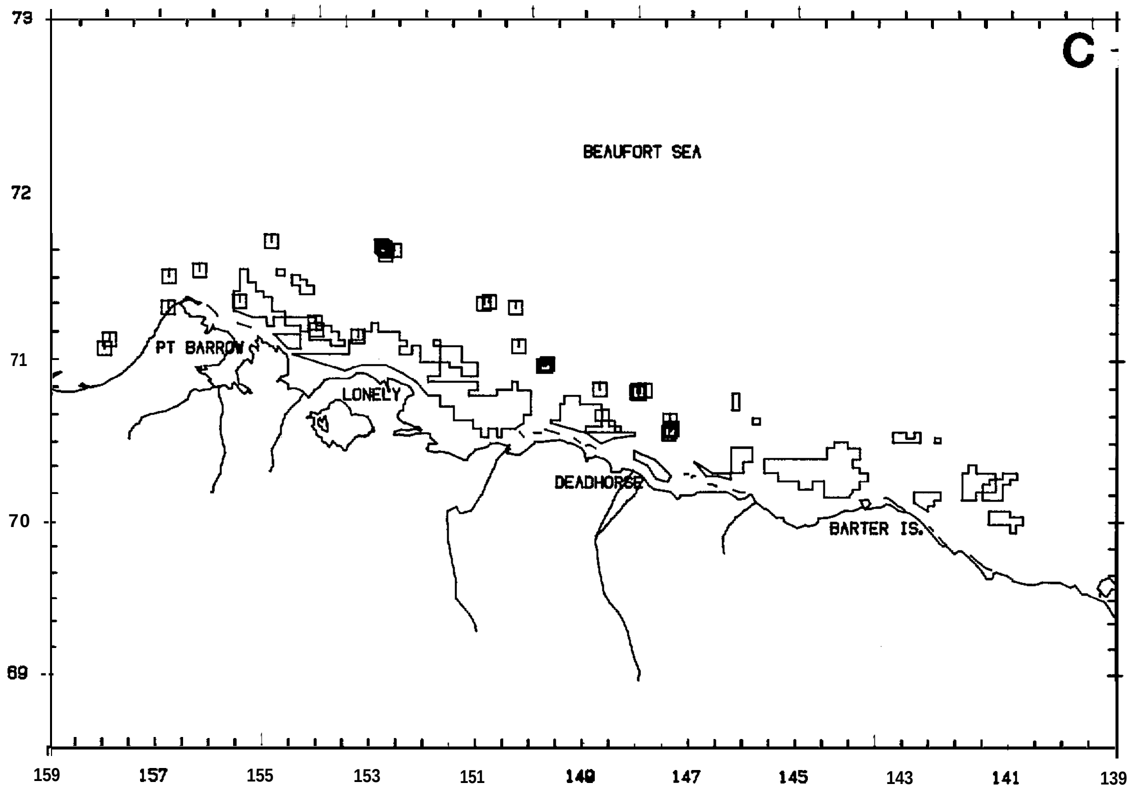


Figure 11. Distribution of 77 sightingsof 139 towheads, fall 1985: 11 sightings of 12 towheads, August (A); 31 sightings of 67 bowheads, September (B); (contd next page)



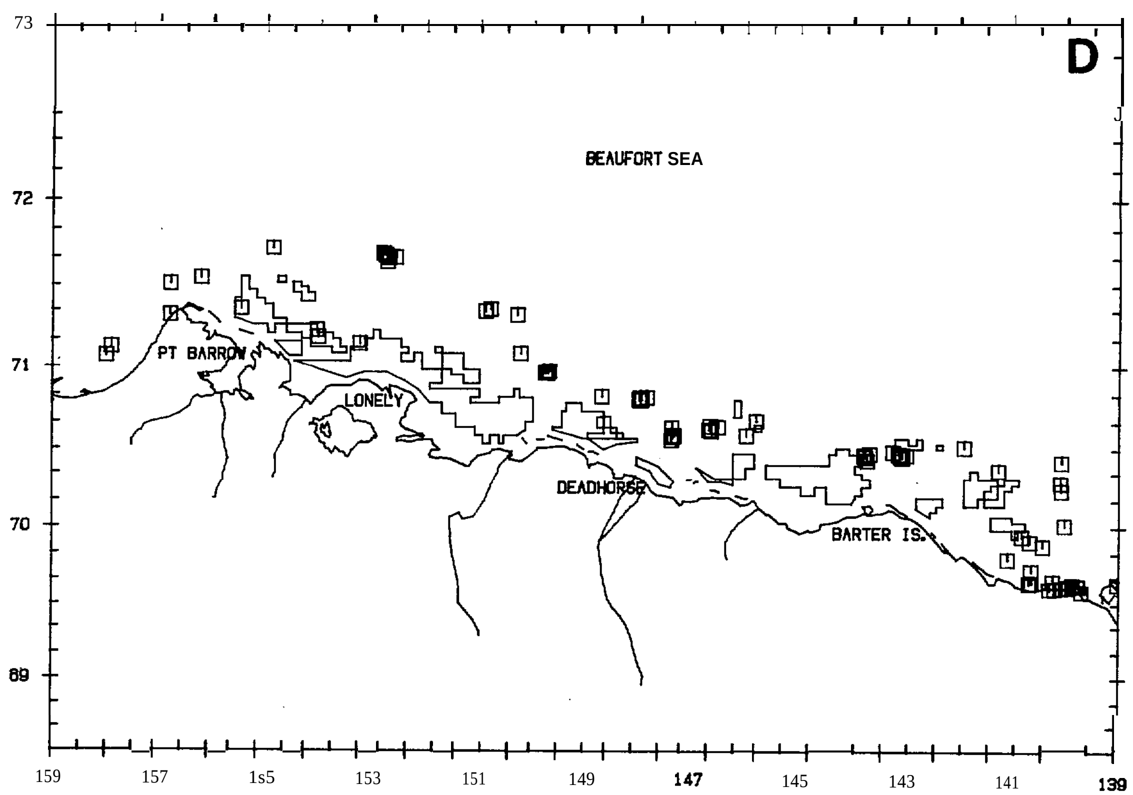


Figure 11 (contd). 35 sightings of 60 bowheads, October (C); all sightings (D). Outlined areas depict OCS oil and gas lease areas within the Beaufort Sea Planning Area of the Alaskan Beaufort Sea.

Bowhead relative abundance within the survey blocks (WPUE) ranged from 8.46 (block 11) to 0.06 (block 7; Table 10). Relative abundance was highest in block 5 in August (WPUE = 0.63), Mock 4 in September (WPUE = 2.21) and block 11 in October (WPUE = 9.00), reflecting a westward shift in flight effort and sightings with time. These relative abundance indices were generally similar to prior years (see Table 26).

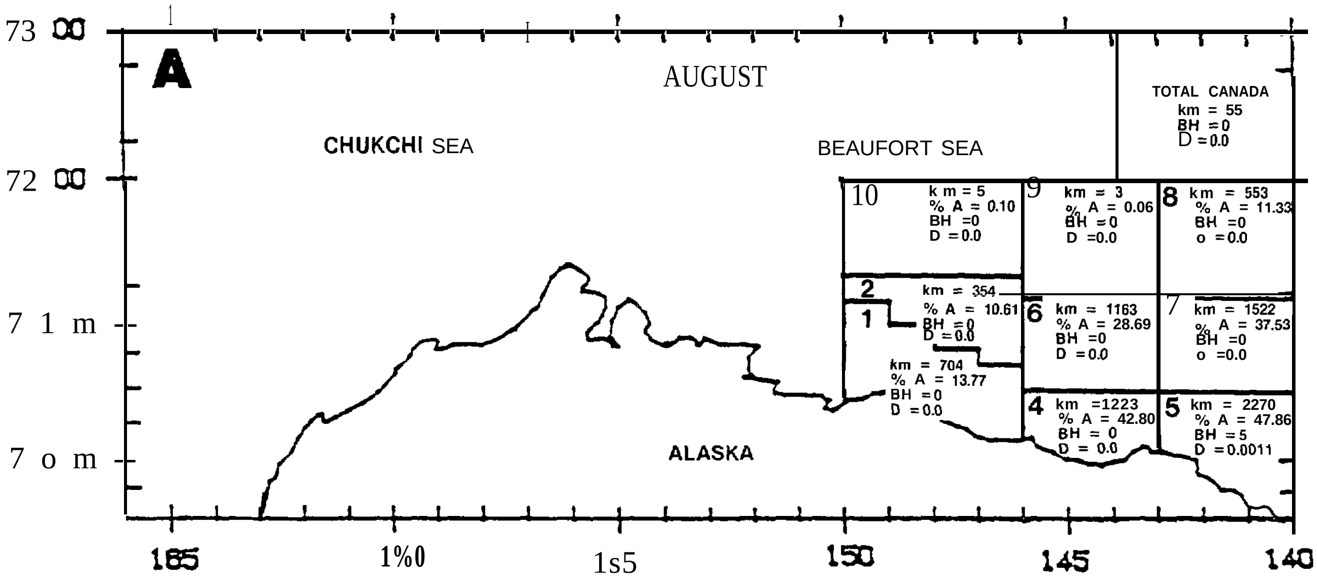
Bowhead density estimates calculated for the survey blocks generally reflected trends evident in the analysis of relative abundance (Figure 12). Density was highest in block 5 in August (0.0011 whales/km^2) and September (0.0007 whales/km^2), and block 11 in October (0.0045 whales/km^2). Total density estimates for the season were 0.0044 whales/km^2 in block 11, 0.0008 whales/km^2 in block 12, 0.0006 whales/km^2 in block 5, 0.0004 whales/km^2 in block 3 and 0.0003 whales/km^2 in block 1. Bowhead density could not be calculated for survey blocks in the Chukchi Sea because whales were never seen there while flying a random transect survey line. The calculation of bowhead density estimates for bathymetrically derived subregions in the Alaskan Beaufort Sea are presented in Appendix B.

Migration Route, Timing, and Habitat Relationships

The observed bowhead migration route across the Alaskan Beaufort Sea was centered roughly along the continental shelf break (Figure 11 D) as in past years (Ljungblad et al., 1985). Bowheads were seen in the Alaskan Beaufort Sea as early as 7 August (Appendix A: Flight 16) from the primary aircraft (N780), and by 11 September (Appendix C: Flight C-2) from the secondary aircraft (N545N); but, except for one whale swimming slowly west near Demarcation Bay on 17 August (Appendix A: Flight 23), all bowheads seen between 7 August and 13 September were resting, displaying, feeding, or swimming slowly in other than a westerly direction and did not appear to be migrating. From 14 to 17 September, neither aircraft flew surveys due to a severe storm that hit Alaska's North Slope in mid-September (see Survey Conditions Summary, pp. 25-28). This hiatus in survey effort made a precise onset of the bowhead migration somewhat difficult to determine because whales seen prior to 14 September may have migrated west during the storm. One bowhead was seen just north of Point Barrow on 18 September (K. Frost, personal communication) indicating that some whales had moved across the Alaskan Beaufort Sea by that time. However, there were no bowhead sightings from the primary aircraft (N780) on surveys conducted from 18

Table 10. Monthly and seasonal relative abundance of bowhead whales (WPUE) by survey block, fa 985.

Block	August				September				October				Total			
No.	Flts	Hrs	BH	WPUE	Flts	Hrs	BH	WPUE	Flts	Hrs	BH	WPUE	Flts	Hrs	BH	WPUE
1	19	10.67	0	-	17	13.04	7	0.54	8	7.97	8	2.26	44	31.68	25	0.79
2	3	1.67	0	-	3	4.1	0	-		1.75	0	-	7	7.58	0	-
3	0	0.00	0	-	3	4.90	0	-	7	12.38	5	0.40	10	17.28	5	0.29
4	8	6.75	0	-	1	10.39	23	2.21	6	6.22	0	-	35	33.36	23	.69
5	14	17.52	1	0.63	3	0.83	3	.74	4	9.16	0	-	27	37.57	30	0.80
6	2	7.3	0	-	8	7.78	3	0.39	3	2.09	0	-	23	7. 8	3	0. 7
7	11	.70		0.11	7	7.08	0	-	4	2.08	0	-	22	17.86	1	0.06
8	5	3.0	0		6	5.33	0	-		0.06	0	-	2	8.40	0	-
3	2	0.32	0		3	0.3[illegible]	0	-	0	0.00	0	-	5	0.68	0	-
0		0 6	0	-	3	0 8	0	-		0.25	0	-	5	0.59	0	-
	0	0.00	0	-		0 3	0	-	5	3.00	27	9.00	6	3.19	27	8.46
2	0	0.00	0	-		3.08	0	-	2	3.25	7	0.53	13	6.33	7	0.43
3	0	0.00	0	-	0	0.00	0	-	4	6.40	2	0.3	4	6.[illegible]0	2	0.31
4	0	0.00	0	-	0	0.00	0	-	3	2.03		0.48	3	2.09		0.48
15	0	0.00	0	-	0	0.00	0	-	3	[illegible].00	0	-	3	.00	0	-
17	0	0.00	0	-	0	0.00	0	-		2.69	0	-	1	2.69	0	-
18	0	0.00	0	-	0	0.00	0	-	2	2.90	0	-	2	2.90	0	-
Block Total	85	66.1	2	0. 8	72	67.38	52	0.77	65	73.29	60	0.82	222	206.78	24	0.60
Total Canada	3	0.91	0	-	3	2.30	5	6.52	2	1.96	0	-	3	5.17	15	2.90
Total Unblocked	0	0.00	0	-	2	0.09	0	-	2	0.78	0	-	4	0.87	0	-
Grand Total	88	67.02	2	0.18	77	69.77	67	0.96	69	76.03	60	0.79	234	212.82	39	0.65



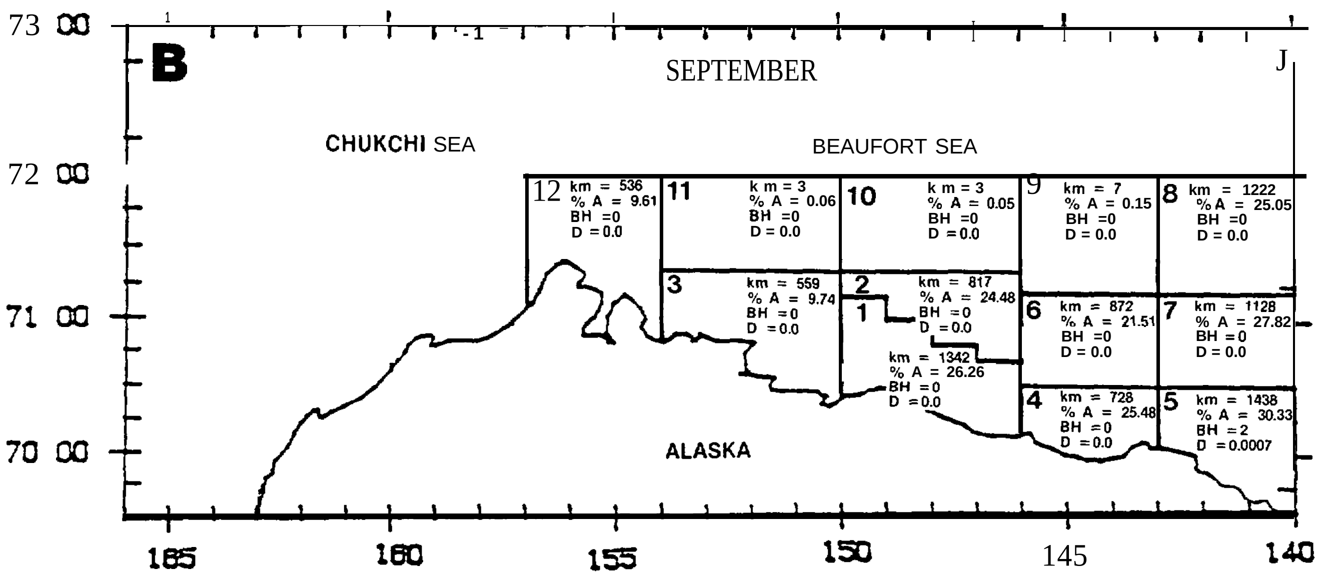
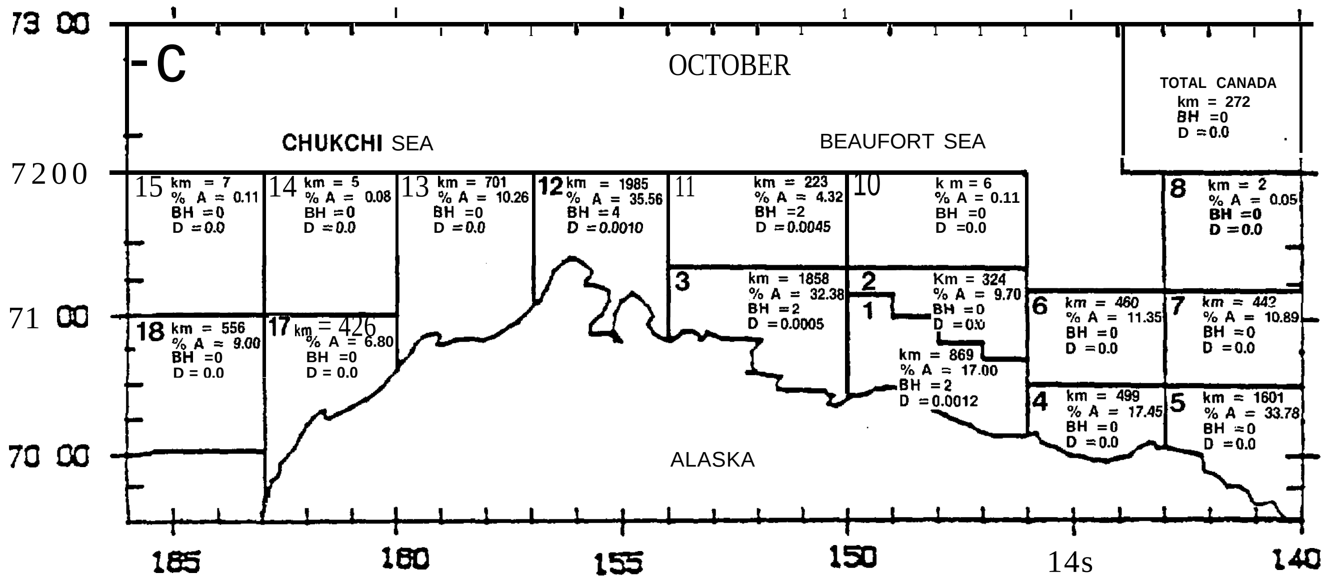


Figure 12. Bowhead whale density by block, fall 1985: August (A); September (B). (contd next page)



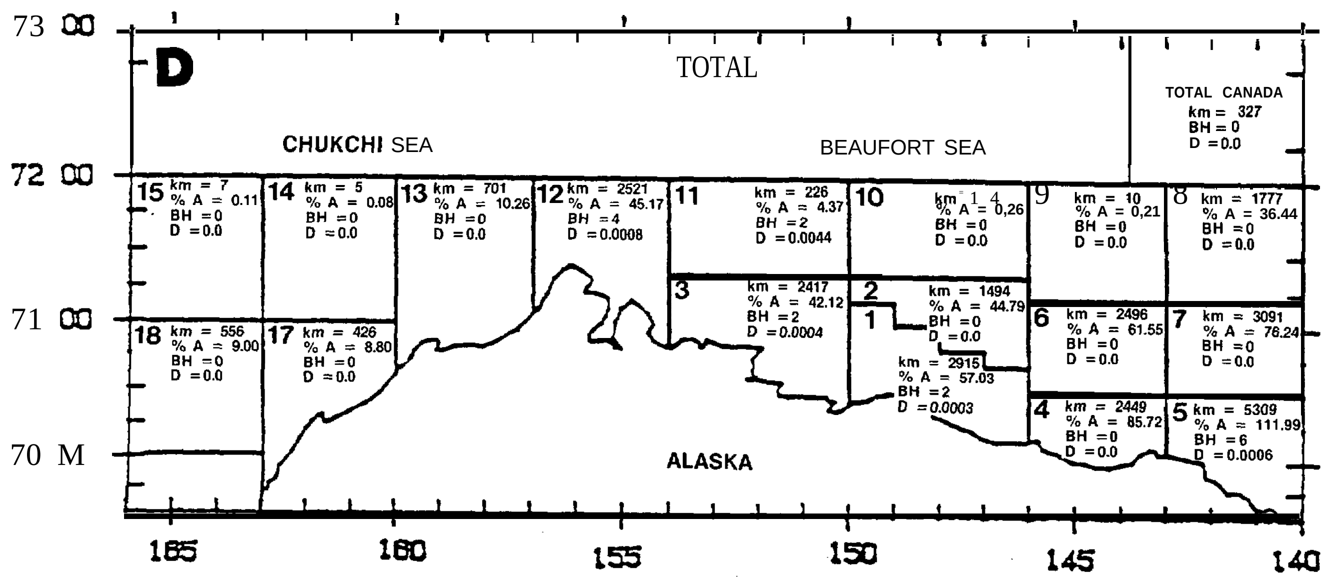


Figure 12 (contd). Bowhead whale density by block, fail 1985: October (C); all sightings (D).

to 20 September (Appendix A: Flights 40 to 42), and only one whale was seen from the secondary aircraft on 19 September (Appendix C: Flight C-6) indicating that whales were not migrating through the Alaskan Beaufort Sea east of 150°W in the days immediately foIlowing the storm.

The observed migration period began on 22 September, when two bowheads were seen from N780 (Appendix A: Flight 43) swimming in a northwesterly direction east of Demarcation Bay, and one whale was seen from N545N (Appendix C: Flight C-7) swimming west approximately 63 km east of Barter Island. The last bowhead seen in the Alaskan Beaufort Sea by this project was at 71° 30.7'N, 1560 47.0'W on 16 October (Appendix A: Flight 62). A few bowheads (n = 7) were seen after 16 October in the Alaskan and Canadian Beaufort Seas by researchers on other aircraft surveying near-shore areas (3. Richardson, personal communication). No bowheads were seen on transect surveys in Canadian waters and in blocks 1, 3, 4, and 5 on 19 and 20 October, nor on surveys of blocks 3, 12, and 13 on 21 and 23 October. The end of the migration period was determined as 20 October after researchers on N780 and two other aircraft (J. Richardson, personal communication) surveyed areas in the western Canadian and Alaskan Beaufort Seas between 1390W and 152°W on two consecutive days and saw no bowheads, indicating that the majority of the migration was probably past.

There were three single-day WPUE peaks in the Alaskan Beaufort Sea during the 22 September to 20 October migration period (Figure 13). The first W PUE peak (4.80) resulted from the sighting of 16 to 19 bowheads, including three calves, that were resting, milling, and swimming slowly approximately 40 km north northeast of Barter Island on 27 September (Appendix A: Flight 48; Appendix C: Flight C-11). A second WPUE peak (5.23) occurred on 6 October (Appendix A: Flight 54) when 26 bowheads, including one group of 18 whales with three calves, were seen between Deadhorse and Smith Bay. The third relatively high WPUE (2.99) was calculated for 13 October when 13 bowheads were seen approximately 55 km north of Deadhorse.

a. Bowhead Sighting Summary From Ten Aerial Survey Crews

Ten aircraft and crews dedicated to surveying for bowhead whales flew over the Chukchi and Alaskan and Canadian Beaufort Seas in August, September, and October 1985 (Table 11). The only aircraft to fly random line transects covering the entire Alaskan Beaufort Sea (140°W to 157°W) was the primary aircraft (N780) from this project. All other aircraft flew either systematic transect surveys or

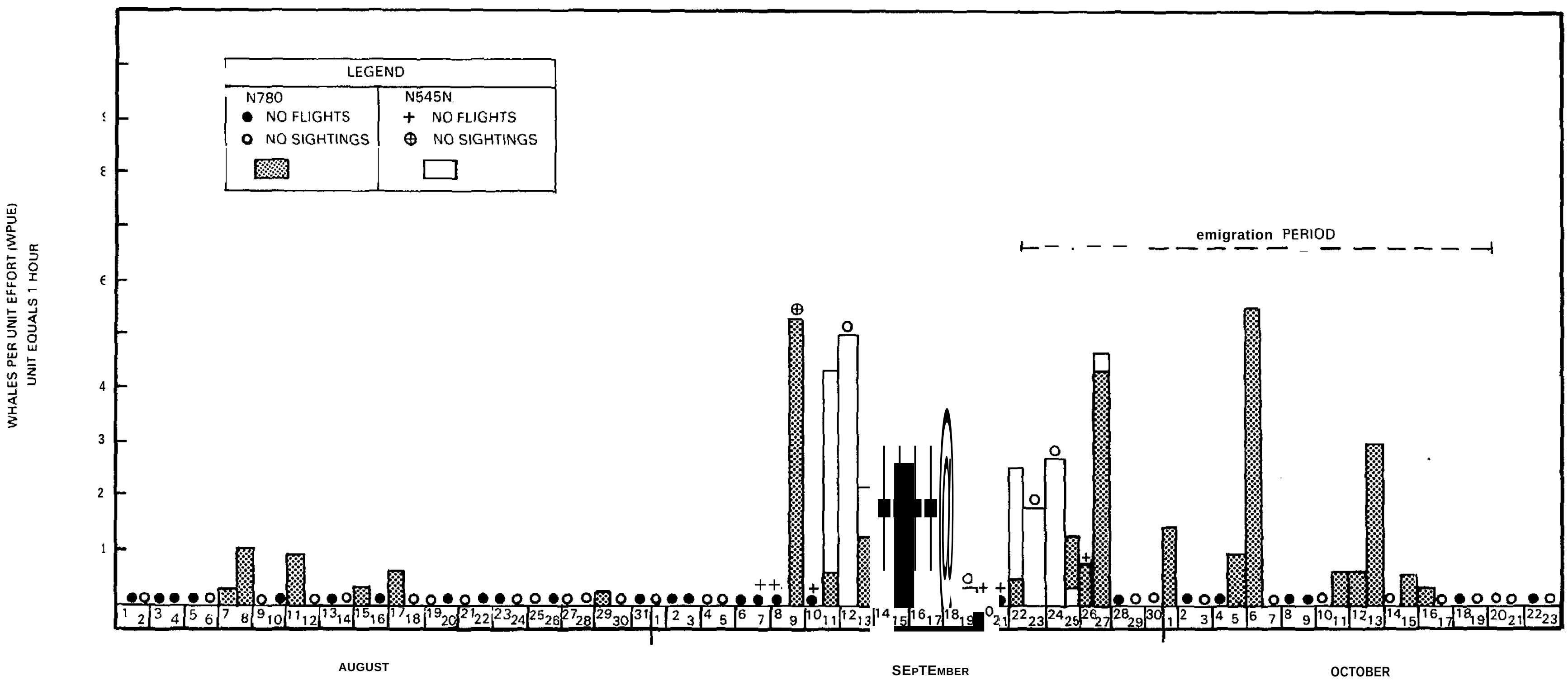


Figure 13. Bowhead whales per unit effort (WPUE) in the Alaskan Beaufort Sea by date, fall 1985.

Table 11. Bimonthly summary of bowhead sightings (number of sightings/number of whales) by ten aircraft and crews surveying the Alaskan Beaufort Sea (ABS), the Canadian Beaufort Sea (CBS) and the Chukchi Sea (CS), August-October 1985

	August		1-15 September		16-30 September			October			Total			
Aircraft	ABS	CBS	ABS	CBS	CS	ABS	CBS	CS	ABS	CBS	CS	ABS	CBS	Total
N7 SO	11/12	0/0	3/6	10/28	0/0	15/30	3/3	3/3	32/57	0/0	3/3	61/105	13/31	77/139
N545N			5/53	0/0		16/53	0/0					19/106	0/0	19/106
*LGL-In/Gov (2 aircraft)	0/0	87/1290	0/0	22/1202								o/0	109/2492	109/2492
ES L	3/4	24/76	4/18	32/55			0/0					7{22	56/131	63/153
LGL-Union			6/10	-		13/13			10/13	-		29/36		29/36
LGL-Shell			0/0	-		5/5			9/18	0/0		14/23	0/0	14/23
LGL-Feeding Study			8/1 02	0/0		25/92	2/5					33/194	2/5	35/199
LGL-Shell (Inuvik)									1/2	26/119		1/2	26/119	27/121
USFWS (Barrow)					4/5	5/8		4/6	0/0	-	8/1 1	5/8		13/19
Total	14/16	111/1366	24/189	64/1 285	4/5	79/201	5/8	7/9	52/90	26/119	11/1 4	169/496	206/2778	386/3288

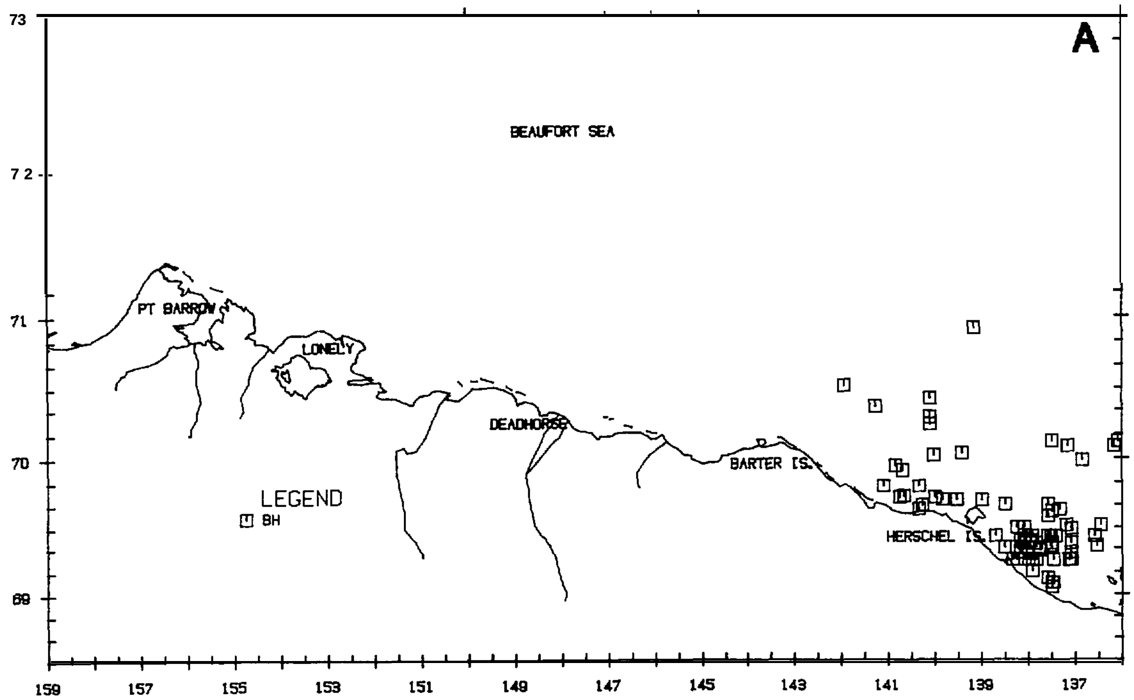
- = no effort reported

* LGL-In/Gov includes the following industry and government agencies: Amerada Hess Corporation, Amoco Production Company, BP Alaska Exploration, Chevron USA, Exxon USA, Shell Western E&P, Standard Alaska Production Company, Tenneco, Texaco, Unocal, Canadian Department of Fisheries and Oceans. Canadian Department of Indian and Northern Affairs. National Marine Fisheries Service, North Slope Borough, U.S. Marine Mammal Commission. Number of whales is estimated. ‘

search surveys north to 720N and between 1440W and 1170W (N545N, Appendix C; LGL-Feeding Study, Richardson et al., 1985c; LGL-Shell (Inuvik), J. Richardson, personal communication; ESL, Environmental Sciences Limited, L. Harwood, personal communication; LGL-In/Gov, G. Miller, personal communication), or fixed-grid systematic surveys near drill sites, one of which extended north to 70°45'N between 144°20'W and 146°50'W (LGL-Union; J. Richardson, personal communication) and the other which extended north to 7 1°N between 147°40'W and 149°30'W (LGL-Shell; S. Johnson, personal communication). One aircraft (USFWS; K. Frost, personal communication) conducting line transect surveys for walrus in the northeastern Chukchi Sea provided incidental bowhead sighting data for that area. Although flight effort and survey rationale varied with each aircraft, an analysis of sighting data from all aircraft was undertaken in order to present the most comprehensive picture of the fall 1985 bowhead migration during the August- October time period.

In August, one aircraft (N780) was dedicated to surveying for bowheads in the Alaskan Beaufort Sea (west of 14 0°W), with three additional aircraft (LGL-In/Gov, two aircraft, and ESL) surveying in the Canadian Beaufort. Numerous bowheads (> 1000) were seen in the Canadian Beaufort (L. Harwood, personal communication; G. Miller, personal communication), but few (n = 16) were seen in the Alaskan Beaufort (Table 11). Bowheads were seen as far east as Amundsen Gulf (7 1°30'N, 119°50'W), but the majority of sightings" in Canada were made north of Kay (69°10'N, 138 °20'W) and Shingle (68°55'N, 137°25'W) Points (Figure 14A). Bowheads in the Alaskan Beaufort Sea were seen approximately 0.5 to 89 km offshore in water 7 to 146 m deep ($\bar{x}$ = 48.4, 38.66 s.d., n = 15). Although systematic surveys were flown west to 150°W (Appendix A: Flights 21 and 31), bowheads were seen only as far west as 1410 55'W (Figure 14A).

In the first half of September, four aircraft and research crews were dedicated to surveying for bowheads primarily in the Alaskan Beaufort Sea, with three additional aircraft (LGL-In/Gov, two aircraft, and ESL) surveying in the Canadian Beaufort. Bowheads were seen in Canada as far east as Franklin Bay (70°N, 126°20'W) and again in large numbers (> 1000) north of Kay and Shingle Points (L. Harwood, personal communication; G. Miller, personal communication), and there were more bowhead sightings (n = 189) in the Alaskan Beaufort Sea (Figure 14B). Data from the four aircraft surveying in Alaskan waters indicate that bowheads were seen approximately 0.5 to 120 km offshore in water 7 to 1850 m deep ($\bar{x}$ = 81.7, 334.2 s.d., n = 30). Whales were seen as far west



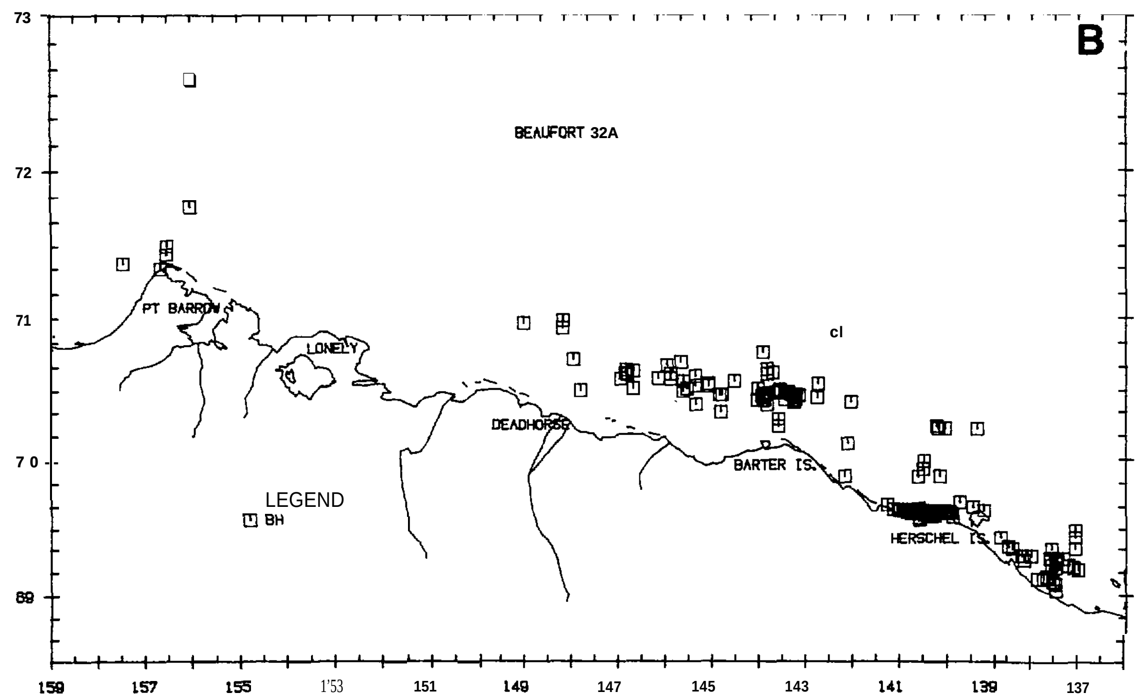
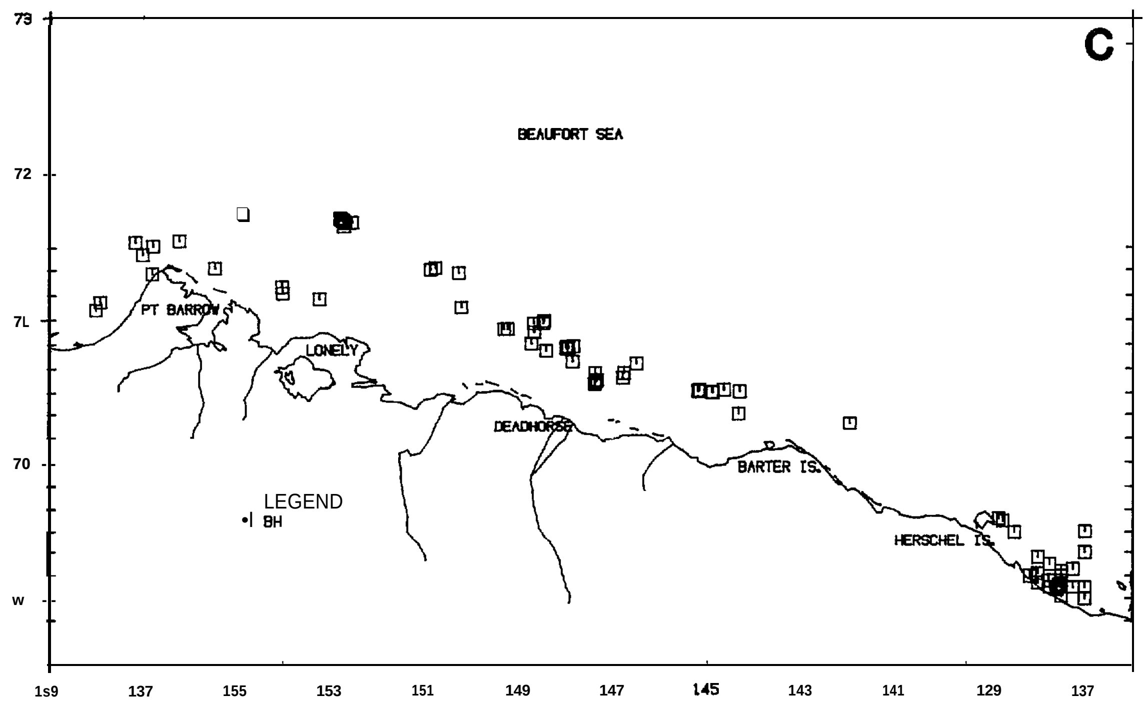


Figure 14. Distribution of 325 sightings of 3008 bowhead whales from the combined data of ten survey aircraft, August-October 1985: 78 sightings of 1187 whales, August (A); 165 sightings of 1607 whales, September (B); (contd next page)



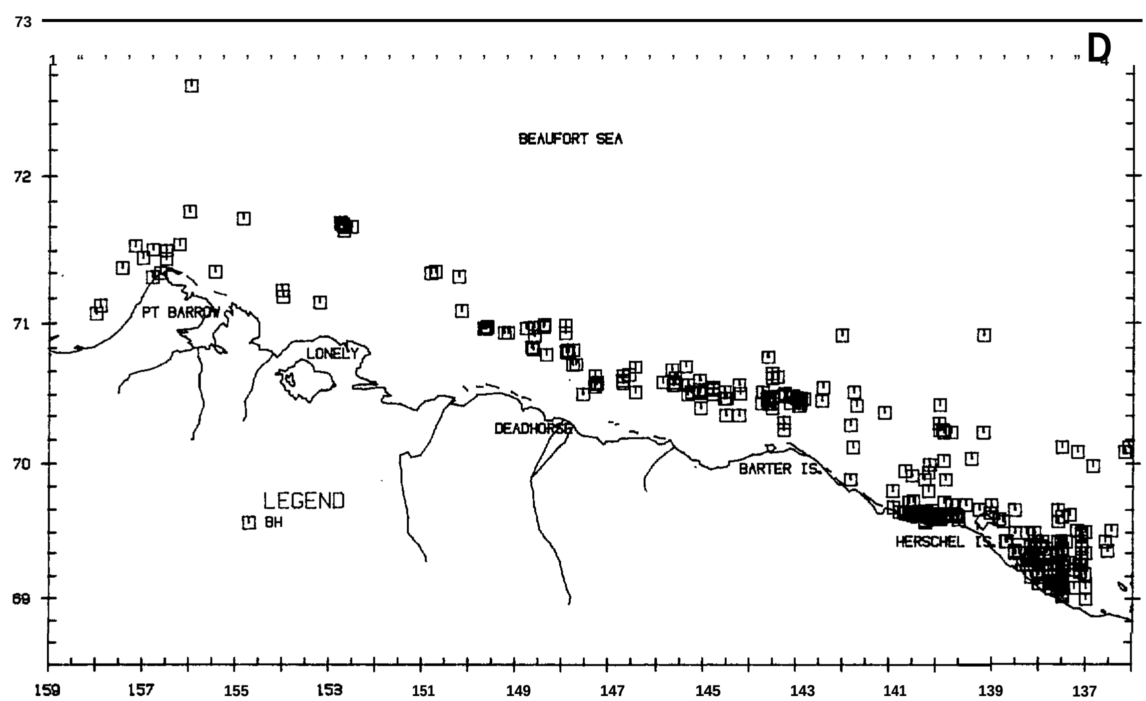


Figure 14 (contd). 82 sightings of 214 whales, October (C); all sightings (D). Note: 61 sightings of 280 whales were not plotted because they were east of 136°W or west of 159°W.

as 146 °48'W (Figure 14B), although systematic surveys were flown west to 1500W (Appendix A: Flight 39). Aggregations of 10 to 25 whales were consistently seen east of Demarcation Bay along Komakuk Beach by researchers on four aircraft (Appendix A: Flights 36 and 37; Appendix C: Flights C-2, C-3 and C-4; Richardson et al., 1985c; L. Harwood, personal communication).

In the latter half of September, there were no crews surveying exclusively in the Canadian Beaufort, but five aircraft and crews were surveying in the Alaskan Beaufort and bowheads were seen between 1400W and 149019'W from 0.5 to 78 km offshore (Figure 14 B), in water 7 to 387 m deep ($\bar{x}$ = 47.8, 62.6 s.d., n = 79). Three bowheads were seen swimming in a westerly direction in the Alaskan Beaufort Sea on 20 September at 70°32'N, 145012'W (n = 2; J. Richardson, personal communication) and 70°43'N,147°48'W (n = 1; S. Johnson, personal communication). These sightings, together with sightings on 22 September (Appendix A: Flight 43), were the first westward migrating bowheads seen since 17 August. As a result, the NMFS officially recognized the onset of the bowhead migration as 24 September (B. Morris, personal communication). No bowheads were seen in the western Alaskan Beaufort Sea (between 149°30'W and 157°W), although transect surveys were flown west to 157°W (Appendix A: Flight 45). Surveys in Canada were flown only between 130°30'W and 131°30'W (L. Harwood, personal communication) and there were no surveys of the western Canadian Beaufort (1360W to 139°) during the latter part of September. Therefore, the presence or absence of bowheads north of Kay and Shingle Points during this time period cannot be verified. Research personnel flying walrus surveys in the far western Alaskan Beaufort (1560W to 157°W) and northeastern Chukchi Seas between 18 and 30 September saw 13 bowheads between 7 and 140 km offshore (K. Frost, personal communication; Figure 14B and 15). This indicated that either a portion of the bowhead population had migrated from the Canadian Beaufort through the Alaskan Beaufort by mid to late September, or that a segment of the western Arctic stock of bowheads may have never completed a migration to the eastern Canadian Beaufort Sea and instead remained in the Chukchi or Alaskan Beaufort Sea throughout the summer and fall, as suggested by Ljungblad et al. (1983). Bowheads have been sighted in the Chukchi Sea in August and September (Bogoslovskaya et al., 1981; Braham et al., 1984; Moore et al., 1986a; Ray and Wartzok, 1980) and the USFWS sightings may have been of bowheads that were early migrants from only as far as the Alaskan Beaufort Sea.

In October, surveys continued to be flown over the Alaskan Beaufort by three aircraft, and an additional aircraft and crew flew surveys in the western Canadian Beaufort Sea from 7 to 18 October. Sightings were generally farther to the west (Figure 14C), and nine bowheads were sighted in the Chukchi Sea (Appendix A: Flights 58 and 61; K. Frost, personal communication; Figure 15). The aggregation of whales consistently seen east of Demarcation Bay along Komakuk Beach in September was not seen in October, although there were numerous sightings of bowheads (n = 25 to 30) in Canadian waters, particularly between Kay and Shingle Points (J. Richardson, personal communication; Figure 14C). Bowheads have been seen in October in the western Canadian Beaufort Sea in past years (Ljungblad et al., 1985), although not in such substantial numbers. Most October sightings in the Alaskan Beaufort Sea were west of 1440W, between 18 and 92 km offshore and in water 4 to 595 m deep ($\bar{x}$ = 49.9, 85.5 s.d., n = 78). There were no sightings of bowheads made by any aircraft in the Alaskan Beaufort Sea after 17 October, nor in the Canadian Beaufort Sea after 18 October. Extensive survey effort between 139°W and 152°W on 19 and 20 October by three aircraft produced no sightings of bowheads, indicating the majority of the migration had passed.

Despite differences in data-collection techniques and project rationale, the combined sighting data base indicated that the observed migration route across the Alaskan Beaufort Sea was centered roughly shoreward of the continental shelf break generally along the 29 m isobath (see Figure 14D). Combined sighting rates were relatively low in August and through early September, particularly in the Alaskan Beaufort Sea, suggesting that the fall 1985 bowhead migration was somewhat abbreviated and had a later peak period than in some other years (1982, 1983). The 1985 migration was most similar to 1979 when there were peak daily WPUE and peak 5-day SPUE in mid-October (Ljungblad et al., 1985; see Figure 27).

Most whales seen from the primary aircraft (75%, n = 104) were found in shallow (0-50 m) depths throughout the fall (Table 12). Twenty-five percent (n = 35) were found in transitional (51 to 2,000 m) depths and no bowheads were seen in deep water (over 2,000 m). Mean depth at bowhead sightings was 56 m, with the deepest sighting (595 m) that of a group of 18 whales that appeared to be feeding in waters north of Harrison Bay on 6 October (Appendix A: Flight 54).

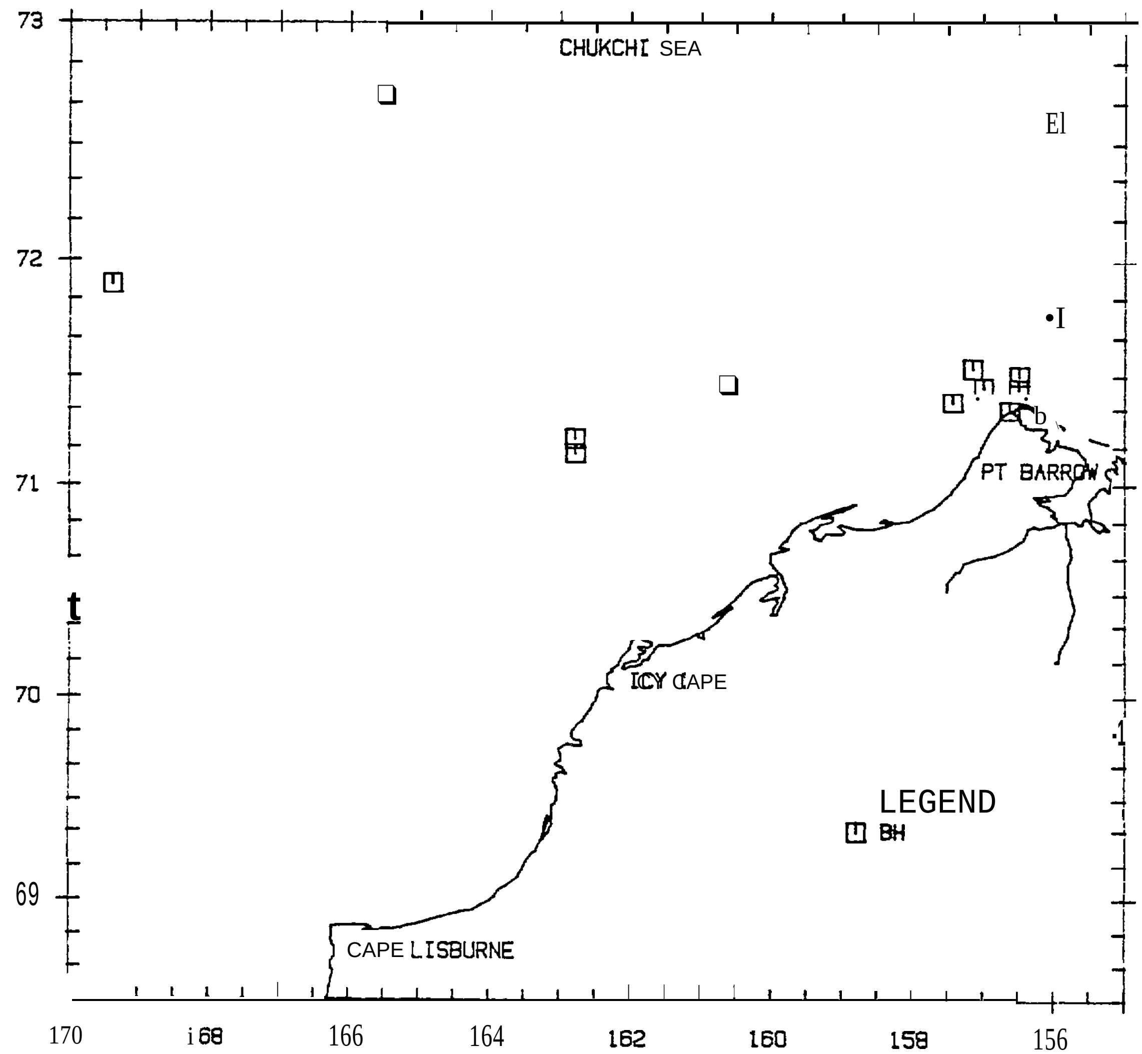


Figure 15. Distribution of 13 USFWS sightings of 19 bowheads in the western Beaufort and northeastern Chukchi Sea, 18 September - 1 October, 1985. All sightings made by observers flying walrus surveys for the USFWS (K. Frost, personal communication).

Bowheads were usually seen in light ice conditions (O to 30% coverage; 64%, n = 88), or heavy ice conditions (71 to 99% coverage; 33%, n . 47) (Table 13). Bowheads seen in August (9%, n . 12), when ice coverage was heavy in all areas of the Alaskan Beaufort Sea, were in relatively ice free water (0-5%) north and east of Herschel Island. Most whales (61 %, n = 41) seen in September were in open ($\leq$1 % ice) water with the remainder seen in 21 to 40 percent coverage (33%, n = 22) and 81 to 90 percent coverage (6%, n = 4). Bowheads seen in October were mainly (71 %, n = 43) in >71 percent ice as most of the Beaufort Sea was frozen over.

Table 12. Bimonthly summary of depths at bowhead sightings, fall 1985.

	1-15 Aug No.(%)	16-31 Aug No.(%)	1-15 Sep No.(%)	16-30 Sep No.(%)	1-23 Ott No.(%)	Total No.(%)
Shallow (0-50 m)	4(44)	2(67)	34(100)	31(94)	33(55)	104(75)
Transition (51-2,000 m)	5(56)	1(33)	o	2(6)	27(45)	35(25)
Deep (over 2,000 m)	o	0	0	0	0	0
TOTAL	9	3	34	33	60	139

Table 13. Number and percent of bowheads found in each ice coverage class, fall 1985.

Ice Coverage (%)	1-15 Aug No.(%)	16-31 Aug No.(%)	1-15 Sep No.(%)	16-30 Sep No.(%)	1-23 Ott No.(%)	Total No.(%)
0-10	9 (loo)	3 (loo)	34 (loo)	7 (21)	15 (25)	68 (49)
11-20	o	0	0	0	1 (2)	1 (1)
21-30	0	0	0	19 (58)	O	19 (14)
31-40	o	0	0	3 (9)	o	3 (2)
41-50	0	0	0	0	0	0
51-60	0	0	0	0	0	0
61-70	0	0	0	0	1 (2)	1 (1)
71-80	o	0	0	0	29 (48)	29 (21)
81-90	o	0	0	4 (12)	1 (2)	5 (3)
91-99	o	0	0	0	13 (21)	13 (9)
TOTAL	9	3	34	33	60	139

b. Temporal Distribution of Bowheads in Relation to OCS Drilling Activities

Five OCS drill sites were active at various times during fall 1985 (Table 14). Activity at and near these sites included actual drilling procedures (drilling, casing, cementing, logging, testing) as well as daily helicopter and vessel (tugboats and icebreakers) support efforts. Very little actual drilling took place between August and October; the majority of activity involved support efforts by helicopters and vessels. AH drill sites were located between 143°W and 153°W. Bimonthly bowhead sightings collected from all research crews conducting studies in the Alaskan Beaufort Sea were plotted within this 10o window for September and October to exhibit the spatial and temporal distribution of whales in relation to these OCS drilling activities (Figure 16A-C). Whale sightings near drill sites were not plotted in August because all sightings were east of 1430W.

The concrete island drilling structure (CIDS) was anchored at Orion Prospect near Point Lonely and preparatory activity was taking place there as well as on Sandpiper Island by 1 August. The drillship Canmar Explorer II arrived at Hammerhead Prospect on 6 August. All bowheads seen in August were well to the east of these sites; the closest bowhead sighting was of one whale 166 km east of Hammerhead Prospect (Appendix A: Flight 22).

The same three sites remained active between 1 and 15 September. As in August, Orion Prospect and Sandpiper Island had only support activities taking place, but Hammerhead Prospect carried out logging, casing, cementing, and testing procedures (Table 14). Nine sightings of 16 bowheads were made by crews aboard two survey aircraft between 143°W and 153°W (Figure 16A). Bowheads were sighted 18 to 77 km from Hammerhead Prospect (Appendix A: Flights 37 and 39; J. Richardson, personal communication). All whales were either northeast or northwest of the drilling site (Figure 16A); no bowheads were seen south of the drillship between it and the shoreline. All bowhead sightings during this period were well east of Sandpiper Island and Orion Prospect; the closest whales to these sites were 85 and 197 km distant, respectively (J. Richardson, personal communication). In late September, four drill sites were active, including Orion Prospect, Sandpiper Island, Hammerhead Prospect and Corona Prospect, to which the Canmar Explorer II drillship was moved after work was completed at Hammerhead Prospect. Orion and Sandpiper again had only support activity taking place, but Hammerhead was drilling between 22 and 24 September and Corona was drilling between 25 and 28 September. Sixty-five sightings of 161 bowheads were

Table 14. Summary of five OCS drilling site positions, periods of activity, and closest bowhead whale sighting, fall 1985.

Site Identif ier	Type of drilling site	Position (Lat N, Long W)	Period of Drilling Activity	Total Period of Activity (including helicopter and vessel support)	Closest Bowhead Sighting (date and distance)
Orion Prospect	concrete island drilling structure (CIDS)	70057.2 152003.8	began drilling in Nov.	on site 1 Aug	6 Ott 59.5 km NE
Sandpiper Island	artificial island	70°35.4 149°05.5	began drilling 13 Ott	on site 1 Aug	6 Ott 32.6 km NNE
Hammerhead Prospect	drill ship-Canmar Explorer H	70°21.6 146021.3	8-17 Aug; 22 Aug -16 Sept; 22 Sept -24 Sept	6 Aug -24 Sept	11 Sept 18.6 km NW
Corona Prospect	drill ship-Canmar Explorer H	70°18.9, 144049.7	25-23 Sept; 3-4 Ott	25 Sept -20 Ott	23 Sept 16 km NNE
Erik Prospect	drillship-Canmar Explorer II	70°20.7 143058.8	5 Ott; 13-14 Ott	5-14 Ott	7 Ott 14.5 km W

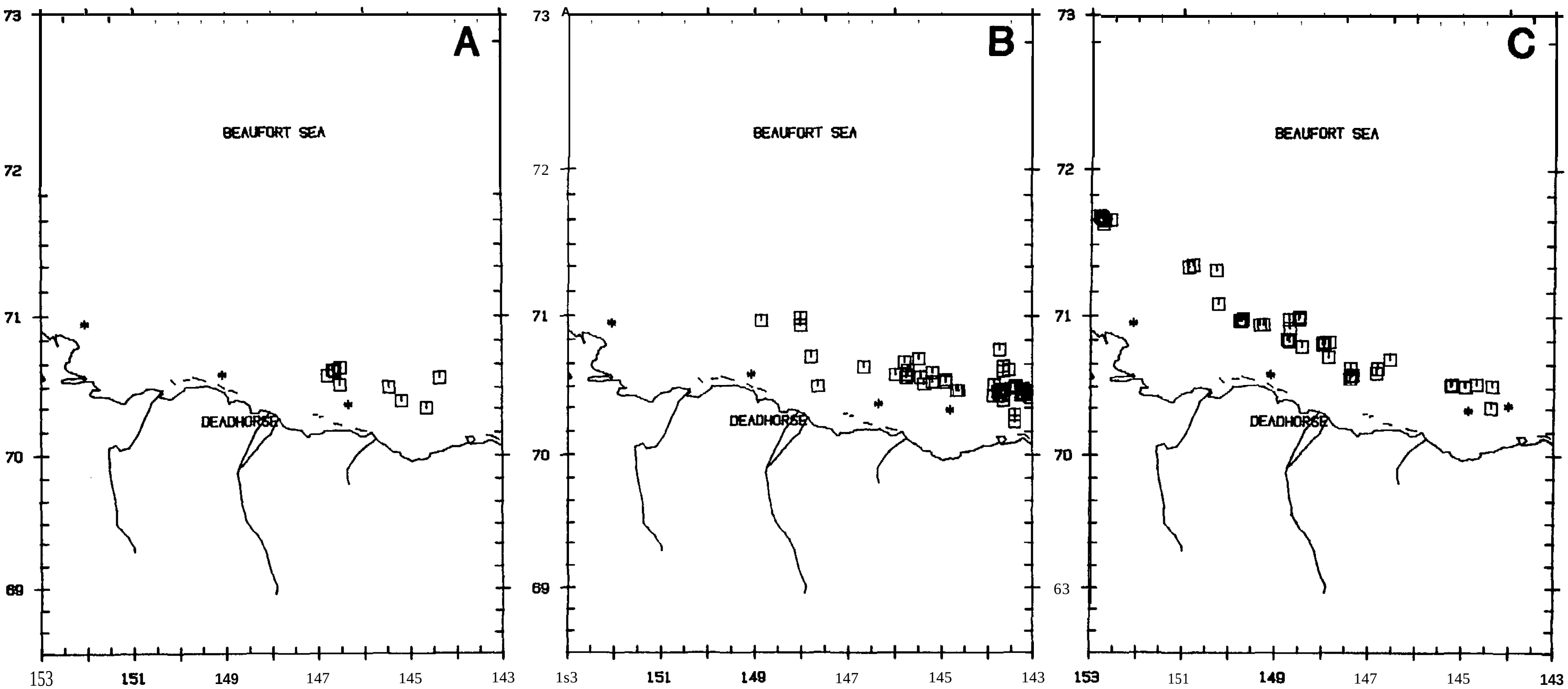


Figure 16. Distribution of 12.1 sightings of 261 bowhead near five OCS drilling sites (*), fall 1985: 9 sightings of 16 bowheads, 1-15 September (A); 65 sightings of 161 bowheads, 16-30 September (B); 47 sightings of 84 bowheads, 1-20 October (C). Data represents the combined sightings of five survey aircraft. Bowheads were not plotted for August because all sightings were east of 143°W. Drilling sites were plotted only when operative; see Table 14 for dates of operation.

made in the area between 1430W and 153°W by crews aboard five survey aircraft between 16 and 30 September (Figure 16B). Bowheads were seen 16 to 68 km north and east of Corona Prospect (Appendix A: Flights 46 to 48; Appendix C: Flight C- 11; J. Richardson, personal communication), and 28.5 to 49 km northeast of Hammerhead (Appendix A: Flight 47; J. Richardson, personal communication). Bowheads were also sighted 43 to 59 km north of Sandpiper Island (S. Johnson, personal communication), but none were seen near Orion Prospect.

In October, support activities continued to take place at Orion Prospect, and Sandpiper Island began to drill on 13 October. The Canmar Explorer II drillship divided its time between Corona Prospect and Erik Prospect, only 32 km apart. Forty-seven sightings of 84 bowheads were made by crews aboard three survey aircraft between 1430W and 153° in October (Figure 16C). Bowheads were generally seen north of all drill sites. Closest whale sightings were 59.5 km from Orion Prospect (Appendix A: Flight 54), 32 to 50 km directly north of Sandpiper Island (Appendix A: Flight 53; S. Johnson personal communication), and 14 to 28 km from both Erik and Corona Prospects, including one whale seen directly between the two sites on 7 October (3. Richardson, personal communication[3]; Figure 16C). There was no actual drilling activity taking place at either site on that day due to ice conditions and the whale migration, but vessel and helicopter support activities were going on.

The effects of underwater noise generated by industrial operations on bowheads may be manifested relatively far from their source because sound travels very efficiently in water (Urick, 1983). The underwater sound fields around offshore drilling sites are comprised of the combined noise generated by support vessels, helicopter and fixed wing aircraft overflights, drilling activities, and occasionally icebreakers (Gales, 1982; Greene, 1985; Moore et al., 1984). Peak noise levels from these industrial sources are generally low frequency (< 500 Hz), and are comprised of a variety of spectral components that are described as either a) broadband "rumbling" sounds that are not concentrated at any particular frequency, or b) narrowband tonal sounds that are concentrated at frequencies associated with rates of machinery operation events (e.g., propeller rotation rate). Overall, the industrial noise associated with shallow water drilling sites, such as those listed in Table 14, is roughly 25 dB above median ambient noise level at 1 km radius and 10 dB above median ambient level at 10 km radius (Greene, 1985). As a result, bowheads seen closest (14.5 to 18.6 km) to the three easternmost drilling sites could probably detect underwater noise associated with the ongoing industrial activities. Because bowhead distribution near these sites was not appreciably different from that of prior years, it does not appear that industrial noise affected whale movements.

Behavior and Sound Production

Forty-four percent (n = 61) of all whales seen were either swimming or diving (Table 15). Bowhead swimming direction was not significantly clustered around a mean heading in August (Figure 17). In September, headings were significantly clustered around a mean of 286°T, and in October there was significant clustering around a mean heading of 276°T, for a total combined heading of 2790 for whales seen in the Beaufort Sea. In the Chukchi Sea in October, bowhead swim direction (n = 2) was not significantly clustered around any mean heading. Bowheads not migrating were resting (11%, n = 15), feeding (25%, n = 35), milling (7%, n = 9), part of cow-calf association (9%, n = 12) or displaying (5%, n = 7). One solitary calf was seen resting at the surface without an adult (Appendix A: Flight 17).

Feeding bowheads were seen on two occasions. The first group, of 23 to 25 adults, was seen on 9 September (Appendix A: Flight 36) within 0.5 km of shore between 139°45'W and 140°41'W. The second feeding group was seen on 6 October (Appendix A: Flight 54) at 71°20'N, 150°47'W and contained 18 to 20 individuals, including three calves that were each closely associated with an adult. This group was located near the shelf break north of Harrison Bay and was in 80 percent ice. Milling, repeated dives and defecation were among the behaviors exhibited by each group, and mud and sediment were evident on the surface.

Two bowheads, among a group of four westerly swimming whales, were seen breaching on 5 October (Appendix A: Flight 53). Both whales were swimming when initially sighted and then began series of breaches. The two whales accompanying the breaching whales continued swimming with no apparent change in speed or direction. Bowheads were seen tail slapping twice in August and twice in September, and one whale was observed rolling (Appendix A: Flight 48).

Most bowheads (67%, n = 93) were swimming at slow (<2 km/hr) to medium (2 to 4 km/hr) speeds and none were observed swimming fast (>4 km/hr) (Table 16). Thirty-one percent (n = 43) were still.

Table 15. Bimonthly summary of bowhead behavior, fall 1985.

	1-15 Aug No.(%)	16-31 Aug No.(%)	1-15 Sep No.(%)	16-30 Sep No.(%)	1-23 Ott No.(%)	Total No.(%)
MIGRATORY						
Swim	5(56)	3(100)	3(9)	.1 7(52)	30(50)	58(42)
Dive	0	0	0	2(6)	1(2)	3(2)
SOCIAL						
Rest	2(22)	0	2(6)	5(15)	6(10)	15(11)
Feed	0	0	23(68)	0	12(20)	35(25)
Mill	0	0	6(18)	2(6)	1(2)	9(6)
Cow-Calf	0	0	0	6(18)	6(10)	12(9)
Display	2(22)	0	0	1(3)	4(6)	7(5)
TOTAL	9	3	34	33	60	139

Table 16. Bimonthly summary of bowhead swimming speeds, fall 1985.

	1-15 Aug No.(%)	16-31 Aug No.(%)	1-15 Sep No.(%)	16-30 Sep No.(%)	1-24 Oct No.(%)	Total No.(%)
Still 0 km/hr	3(33)	--	3(9)	9(27)	28(47)	43(31)
slow < 2 km/hr	5(56)	3(100)	30(88)	20(61)	19(32)	77(55)
Medium 2-4 km/hr	--	--	1(3)	4(1 2)	11(18)	16(12)
Fast >4 km/hr	--	--	--	--	--	0(0)
Unknown	1(11)	--	--	--	2(3)	3(2)
TOTAL	9	3	34	33	60	139

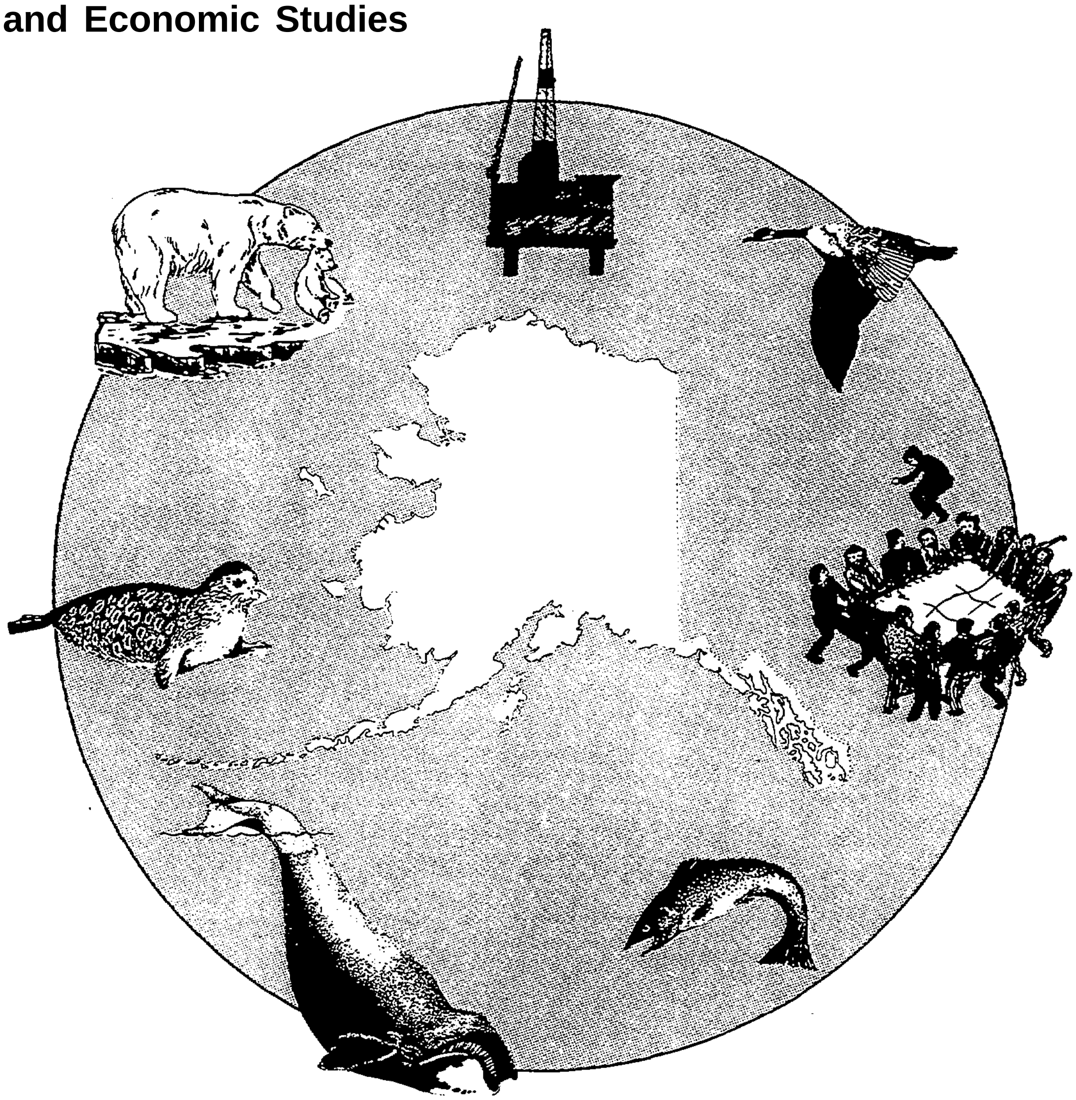
OCS Study
MMS 92-0052

Social Indicators Study of Alaskan Coastal Villages

IV. Postspill Key Informant Summaries

Schedule C Communities, Part 1
(Cordova, Tatitlek, Valdez)

Social and Economic Studies



U.S. Department of the Interior
MMS Minerals Management Service
Alaska Outer Continental Shelf Region

OCS Study
· MMS 92-0052

Technical Report No. 155

Contract No. 14-12-0001-30300

Social Indicators Study of Alaskan Coastal Villages

IV. PostspiLl Key Informant Summaries

Schedule C Communities, Part 1
(Cordova, Tatitlek, Valdez)

Submitted to:

U.S. Department of the Interior
Minerals Management Service
Alaska OCS Region
Anchorage, Alaska

Human Relations Area Files

February 1993

Alaska OCS Environmental Studies Program

Social Indicators Study of Alaskan Coastal Villages
IV. Postspill Key Informant Summaries. Schedule C Communities, Part 1.

Human Relations Area Files
New Haven, Connecticut

Prepared by Joanna Endter-Wada, Jon Hofmeister, Rachel Mason, Steven McNabb, Eric Morrison, Stephanie Reynolds, Edward Robbins, Lynn Robbins, and Curtiss Takada Rooks. Joseph Jorgensen was the principal investigator and project manager. The authors appreciate the efforts of the Minerals Management Service technical editors in Anchorage who helped edit this report.

February 1993

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EFFECTS OF THE 1989 EXXON VALDEZ OIL SPILL ON CORDOVA

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PERIPHERY NATIVE COMMUNITIES

TATITLEK

Table of Contexts

Acronyms

AANHs	Alaska Area Native Health Service
ABE	Adult Basic Education
ACES	Alaska Community Engineering Services
ADCRA	Alaska Department of Community and Regional Affairs
ADF&G	Alaska Department of Fish and Game
ADH&SS	Alaska Department of Health and Social Services
ADoc	Alaska Department of Corrections
ADOT&PF	Alaska Department of Transportation and Public Facilities
ADOL	Alaska Department of Labor
AEwc	Alaska Eskimo Whaling Commission
AFN	Alaska Federation of Natives
AMSA's	Areas Meriting Special Attention
ANA	Administration for Native Americans
ANCSA	Alaska Native Claim Settlement Act
ANILCA	Alaska National Interest Lands Conservation Act
ANWR	Alaska National Wildlife Refuge
AOSIS	Alaska Outer Continental Shelf Social Indicators Study
ASHA	Alaska State Housing Authority
ASRC	Arctic Slope Regional Corporation
AVCP	Association of Village Council Presidents
AWIC	Arctic Women in Crisis
BBAHC	Bristol Bay Area Health Corporation
BBHA	Bristol Bay Housing Authority
BBNA	Bristol Bay Native Association
BBNC	Bristol Bay Native Corporation
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BSNA	Bering Straits Native Association
BSNC	Bering Straits Native Corporation
BSSD	Bering Strait School District
BVNC	Bethel Village Native Corporation
ca.	circa
CETA	Comprehensive Employment and Training Act
CHA	Community Health Aide
CIP	Capital Improvements Program
CIRT	Crisis Intervention Response Team
CMC	Coastal Management Corporation
CPI	Consumer Price Index

Acronyms (continued)

CRSA	Coastal Resource Service Area
DOL	U.S. Department of Labor
DWI	driving while intoxicated
EDA	Economic Development Administration
EIS	Environmental Impact Statement
EMS	Emergency Medical Services
F.I.R.E.	Finance, Insurance, and Real Estate
FAA	Federal Aviation Administration
FCZ	Fisheries Conservation Zone
FTE	Full-time equivalent
FWS	U.S. Fish and Wildlife Service
FY	Fiscal Year
HEss	Health, Education, and Social Services (Task Force)
HS	High School
HUD	Housing and Urban Development (U.S.)
ICAS	Inupiat Community of the Arctic Slope
ICWA	Indian Child Welfare Act
IHs	Indian Health Service
IRA	Indian Reorganization Act
ISER	Institute of Social and Economic Research
KANA	Kodiak Area Native Association
KCA	Kodiak Council on Alcoholism
KCC	Kuskokwim Community College
KDc	Kikiktagruk Development Corporation
KI	Key Informant
KIC	Kikiktagruk Inupiat Corporation
KTC	Kodiak Tribal Council
KVSN	Kodiak Village Services Network
MMS	Minerals Management Service
NAB	Northwest Arctic Borough
NANA	Northwest Alaska Native Association Corporation
NOL's	Net Operating Losses
NSB	North Slope Borough
NSHC	Norton Sound Health Corporation
NWASD	Northwest Arctic School District
NWTC	Northwest Tribal Council
Ocs	Outer Continental Shelf
OED	Office of Economic Development (U.S.)
OEDP	Overall Economic Development Plan
P.L.	Public Law
PHS	Public Health Service

Acronyms (continued)

QI	Questionnaire Informant
REAA	Rural Education Attendance Area
RELI	Resident Employment and Living Improvements (program)
S.A.F.E.	Safe and Fear-Free Environment
SIC	Standard Industrial Classification
Sos	State-Operated School
SRC	Social Rehabilitation Center
SWAMC	Southwest Alaska Municipal Conference
U s .	United States
U.S.S.R.	Union of Soviet Socialist Republics
UIC	Unemployment Insurance Compensation
UIC	Ukpeagvik Inupiat Corporation
USCG	U.S. Coast Guard
USDOI	United States Department of the Interior
VEco	VEco, Inc.
VPso	Village Public Safety Officer
XCED	Cross-Cultural Education Development (program)
YKHc	Yukon-Kuskokwim Health Corporation

Glossary

Affines	Kinwhoare related through marriage; "in-laws" without a blood-relationship.
Avunculate	A privileged relationship with an uncle (often including residence in an uncle's home).
Bilateral	A non-lineal kinship system in which the families of the mother and father are not differentiated, nor are the children of brothers and sisters.
Cohort	In social science terminology, a group of persons who comprise a distinct sample defined by properties such as age.
Collaterals	Siblings of core members of a kinship group (such as a nuclear family) and children of one's own siblings.
Consanguine	Kin who are related by blood (in contrast to affines).
Deme	An intermarrying population that forms a sociopolitical unit.
Dendrogram	A "tree diagram" that depicts relative degrees of relatedness and distance.
Emit	Refers to facts that are defined in terms of their cultural classifications.
Endogamy	Intermarriage within one's own bounded social group.
Etic	Refers to objective facts whose reality is independent of cultural classifications.
Exogamy	Marriage outside one's own bounded social group.

Glottochronology	**A** technique for dating divergence of languages or dialects, based on rates of retention of common words.
Kashim	An Eskimo mens' house, usually used also for ceremonial purposes; this term is associated with **Yupik** societies (the **Iñupiaq** variant **is** usually rendered as **qargi).**
Kindred	**A** group of persons related to a common ego in a cognatic descent system such persons are not all related to one another inasmuch as they are defined in terms of their relationship to a single person (i.e., such a system is ego-focused as opposed to ancestor-focused systems).
Matrilineal	A **unilineal** descent (kinship) system that defines relatedness and group membership by common descent through females.
Matrilocal	Post-marriage residence with or close to a woman's mother's kin.
Neolocal	Unrestricted post-marriage residence (i.e., spouses may reside where they choose).
Otitis media	Inflammation of the middle ear.
Patrician	A corporate descent group, usually named, often consisting of several lineages and jointly controlling property and/or privileges, **defined** by common descent through males.
Patrideme	An **intermarrying** population that forms a sociopolitical unit organized around **patrilineal kin** groups.
Patrilineal	A **unilineal** descent (kinship) system that defines relatedness and group membership by common descent through males.

Glossary (continued)

Patrilocal	**Postmarriage** residence **with** or **close** to a man's father's kin.
Sodality	**An association or society** (note: society inlay or generic terms, not society in social science terms).
Syncretic	Refers to the merging or fusion of differing concepts, principles, or philosophies.
Virilocal	**Postmarriage** residence with or close to husband's kin.

Postspill Key Informant Summaries

Introduction

Steven McNabb

INTRODUCTION

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[1]This table of contents (TOC) reflects only theKeyInformant (KI) summaries for Schedule C communities in Part 1. There is a separate TOC as a guide to the KI summaries of the other Schedule C communities in Part 2 (Kenai, Seldovia, Tyonek, Kodiak City, Karluk, Old Harbor, and Chignik Bay).

Introduction

I. OVERVIEW

I.A. General

Two years before the infamous foundering of the Exxon Valdez on Bligh Reef, the Minerals Management Service contracted a large social indicators project among 30 coastal Alaskan villages from Kodiak Island in the south to Kaktovik on the arctic coast. The research team created a sampling design for this large study with the sole intention of providing valid analyses of the consequences of exogenous factors, including oil-related factors, on village economies, societies, and households. The design is complex, embracing several data sets drawn from several samples interviewed over four research waves. The design is simplified here for quick comprehension.[1]

In 1988, while conducting the second year of field research pursuant to the original research design, we made our first research visits below the Alaska Peninsula, conducting interviews in the villages of Kodiak City and Old Harbor. We returned to those villages again in the winter of 1989, completing our second wave of research there only days before the North Slope crude oil began spewing from the ruptured hull of the Exxon Valdez. The oil slick and blobs of oil began washing up on Kodiak Island beaches only 3 weeks after the foundering. None of the Prince William Sound, Cook Inlet, and Alaska Peninsula villages directly affected by the oil, other than Kodiak City and Old Harbor, were included in our 30-village sample.

On an emergency basis, the Minerals Management Service moved as fast as possible to secure funds to study the affected villages. As a consequence, our research assignments increased in size and became more complex. Our research design was modified and our inquiry expanded to determine the consequences of the spill to the residents of the affected villages.(Endnote 1)

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[1]The research designs for the original Social Indicators project begun in 1987 and for the Exxon Valdez spill area project begun in 1989 are explicated fully in Social Indicators Project II. Research Methodology Design, Sampling, Reliability, and Validity (1993), and Social Indicators Project V. Research Methodology Design, Sampling, Reliability, and Validity for Villages Affected by the Exxon Valdez Oil Spill (1993).

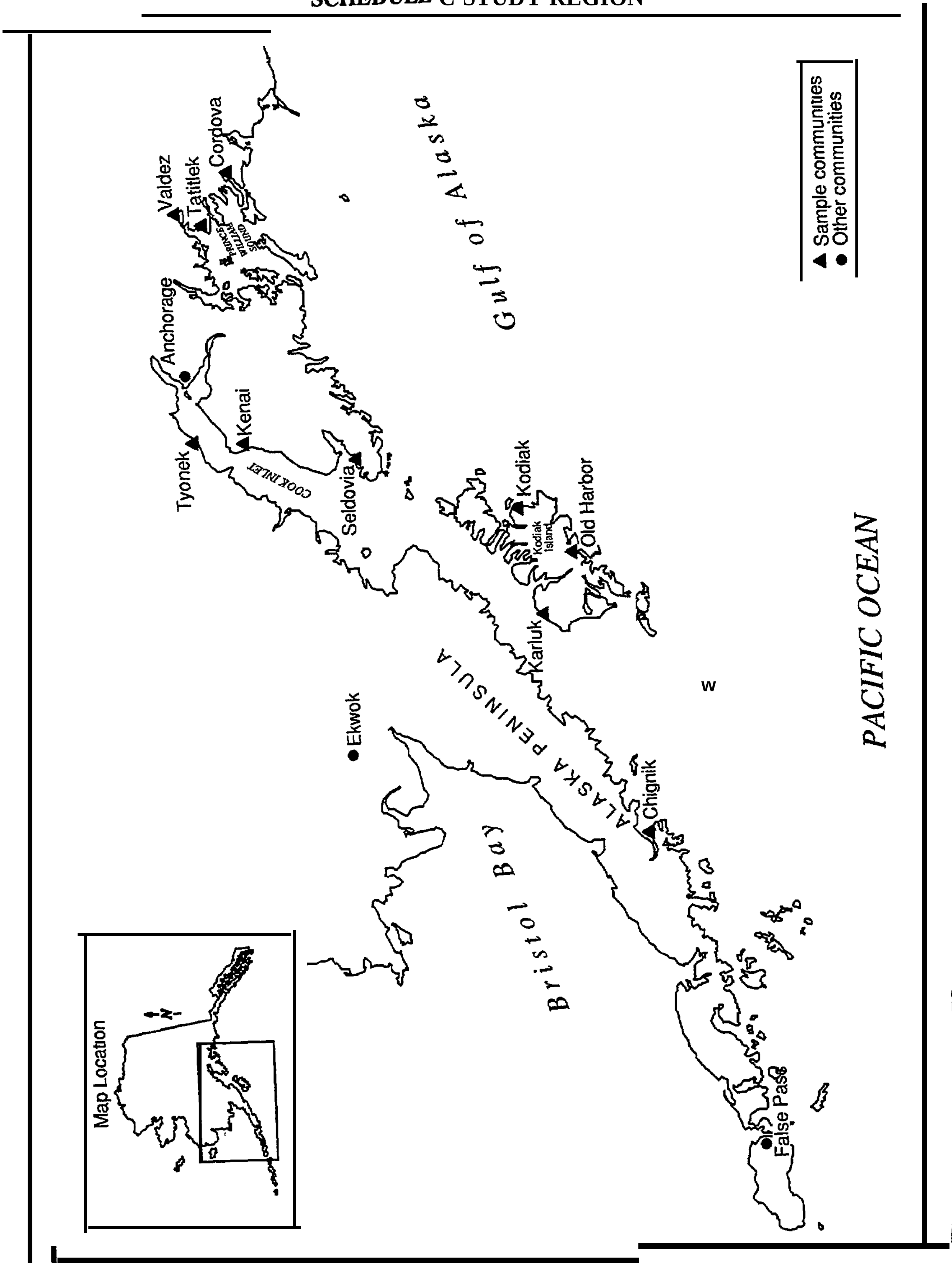
Although we had been to the Kodiak Island villages in February, we returned in the summer of 1989. We also studied eight Cook Inlet, Prince William Sound, and Alaska Peninsula villages and--as control groups--two small villages that had not been directly affected by the spill, one in the Aleutians and one up the Nushagak River in Bristol Bay. The data we had collected in Kodiak City and Old Harbor prior to the spill provide an important baseline for the postspill analysis of Kodiak Island communities. We were not so fortunate for other villages in the spill area.

In the initial phase of the Social Indicators Study, we established Schedule A and B datasets. Schedule A consists of sample communities in the North Slope, NANA, Calista, and Aleutian-Pribilof Islands regions. Schedule B consists of sample communities in the Bering Straits, Bristol Bay, and Kodiak regions (see Human Relations Area Files 1992a and b). Comprising Schedule C are communities in the Kodiak, Prince William Sound, and Cook Inlet regions that are part of the oil-spill component of the study. The Schedule C reports (Part 1 and 2) present ethnographic summaries of selected communities in the spill zone. Map 1 depicts the Schedule C study area.

This introduction describes the political-economic contexts of the State and the regions in which Schedule C communities are located. The political-economic contexts are instrumental in allowing us to account for several key social and economic relations that shape Schedule C communities. The KI summaries that follow the introduction are descriptive ethnographies of spill-affected villages that provide substantial detail beyond the information provided here. We do, however, provide some results from the first wave of research in Schedule C communities subsequent to the spill in 1989 that will facilitate understanding of the village ethnographies that follow.

The sample communities of Schedule C are Valdez, Cordova, Tatitlek, Seldovia, Kodiak, Old Harbor, Chignik, Sand Point, Unalaska, Saint Paul, False Pass, Nikolski, Atka, Dillingham, Togiak, Manokotak, Naknek, Kenai, Tyonek, and Ekwok. Karluk, on Kodiak Island, was added during 1990, Tatitlek was studied only once in 1989. The communities identified above that are in the Bristol Bay and Aleutian-Pribilof Islands regions north of the Alaska Peninsula were sampled mainly as “controls” for the oil-

Map 1
SCHEDULE C STUDY REGION



affected villages. They are separated from the villages most intensely affected by the physical oil spill. The villages north of the Alaska Peninsula could be viewed as having not received the "intervention" or "treatment" (i.e., physical oil spill) in experimental terms, although such a view would disregard social and economic consequences to persons residing in areas adjacent to the spill. Two new control communities (Ekwok and False Pass) were added in 1989; the other control communities (Sand Point, Unalaska, St. Paul, Nikolski, Atka, Dillingham, Togiak, Manokotak, and Naknek) were drawn from existing Schedule A and B samples. In our subsequent waves of research, the control communities were eliminated for logistical, cost, and scientific reasons? Schedule C communities can be divided into groups on the basis of geographic proximity and administrative boundaries (see Map 1). Prince William Sound communities are identified as Cordova, Valdez, and Tatitlek. Cook Inlet communities are Tyonek, Seldovia, and Kenai. Kodiak communities are Kodiak, Old Harbor, Karluk, and Chignik.[3]

I.B. Alaska Social Indicators Research Design

Each village is studied at several points in time to determine whether changes have occurred among the items that we measure between research waves. To select villages for our samples, we classified all villages in the spill area by several "theoretical contrasts." This is called "stratifying" a universe that we intend to sample. We wanted to make sure that each of the village types we considered to be theoretically important would be included in our sample. For example, commercial fishing is extremely important in some villages in the spill area, but not all.

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[2] The study team quickly discovered that the social and economic effects of the spill extended far beyond the area of physical contamination. The ANCSA regional corporation that secured the greatest volume of oil-spill-cleanup employment, for example, was NANA in northwest Alaska. Other evidence (such as the shipment of subsistence salmon to affected communities from Togiak and possible commercial-fishing impacts as far north as Unalakleet) supports our concern that the definition of "control" immunities is quite complex. We abandoned the concept as a feature of Schedule C research design, although we continue to examine. the characteristics of communities distant from the spill from time to time.

[3] Chignik is not aligned with Kodiak Island in an institutional sense, but it is adjacent to this area.

To account for these differences in villages, one of the primary features we used to classify villages before selecting our sample was whether they gained more than 60 percent or whether they gained less than 40 percent (there was nothing in between) of their total incomes from commercial fishing-related businesses. We refer to the different types of villages as "theoretical contrasts" between Commercial Fishing and Noncommercial Fishing villages. We also classified as Hubs villages that (1) had well-developed transportation services and complex and well-developed infrastructures and (2) provided many services; and we contrasted these Hubs with Periphery villages that had (1) poorly developed transportation services, (2) modest infrastructures, and (3) few services. We classified villages along other dimensions, but those we have mentioned should make the point. Every village in the spill area was classified along each of the above dimensions we created as "theoretical contrasts." When we selected villages for our sample, we assured that each half of each theoretical contrast (for instance, Commercial Fishing/Noncommercial Fishing and Hub/Periphery) was represented by several villages. The contrasts allowed us to determine whether the oil spill affected similar types of villages in similar ways, and possibly why those effects would be similar (or different).

The research design also calls for a "Pretest" sample comprising respondents interviewed once and only once, and a "Posttest" sample--conducted at a later date--comprising respondents who have not been interviewed previously and who are interviewed once and only once.

To accomplish this, in the summer of 1989--after selecting the sample villages--we entered each study village, mapped all of the housing structures in the village, and assigned a number to each house. Next, we consulted a table of random numbers and selected a sample from all of the occupied housing structures; and then we interviewed an adult in each house. During that first research wave after the spill, we carefully noted each household that was selected for the sample by location and number. We did so because the postspill sample of 1989 is actually a "Pretest Sample" in our research design. To call a sample a "Pretest" (even though it is postspill), anticipates that we will draw a "Posttest Sample" at a later date. In our research design, we took care to make sure that persons drawn for the “Pretest” sample were not selected again and interviewed in the "Posttest" sample.

We assured that pretest respondents did not appear in the posttest samples by “not replacing” the pretest households into the population from which we drew our posttest sample. This was easily accomplished by checking our original maps and not selecting any house that had been selected for the pretest sample. Additionally, if a pretest respondent had relocated and that person’s household was then selected for the posttest sample, we simply did not reinterview that person or anyone else in the house. This procedure is called “sampling without replacement”: once interviewed, a person is not returned to the sample to be selected again. We followed this procedure so that we could avert the problem of “reactivity,” meaning that a person’s response may be conditioned by a previous response to the same question--hence introducing subjective bias into the results.

It is important to note that although we have just claimed that we selected a “Posttest” sample from a population that excluded all “Pretest” respondents, we also took care to interview some respondents as many as four times, others three, and some two. Persons selected for reinterview comprise “Panels.” We created our panels through the following process: We had the names and house locations of each respondent in each pretest sample, so when we returned to a village to select and interview a posttest sample, we both selected the posttest sample and drew at random a small sample of respondents from the pretest sample that we had interviewed the previous year. The small samples, or panels, comprise about 30 percent of the original pretest respondents. We asked these 30 percent the identical questions we had asked them the previous year. And if we returned a third time, we asked these identical respondents the identical questions for a third time. In this fashion we could determine whether changes had occurred to a subsample of respondents from our original pretest sample. But we couldn’t know whether any differences we discovered represented changes that had occurred, unless we could compare responses of panel members with responses of persons interviewed in the posttest samples. The comparisons of panels with pretest and posttest samples, then, gave us a means to test threats to validity posed by reactivity, regression, and other factors. If those threats do not materialize, we are able to account for change.

Our research design, which employs an objective instrument--a forced-choice questionnaire--also employs a more subjective instrument--which is a rather open-ended protocol, or list of topics about which informants respond. Respondents to questionnaires must choose among a set of predetermined choices for each question, but the protocol respondent can provide expansive answers to questions. It is incumbent upon the researcher to classify the responses of the persons they interview. It is evident that the protocol is more subjective than the questionnaire, but it is also deeper and allows for greater understanding than the questionnaire. The objective strength of a questionnaire can be lessened through the trivializing of topics. In our design, we compensate for the weaknesses of the questionnaire with the strengths of the protocol, and vice versa.

11. ORGANIZATION OF THE KI SUMMARIES

The Schedule C KI summaries are organized as two documents. One is devoted to Prince William Sound and the other to Cook Inlet and the Kodiak Island area. These summaries focus on communities (in contrast to Schedule A and B summaries for the first phase of the MMS Social Indicators study, which focused on samples of communities within regions). In part, this organization of reports is merely convenient. The summaries are too long to collect in a single document, and two documents make packaging easier. The organization also is logical: one document focuses on communities adjacent to the Exxon Valdez spill itself, and another addresses communities some hundreds of kilometers away. This section also explains in more detail the aspect of organization described in Section I--the division of communities into Hubs and Periphery villages. Additionally, Native and Mixed villages are discussed.

Schedule A and B Social Indicator research clearly showed that Hubs and Periphery villages behaved differently along many parameters. As stated in Section I, this contrast (Hub versus Periphery) is one of the principal theoretical contrasts used in our analysis. Hubs are centers of administrative and economic infrastructure. They are socially complex in terms of ethnic and economic cross-sections; generally display greater