TUNDRA SWAN AND BRANT SURVEYS ON THE ARCTIC COASTAL PLAIN, COLVILLE RIVER TO STAINES RIVER, 1990

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EXECUTIVE SUMMARY

Tundra Swans and Brant traditionally have been important in planning oilfield development in northern Alaska. Because information about these species is limited in some areas, ABR, under contract to ARCO Alaska, Inc. and BP Exploration Alaska, Inc., undertook aerial waterfowl surveys in the region between the Colville and Staines rivers and ground surveys in three general locations between the Sagavanirktok River delta and the Kuparuk Oilfield.

The goals of the Tundra Swan study were to locate Tundra Swans by aerial surveys in the Kuparuk Oilfield, the Oil and Gas Lease Sale 54 (OGL 54), and Prudhoe Bay, to count pairs, flocks, nests, and broods, and to determine the proximity of Tundra Swans, nests, and broods to new or proposed drill sites.

The major goals of the cooperative Brant studies were to collect information on the abundance, distribution and productivity of Brant on the Coastal Plain between the Colville and Staines rivers. Aerial surveys were used to locate Brant nesting colonies and brood-rearing areas throughout the region. Ground surveys on the Sagavanirktok River delta and in the Kuparuk Oilfield were used to document the numbers of Brant nests and their fates at selected nesting locations.

TUNDRA SWAN SURVEYS

In the Kuparuk/OGL 54 study area, 539 Tundra Swans and 123 nests were observed at 305 locations between 17 and 22 June. In general, swans were uniformly distributed wherever large lakes and drained-lake basins occurred, but were rarely recorded south of 70°10'N in the Kuparuk Oilfield or east of 150°40'W in the OGL 54 area.

In June 1990, the densities of Tundra Swans were estimated at 0.03 nests/km^2 and 0.13 swans/km^2. Although the numbers of swans and nests in the study area were higher than in 1988 and 1989, densities in all three years were similarly low. New or proposed drill sites were located from 1.0 to 6.2 km from the nearest Tundra Swan nests.

Between 19 and 24 August, 706 adult Tundra Swans and 296 cygnets in 104 broods were recorded in the study area. Mean brood size was 2.8 cygnets, somewhat larger than that observed in 1988 ($\bar{x}$ = 2.1) and 1989 ($\bar{x}$ = 2.3). Densities during August were 0.02 broods/km^2 and 0.17 swans/km^2, similar to estimates made in 1988 and 1989, although the actual number of broods and swans/km^2 was higher than in the previous two years. New or proposed drill sites were 1.5 to 4.0 km from the nearest brood locations.

In the Prudhoe Bay Oilfield study area, 82 Tundra Swans and 26 nests were observed at 52 locations between 21 and 22 June. As in the Kuparuk/OGL 54 study area, swans in general were uniformly distributed wherever large lakes or drained-lake basins occurred. Densities of swans and nests in June were comparable to those in the adjacent Kuparuk/OGL 54 study area: 0.03 nests/km^2 and 0.11 swans/km^2.

Between 19 and 24 August, 108 adult Tundra Swans and 61 cygnets in 22 broods were observed in the Prudhoe Bay Oilfield study area. Values for mean brood size (2.8 cygnets) and broods/km^2 (0.03) and adults/km^2 (0.14) were similar to those observed in the adjacent Kuparuk/OGL 54 study area. All 1990 estimates were within the range of densities recorded historically for the Coastal Plain.

Increases in Tundra Swan numbers in the Kuparuk/OGL 54 study area were probably the result of previous years of good productivity, and an early, mild spring which created favorable conditions for nesting. Nesting success appeared identical between the Kuparuk/OGL 54 and Prudhoe Bay study areas. However, the density of adults without nests was substantially lower in the Prudhoe Bay study area. Even with the increased numbers in 1990, densities of both breeding and nonbreeding Tundra Swans in the Kuparuk/OGL 54 and Prudhoe Bay were low compared to those reported elsewhere in northern Alaska.

BRANT SURVEYS

In the region between the Staines and Miluveach rivers, 517 Brant nests in 61 nesting locations were identified by aerial and ground surveys. Nesting data for the colonies on Howe and Duck islands, in the Lisburne Development Area (LDA), and for selected sites in the Kuparuk Oilfield were collected by ground surveys. Aerial surveys were conducted in June 1990 to collect information on Brant nests elsewhere in the region. Information on brood-rearing Brant throughout the region was collected solely by aerial surveys in July 1990.

During June aerial surveys, 182 Brant nests (excluding colonies searched on the ground) were located in the region. Many of these were solitary (37%), but at least 14 sites had $\geq$ 5 nests. In addition, 477 adult Brant, probably nonbreeding birds, were observed in the region. As in 1989, Brant nests were located in a number of wet tundra vegetation types and were between 1.0 and 23 km from the coast.

No new large colonies were identified during these surveys, but nesting Brant were recorded for the first time on Tigvariak Island and on islands in the Kadleroshilik River delta. Brant numbers in the study area were higher in 1990 than in 1989 (1489 vs. 1232 adults), with breeding birds largely responsible

for the increase.

In 1990, there were 226 Brant nests on Howe Island, 13 on Duck Island, and 17 in the Surfcote colony in the LDA. For all 3 colonies, the number of nests in 1990 represented an increase over the previous 2 years. In the Kuparuk Oilfield, 143 nests were located in 13 nesting locations including the Kuparuk River delta, and along the road systems in both the Kuparuk River and Milne Point units. Nesting success ranged from 67% (the average for the Kuparuk Oilfield) to 94% (Surfcote). A minimum of 79% of the Howe Island nests was successful and the average brood size at dispersal was 3.0 goslings.

In 1989, it appeared that the Brant from the Howe and Duck island colonies were part of a discrete breeding population using the area between Prudhoe Bay and the Kadleroshilik River. In 1990, there were an estimated 296 nests in this area. Using the average brood size at hatch for Howe Island and the combined average nesting success for the Howe Island and Surfcote colonies, an estimated 592 adults produced between 721-867 goslings. An aerial survey at the end of July counted 610 goslings in the same area, a 15-20% mortality, considerably lower than mortality in 1989 (approximately 50%).

Aerial surveys and photo censuses indicated that approximately 3200 Brant (including more than 1500 goslings) were on the coast between the Staines and Colville rivers in late July 1990. The number of adults in each section increased between 61 and 153% from numbers recorded in 1989, and numbers of goslings increased 14-712%. As in 1989, few Brant (<50) were recorded inland. Brant were observed at 21 sites along the coast, including salt marsh areas at the mouth of the Putuligayak River, Simpson Lagoon, and the Kadleroshilik River delta. New brood-rearing locations included the mouth of Sakonowyak River, the western shoreline of Foggy Island, and Tigvariak Island. Brant with goslings were most abundant and dense between Heald Point and Kalubik Creek (67% of total adults, 65% of total goslings).

More favorable nesting conditions in 1990, compared to previous years, probably contributed to the increased nesting effort by Brant. These conditions included a mild spring with early snow melt, lower than normal water levels, and reduced ice cover in some wetlands. In addition, nest success and gosling survival were high and consequently more goslings were evident during brood-rearing. Fluctuations in numbers of brood-rearing Brant may not be unusual, but more data will be needed to determine the natural range of variation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

APPENDIX A, TABLES

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INTRODUCTION

Tundra Swans (*Cygnus columbianus*) are a conspicuous and important component of waterbird communities in northern Alaska. Arctic-nesting swans winter primarily on the mid-Atlantic coast of the United States (Sladen 1973), and are among the first migrants to arrive on the Coastal Plain in mid-May (Bergman et al. 1977). Early arrival on the breeding grounds is critical because swans have a protracted breeding season; after an incubation and brood-rearing period of approximately 120 days, they typically depart the Coastal Plain at the time of freeze-up in early October (Salter et al. 1980). Several previous surveys on the Coastal Plain (e.g., King 1970, Bartels and Doyle 1984, Conant and Cain 1987, Ritchie et al. 1990), have provided basic information on the distribution, productivity, and abundance of swans.

Brant (*Branta bernicla*) are important colonially-nesting geese on the Coastal Plain. They have been recorded as the most common nesting waterfowl near Barrow (Bailey et al. 1933) and the most common goose near Pitt Point (D. H. Fiscus, 1952-1953, unpubl. notes). Hansen (1957) reported that a large population of Brant molted on the Coastal Plain and King (1970) identified a large gosling component of this population during aerial surveys. Although broods have been located up to 25 miles inland, most colonies have been found along the coast and on major river deltas. Colony locations include the Colville River delta (Shepherd 1961), the Sagavanirktok River delta (Gavin 1980, Johnson et al. 1985), the Okpilak River delta (Spindler 1978), and Teshekpuk Lake (Derksen et al. 1979). Brant also nest on barrier islands associated with river deltas (Gavin 1977, Divoky 1978, Johnson and Richardson 1980).

Both Tundra Swans and Brant have historically been the focus of concerns of both the regulatory agencies and the oil industry. These species are traditional in their selection of nesting and brood-rearing areas; therefore it

is important to regularly assess their distribution, productivity, and abundance as development expands. In 1988, Alaska Biological Research, Inc. (ABR) initiated intensive aerial surveys, primarily for swans, in the Kuparuk Oilfield and Oil and Gas Lease Sale 54 (OGL 54) for ARCO Alaska, Inc (ARCO) (Figure 1). Survey efforts were coordinated with the U.S. Fish and Wildlife Service (USFWS), which was conducting similar surveys in the area. In 1989, BP Exploration (Alaska) Inc. became a partner in the survey program, in response to an increasing interest in the status of Brant and a continuing interest in swans. Aerial surveys for Brant were extended to Brownlow Point and ground surveys were conducted in colonies in the Sagavanirktok River delta (1989-1990), the Lisburne Development Area (LDA) (1983-1990; reported in the LDA Monitoring reports), and in the Kuparuk Oilfield (1990). Aerial surveys for Tundra Swans were also extended in 1990 to include the area surrounding the Prudhoe Bay Oilfield. The objectives of the combined Tundra Swan and Brant surveys in 1990 included the following components:

1) continued aerial surveys to determine Tundra Swan nest numbers and productivity in the Kuparuk Oilfield and OGL 54, with estimation of the proximity of swans to new and proposed drill sites;

2) aerial surveys to determine Tundra Swan nest numbers and productivity in the Prudhoe Bay Oilfield;

3) aerial survey coverage of the coastal region between the Miluveach River and Brownlow Point to locate and monitor Brant nesting colonies;

4) aerial survey coverage of the coastal region between the Miluveach River and Brownlow Point to locate Brant brood-rearing areas and enumerate Brant;

5) ground censuses of Howe and Duck islands to determine nest numbers, distribution, and success of Brant and other species;

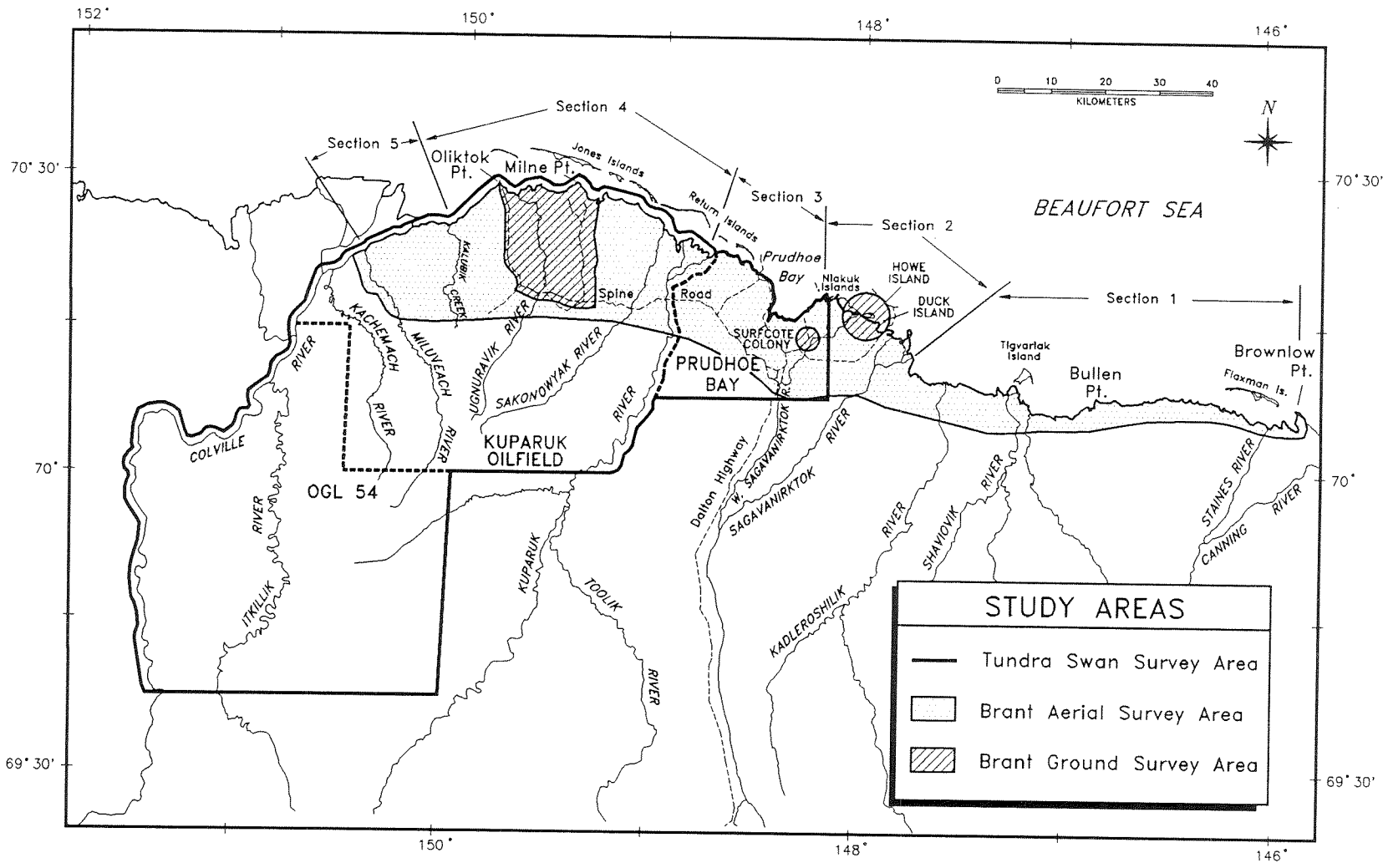

Figure 1. Study areas for Tundra Swan and Brant investigations in 1990.

6) surveys to estimate Brant numbers, brood sizes at hatching and survival rates in the area between Point McIntyre and the Kadleroshilik River; and

7) ground surveys at selected sites in the Kuparuk River and Milne Point units to determine nest numbers and productivity of Brant.

STUDY AREA

Ground and aerial surveys for Tundra Swans and Brant were conducted on the Arctic Coastal Plain between Brownlow Point (Staines River) and the eastern channel of the Colville River (Miluveach River) (Figure 1). Inland areas along the Itkillik River were also surveyed for swans. The region is typical of the Arctic Coastal Plain and is dominated by thaw lakes and polygonized tundra (Carson and Hussey 1962). The upland areas directly south of the Kuparuk Oilfield and east of the Shaviovik River (White Hills) are characterized by drier vegetation types (Wahrhaftig 1965) with fewer lakes. Land forms and vegetation of the Arctic Coastal Plain have been described in detail by Walker et al. (1980).

Aerial surveys for Tundra Swans in the Kuparuk Oilfield and OGL 54 were conducted in an area of 4246 km^2 bounded by the Colville River on the west and the Kuparuk River on the east (Figure 1). The Kuparuk Oilfield encompassed 57% of the area surveyed while the OGL 54 section contained the remaining 43% (Appendix Table A1). The Beaufort Sea coast was the northern boundary, and the southern limit was formed by a line running west from the Kuparuk River approximately along 70°10'N to 150°00'W, then south to 69°37'N, then west again to the Colville River. The entire Kuparuk Oilfield (including the Kuparuk River and Milne Point units) and OGL 54 were covered in the surveys.

Tundra Swan surveys in the Prudhoe Bay Oilfield covered a 778 km^2 area bounded by the Kuparuk River on the west and 148°12'W on the east (approximately 10 km east of the Deadhorse airport) (Figure 1). The Beaufort Sea formed the north boundary, and the south boundary was 70°07'30"N (approximately 8 km south of the Deadhorse airport). The entire Prudhoe Bay oilfield was included.

Aerial surveys for Brant were conducted between Brownlow Point (Staines River) on the east and the Miluveach River near its junction with the Colville River on the west (Figure 1). The Niakuk Islands, gravel spits in Foggy Island Bay, Tigvariak Island, and Flaxman Island were included in the survey area. The Simpson Lagoon barrier islands (Spy Island to Stump Island) were not surveyed in 1990. Inland surveys included the Kuparuk and Prudhoe Bay oilfields south to approximately 70°05'N, and the area between the Sagavanirktok and Staines rivers south to approximately 5 km from the coast.

For analytical purposes, the study area for regional Brant surveys was divided into five sections from east to west (Figure 1). The boundaries of each section were as follows: Section 1 (Staines River to Sagavanirktok River) extended from Brownlow Point to the east channel of the Sagavanirktok River. Section 2 (Sagavanirktok River delta) included all the mudflats, islands, and tundra between the east and west channels of the Sagavanirktok River. This section contained the Howe and Duck island Brant colonies (monitored by ground surveys), which are associated with the Duck Island Unit. Section 3 (Heald Point to Kuparuk River) extended from the west channel of the Sagavanirktok River to the east channel of the Kuparuk River, including the Niakuk Islands. The Surfcote colony in the LDA, which was monitored by ground surveys, was in this section. Section 4 (Kuparuk River to Kalubik Creek) included the Kuparuk River delta and extended west to Kalubik Creek. Ground surveys in this section included islands in the Kuparuk River delta, and nesting locations along the road systems of the Kuparuk River and Milne Point units (Kuparuk Oilfield). Section 5 (Kalubik Creek to Miluveach River) included the area between Kalubik Creek and the Miluveach River, but excluded the area west and north of the eastern channel of the Colville River.

PART 1: TUNDRA SWAN SURVEYS

METHODS

Two aerial survey methods were used: 1) fixed-width (1.6 km) strip transects in regions of extensive wetlands and 2) a direct route between bodies of water in areas where wetlands were scattered (King 1973). Township and section lines on 1:63,360 U.S. Geological Survey (USGS) topographic maps were used as transect centerlines. A Cessna 185 aircraft with a pilot and two observers was used for both nesting and brood-rearing surveys in 1990. Surveys were flown at approximately 150 m above ground level (agl), at an airspeed of approximately 145 km/h.

Swan observations followed the USFWS Tundra Swan Survey Protocol (USFWS 1987). Each observer scanned a transect approximately 800 m wide on one side of the aircraft, while the pilot navigated and scanned ahead of the aircraft. The flightline and all observations were recorded on 1:63,360 USGS maps. Sightings of Tundra Swans were reported to the observer in the right front seat, who was responsible for logging them. Each observation was numbered and plotted on the map and described in the margin using a standard set of codes for pairs, single birds, flocks, nests, and broods. Whenever possible, observations of other wildlife (primarily geese, loons, and Glaucous Gulls [*Larus hyperboreus*]) were recorded by the other observer on a second set of USGS maps.

Survey dates were selected to correspond with previous USFWS surveys in the same area (Beechey Point B-5 quadrangle [Conant and Cain 1987, R. King, USFWS, pers. comm.]). Nesting surveys were conducted between 17 and 22 June 1990 (Table 1). Although most Tundra Swan nests had been initiated by these dates, some nests were undoubtedly missed. Brood-rearing surveys were conducted between 19 and 24 August 1990 when most young were fairly large and conspicuous, but some broods were probably missed.

Table 1. Summary of Tundra Swan aerial surveys conducted in the Kuparuk and Prudhoe Bay Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June-August, 1990.

Survey Type	Location[1]	Date	Flight Time (hrs)	Distance Flown (km)
Nesting	Kuparuk Oilfield and OGL 54	17-22 June	28	2654
Nesting	Prudhoe Bay Oilfield	21-22 June	5	484
		June Total	**33**	**3138**
Brood-Rearing	Kuparuk Oilfield and OGL 54	19-23 August	27.5	2654
Brood-Rearing	Prudhoe Bay Oilfield	19-24 August	5	484
		August Total	**32.5**	**3138**

[1] Locations are mapped on Figure 1.

Approximately 33 and 32.5 hours of aircraft survey time were used during June and August surveys, respectively. More than 3100 km of transects were flown on each set of surveys. In drier habitats, only scattered wetland areas were surveyed. Estimates of the area (in km^2) of aerial survey coverage were obtained using a Minerva metric map measurer. Swan densities were calculated using only the area covered by survey transects rather than the entire area within the study unit boundaries. Estimates of survey coverage for each USGS quadrangle in the Kuparuk/OGL 54 and the Prudhoe Bay Oilfield study areas are given in Appendix Table A1 and Appendix Table A2 respectively. Relationships of USGS quadrangle maps to study area boundaries are illustrated by Appendix Figure A1.

Summary statistics followed the format established in 1988 with one exception. Adult swans in 1990 were categorized as: 1) adults with nests/broods or 2) adults without nests/broods. The latter includes subadult nonbreeders as well as nonbreeding adults. The new categories for 1990 are directly comparable to those listed under the categories ("breeding adults" and "nonbreeding adults") used previously (Ritchie et al. 1989, Ritchie et al. 1990). The data presented are census counts, not statistical estimates, therefore no statistical tests were performed.

The survey data were used to evaluate the proximity of Tundra Swan nests and broods to new and proposed drill sites in the Kuparuk Oilfield. However, no change in survey methods or effort was made in order to collect more detailed information in the vicinity of these sites.

RESULTS

KUPARUK OILFIELD AND OIL AND GAS LEASE 54 STUDY AREAS

Swan Distribution in June

Five hundred thirty-nine Tundra Swans were observed at 305 locations during nesting surveys (Table 2, Appendix Table A3). Thirty-eight percent of the swans observed in the study area were adults with nests. In the Kuparuk 41% of the swans observed were adults with nests, while in the OGL 54 the figure was 34%.

One hundred twenty-three active Tundra Swan nests were located in the study area during June surveys (Table 2, Appendix Table A3). All swan nests in the Kuparuk Oilfield were located north of 70°11'N, but nests in the OGL 54 area were found as far south as 69°38'N. Few sightings of swans were recorded in the upland portion of the study area (White Hills south of 70°10' N, and east of 150°40'W). Nests were located at elevations from near sea level at the coast to 52 m above sea level (asl) further inland, while pairs of swans without nests were found up to 93 m asl. Nests were most often located on islands or peninsulas in lakes, but occasionally were in drier tundra habitats.

In general, swans were uniformly distributed wherever large lakes and drained lake basins occurred. Mean densities of Tundra Swan nests in the Kuparuk and OGL 54 areas were identical (0.03/km^2), and densities of adults with nests, adults without nests, and total swans were similar (Table 3).

In 1990, a greater percentage of the population consisted of adults with nests (38%) than in 1988 (22%) or 1989 (26%) (Table 4). In addition, the number of swans located during June surveys increased 26% from 1988 to 1990, with a 128% increase in nests and a corresponding 115% increase in adults with nests. The number of adults without nests, however, was similar in all three years (333,356, and 335 for 1988, 1989, and 1990, respectively). Densities of swans and nests changed accordingly (Table 5).

Table 2. Numbers of Tundra Swans and nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 17-22 June 1990.

Location USGS quadrangle		Adults[1] With Nests	Nests			Adults Without Nests[2]					Total Swans
			With Pair	With Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
Kuparuk Oilfield											
Beechey Point	A-4	15	6	3	9	6	3	0	0	15	30
	A-5	1	0	1	1	5	1	1	4	15	16
	B-4	44	19	6	25	8	18	0	0	34	78
	B-5	32	11	10	21	13	20	2	6	52	84
	C-4	0	0	0	0	0	0	0	0	0	0
	C-5	0	0	0	0	0	1	0	0	1	1
Harrison Bay	A-1	5	2	1	3	4	3	0	0	11	16
	B-1	22	9	4	13	15	12	0	0	42	64
	B-2	3	1	1	2	1	5	0	0	7	10
OGL 54											
Harrison Bay	A-2	30	12	6	18	5	4	0	0	14	44
	A-3	4	2	0	2	0	0	0	0	0	4
Umiat	C-1	0	0	0	0	0	1	0	0	1	1
	C-2	10	4	2	6	4	2	0	0	10	20
	C-3	7	3	1	4	4	2	1	4	14	21
	D-1	0	0	0	0	0	0	0	0	0	0
	D-2	20	7	6	13	19	6	1	49	93	113
	D-3	11	5	1	6	9	5	1	3	26	37
Kuparuk Oilfield Subtotal		122	48	26	74	52	63	3	10	177	299
OGL 54 Subtotal		82	33	16	49	41	20	3	56	158	240
Kuparuk/OGL 54 Total		204	81	42	123	93	83	6	66	335	539

[1] "Breeding Adults" in previous reports.
[2] "Non-breeding Adults" in previous reports.

Table 3. Densities of Tundra Swans and nests (per km²) recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June and August 1990.

Location USGS quadrangle		Nesting Survey (June)				Productivity Survey (August)					
		Adults With Nests	Nests	Adults Without Nests	Total Adults	Adults With Broods	Broods	Young	Adults Without Broods	Total Adults	Total Swans
Kuparuk Oilfield											
Beechey Point	A-4	0.05	0.03	0.05	0.11	0.03	0.01	0.04	0.09	0.12	0.16
	A-5	<0.01	<0.01	0.05	0.06	0	0	0	0.05	0.05	0.05
	B-4	0.10	0.06	0.08	0.17	0.10	0.05	0.12	0.19	0.29	0.41
	B-5	0.05	0.03	0.08	0.13	0.08	0.04	0.11	0.11	0.19	0.29
	C-4	0	0	0	0	0	0	0	0	0	0
	C-5	0	0	0.08	0.08	0	0	0	0	0	0
Harrison Bay	A-1	0.02	0.01	0.04	0.06	0.02	0.01	0.04	0.05	0.07	0.11
	B-1	0.05	0.03	0.10	0.15	0.07	0.04	0.12	0.14	0.22	0.34
	B-2	0.05	0.03	0.11	0.15	0.06	0.03	0.08	0.31	0.37	0.45
OGL 54											
Harrison Bay	A-2	0.09	0.05	0.04	0.13	0.08	0.04	0.12	0.10	0.17	0.29
	A-3	0.04	0.02	0	0.04	0.04	0.02	0.03	0.02	0.06	0.09
Umiat	C-1	0	0	0.01	0.01	0	0	0	0	0	0
	C-2	0.06	0.04	0.06	0.12	0.04	0.02	0.06	0.18	0.21	0.28
	C-3	0.05	0.03	0.09	0.14	0.01	<0.01	<0.01	0.07	0.09	0.09
	D-1	0	0	0	0	0	0	0	0	0	0
	D-2	0.04	0.03	0.17	0.21	0.02	0.01	0.04	0.18	0.20	0.23
	D-3	0.03	0.02	0.07	0.10	0.04	0.02	0.07	0.12	0.15	0.22
Kuparuk Oilfield Subtotal		0.05	0.03	0.07	0.12	0.06	0.03	0.08	0.12	0.18	0.26
OGL 54 Subtotal		0.04	0.03	0.09	0.13	0.03	0.02	0.05	0.12	0.15	0.20
Kuparuk/OGL 54 Total		0.05	0.03	0.08	0.13	0.05	0.02	0.07	0.12	0.17	0.24

Table 4. Summaries of numbers of Tundra Swans and nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June 1988-1990.

Location	Year	Adults[1] With Nests	Nests			Adults Without Nests[2]					Total Swans
			With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
Kuparuk Oilfield	1988	50	24	2	26	55	26	3	12	148	198
	1989	70	26	18	44	64	48	3	10	186	256
	1990	122	48	26	74	52	63	3	10	177	299
	3 yr Mean	81	33	15	48	57	46	3	11	170	251
OGL 54	1988	45	17	11	28	65	38	5	17	185	230
	1989	53	19	15	34	50	47	3	23	170	223
	1990	82	33	16	49	41	20	3	56	158	240
	3 yr Mean	60	23	14	37	52	35	4	32	171	231
Kuparuk/OGL 54	1988	95	41	13	54	120	64	8	29	333	428
	1989	123	45	33	78	114	95	6	33	356	479
	1990	204	81	42	123	93	83	6	66	335	539
	3 yr Mean	141	56	30	85	10	81	7	43	341	482

[1] "Breeding Adults" in previous reports.

[2] "Non-breeding Adults" in previous reports.

Table 5. Summaries of densities of Tundra Swans, nests, and broods (per km^2) recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease (OGL 54) study areas, Alaska, June and August 1988-1990).

		June Nesting Surveys				August Brood-rearing Surveys					
Location	Year	Adults[1] With Nests	Nests	Adults[2] Without Nests	Total Adults	Adults[1] With Broods	Broods	Young	Adults[2] Without Broods	Total Adults	Total Swans
Kuparuk Oilfield	1988	0.023	0.012	0.068	0.091	0.031	0.016	0.034	0.082	0.113	0.147
	1989	0.029	0.018	0.077	0.106	0.035	0.019	0.043	0.128	0.163	0.206
	1990	0.051	0.031	0.074	0.124	0.059	0.030	0.083	0.120	0.179	0.261
	3 yr Mean	0.034	0.020	0.073	0.107	0.042	0.022	0.053	0.110	0.152	0.205
OGL 54	1988	0.025	0.016	0.104	0.130	0.018	0.009	0.021	0.157	0.175	0.196
	1989	0.029	0.018	0.092	0.121	0.021	0.010	0.021	0.131	0.151	0.172
	1990	0.045	0.027	0.086	0.131	0.035	0.017	0.053	0.115	0.150	0.203
	3 yr Mean)	0.033	0.020	0.094	0.127	0.025	0.012	0.032	0.134	0.159	0.190
Kuparuk/OGL 54	1988	0.024	0.014	0.085	0.109	0.026	0.013	0.029	0.112	0.138	0.166
	1989	0.029	0.018	0.084	0.113	0.029	0.015	0.033	0.129	0.158	0.191
	1990	0.048	0.029	0.079	0.127	0.048	0.024	0.070	0.118	0.166	0.236
	3 yr Mean	0.034	0.020	0.083	0.116	0.034	0.017	0.044	0.120	0.154	0.189

[1] "Breeding Adults" in previous reports.

[2] "Non-breeding Adults" in previous reports.

New or proposed drill sites evaluated in this study included West SAK, UGNU, COL 1, COL 2, 1J, 1M, 2L, 2N, 3L, and 3T (Figure 2, Appendix Table A4). These drill sites were between 1.0 and 6.2 km ($\bar{x} \pm SD = 2.9 \pm 1.6$ km) from the nearest active Tundra Swan nests located during the surveys. The sites were between 1.0 and 4.5 km ($\bar{x} \pm SD = 2.9 \pm 1.2$ km) from locations of the nearest pairs without nests. The mean distances from these drill sites in 1989 were 2.5 km for nests and 3.4 km for pairs of Tundra Swans.

Swan Productivity and Distribution in August

One thousand two Tundra Swans (706 adults and 296 cygnets) were observed at 345 locations in the study area (Table 6, Appendix Table A5). One hundred four broods were recorded; 29% of all adults were associated with broods. In the Kuparuk Oilfield 33% of the adults were with broods, while 23% of the adults in OGL 54 were accompanying broods.

The number of adults observed in the study area increased 31% from June to August 1990. Most of the increase occurred in the Kuparuk Oilfield where the number of adults was 44% higher in August (Table 6). The increase in OGL 54 during the same period was much smaller (15%). Nearly all of these additional birds were swans without broods (failed breeders or subadult nonbreeding birds). The number of adults with nests or broods in the entire study area was essentially unchanged from June to August although some redistribution apparently occurred within the area; the number of breeding adults increased by 16% in the Kuparuk Oilfield while decreasing by 22% in OGL 54.

There were 123 active nests located in June and 104 broods observed during August surveys, indicating approximately 85% nest success in the study area (Table 6). All swan broods in the Kuparuk Oilfield were located north of 70°11'N, but broods in the OGL 54 were found as far south as 69°38'N. As was the case in June, few swans were recorded in the upland portions of the study area. Most Tundra Swan pairs and broods were found at elevations from slightly above sea level near the coast to approximately 23 m asl for broods

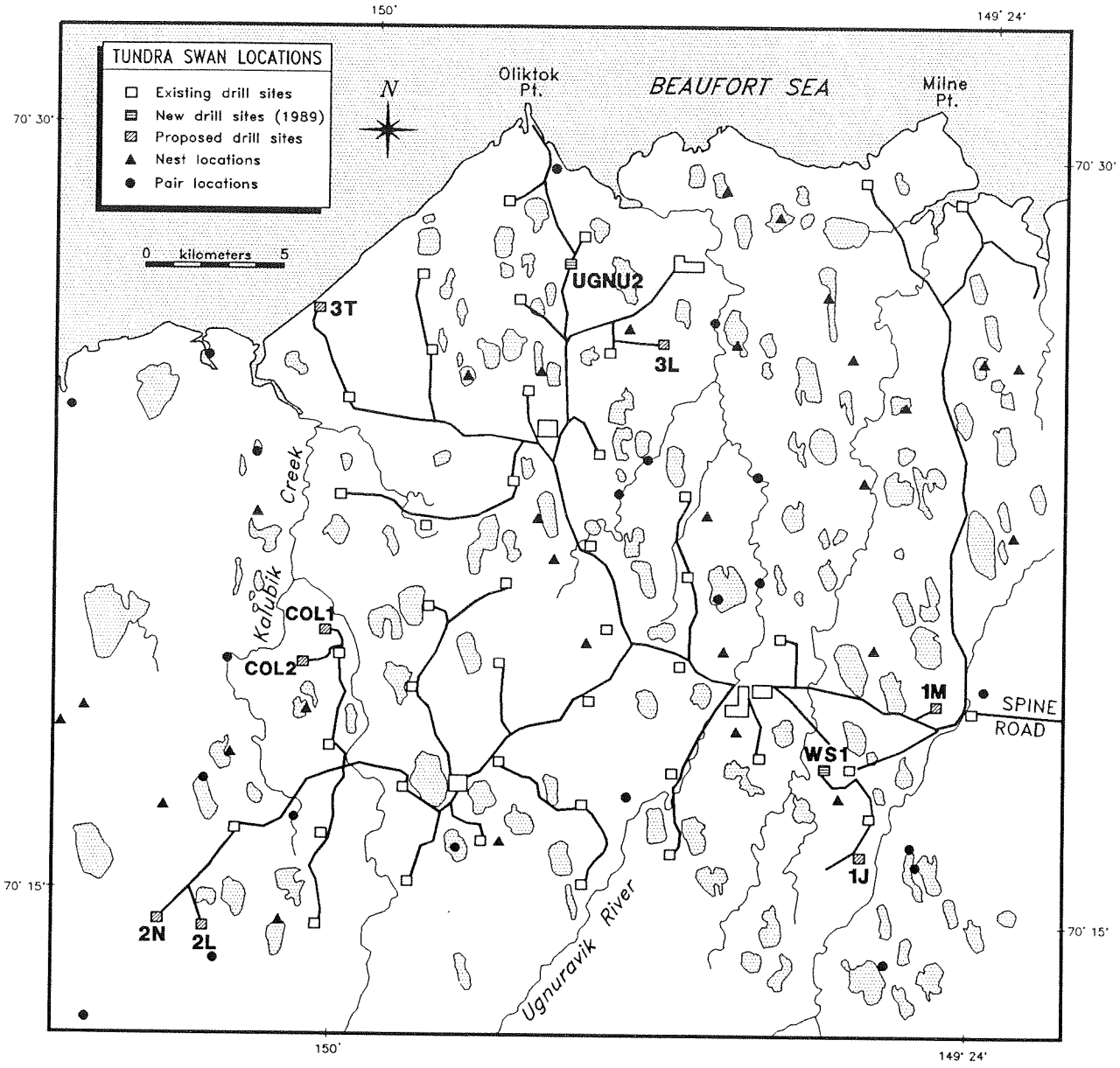

Figure 2. Locations of Tundra Swan pairs and nests observed during aerial surveys in the central Kuparuk Oilfield, Alaska, 17-22 June 1990. (This map does not depict the entire study area nor all locations discussed in the text).

Table 6. Numbers of Tundra Swans and broods recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-23 August 1990.

Location USGS Quadrangle		Adults[1] With Broods	Broods			Total Young	Mean Brood Size	Adults Without Broods[2]					Total Adults	Total Swans	Percent Young
			With Pair	With Single Adult	Total			Pairs	Singles	Flocks	Flocked Swans	Total			
Kuparuk Oilfield															
Beechey Point	A-4	8	4	0	4	11	2.8	10	5	0	0	25	33	44	25.0
	A-5	0	0	0	0	0	0	3	1	2	7	14	14	14	0
	B-4	45	22	1	23	55	2.4	24	11	5	28	87	132	187	29.4
	B-5	47	23	1	24	67	2.8	21	19	3	9	70	117	184	36.4
	C-4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C-5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harrison Bay	A-1	6	3	0	3	10	3.3	7	0	0	0	14	20	30	33.3
	B-1	31	15	1	16	51	3.2	15	8	4	21	59	90	141	36.2
	B-2	4	2	0	2	5	2.5	5	2	2	8	20	24	29	17.2
OGL 54															
Harrison Bay	A-2	26	13	0	13	40	3.1	12	4	1	5	33	59	99	40.4
	A-3	4	2	0	2	3	1.5	1	0	0	0	2	6	9	33.3
Umiat	C-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C-2	6	3	0	3	10	3.3	14	1	0	0	29	35	45	22.2
	C-3	2	1	0	1	1	1.0	5	1	0	0	11	13	14	7.1
	D-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	D-2	12	6	0	6	19	3.2	36	5	3	18	95	107	126	15.1
	D-3	14	7	0	7	24	3.4	16	2	2	8	42	56	80	30.0
Kuparuk Oilfield Subtotal		141	69	3	72	199	2.8	85	46	16	73	289	430	629	31.6
OGL 54 Subtotal		64	32	0	32	97	3.0	84	13	6	31	212	276	373	26.0
Kupuruk/OGL 54 total		205	101	3	104	296	2.8	169	59	22	104	501	706	1002	29.5

[1] "Breeding Adults" in previous reports.
[2] "Non-breeding Adults" in previous reports.

and 46 m asl for pairs further inland. One brood in OGL 54 was located at an elevation of 55 m asl and a pair in the Kuparuk Oilfield was located at 99 m asl.

Densities of adult swans without broods were identical in the Kuparuk Oilfield and in OGL 54 (Table 3). Mean densities of all other categories of swans were higher in the Kuparuk unit than in OGL 54.

Nest success for the entire study area was slightly higher in 1990 than in 1989 (82%) or 1988 (81%) (Ritchie et al. 1989, 1990). However, the number of broods and average brood size increased 68% and 27%, respectively, from 1989. Substantial increases occurred between 1989 and 1990 in nearly all measured categories of swans: adults with broods increased 68%, number of young increased 108%, and total number of swans increased 23%. Smaller increases occurred in all of these categories between 1988 and 1989. The number and density of adults without broods remained relatively stable over the three years (Table 7, 5).

Similar increases in swan numbers occurred in the Beechey Point B-5 quadrangle (central Kuparuk Oilfield), which has been surveyed for Tundra Swans during August of each year since 1986. The number of young increased 347% from 1986 (Figure 3, Appendix A6), while the number of adults with broods and number of broods have increased 236% (14 to 47) and 243% (7 to 24), respectively. Brood size and the percent of young in the population have varied among years, but were higher in 1990 than any previous year (Figure 4). Numbers of adults without broods remained fairly stable, as they did for the entire study area (Figure 3).

New or proposed drill sites evaluated in this study were located between 1.5 and 4.1 km ($\bar{x} \pm SD = 2.7 \pm 0.9$ km) from the nearest observed brood locations (Figure 5, Appendix Table A6), and between 0.7 and 7.3 km ($\bar{x} \pm SD = 3.8 \pm 1.9$ km) from the nearest observed locations of swan pairs without broods. The mean distances from these drill sites for broods and pairs without broods in 1989 were 3.4 and 2.6 km, respectively.

Table 7. Numbers of Tundra Swans and nests and broods recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, during June and August 1990.

Location USGS Quadrangle		Adults With Nests/Broods		Nests	Broods	Adults Without Nests/Broods		Total Adults	
		June	August	June	August	June	August	June	August
Kuparuk Oilfield									
Beechy Point	A-4	15	8	9	4	15	25	30	33
	A-5	1	0	1	0	15	14	16	14
	B-4	44	45	25	23	34	87	78	132
	B-5	32	47	21	24	52	70	84	117
	C-4	0	0	0	0	0	0	0	0
	C-5	0	0	0	0	1	0	1	0
Harrison Bay	A-1	5	6	3	3	11	14	16	20
	B-1	22	31	13	16	42	59	64	90
	B-2	3	4	2	2	7	20	10	24
OGL 54									
Harrison Bay	A-2	30	26	18	13	14	33	44	59
	A-3	4	4	2	2	0	2	4	6
Umiat	C-1	0	0	0	0	1	0	1	0
	C-2	10	6	6	3	10	29	20	35
	C-3	7	2	4	1	14	11	21	13
	D-1	0	0	0	0	0	0	0	0
	D-2	20	12	13	6	93	95	113	107
	D-3	11	14	6	7	26	42	37	56
Kuparuk Oilfield Subtotal		122	141	74	72	177	289	299	430
OGL 54 Subtotal		82	64	49	32	158	212	240	276
Kuparuk/OGL 54 Total		204	205	123	104	335	501	539	706

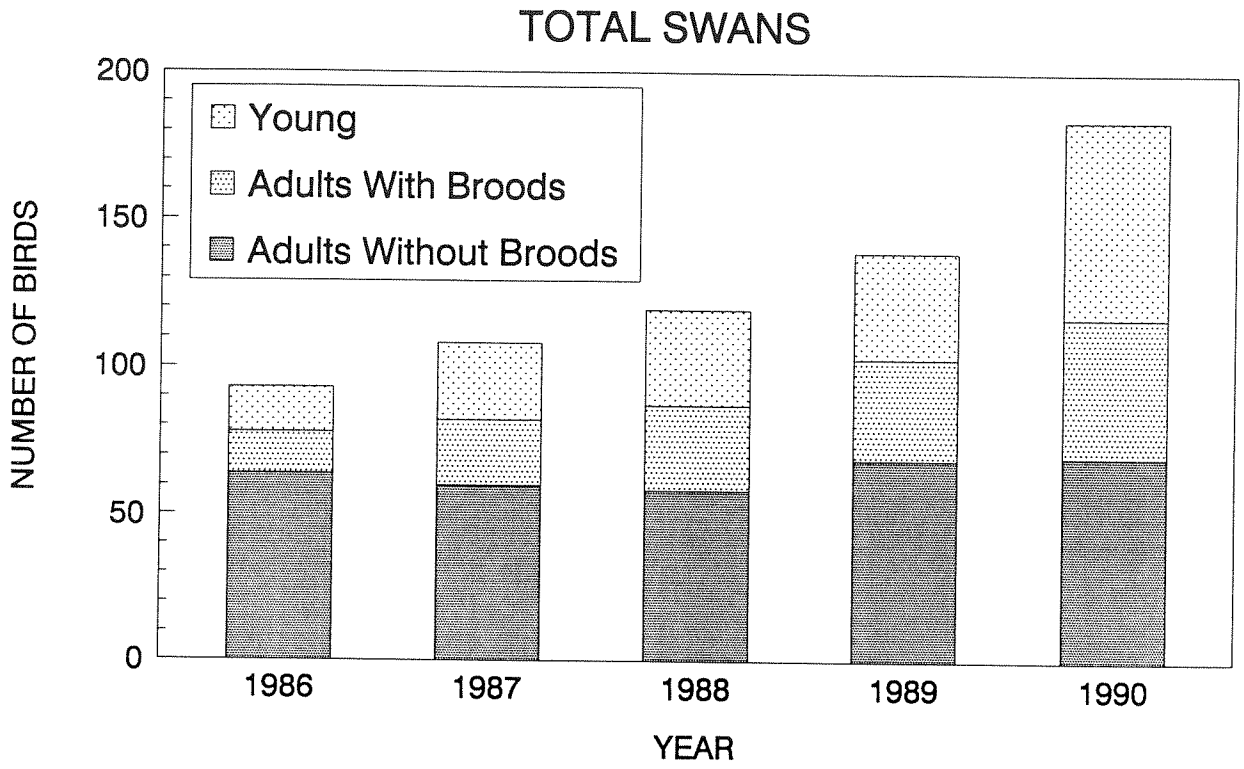

Figure 3. Numbers of Tundra Swans observed during aerial surveys in the Beechey Point B-5 quadrangle (central Kuparuk Oilfield), Alaska, August 1986-1990. (1988 values are means of combined USFWS and ABR surveys, see Appendix A6).

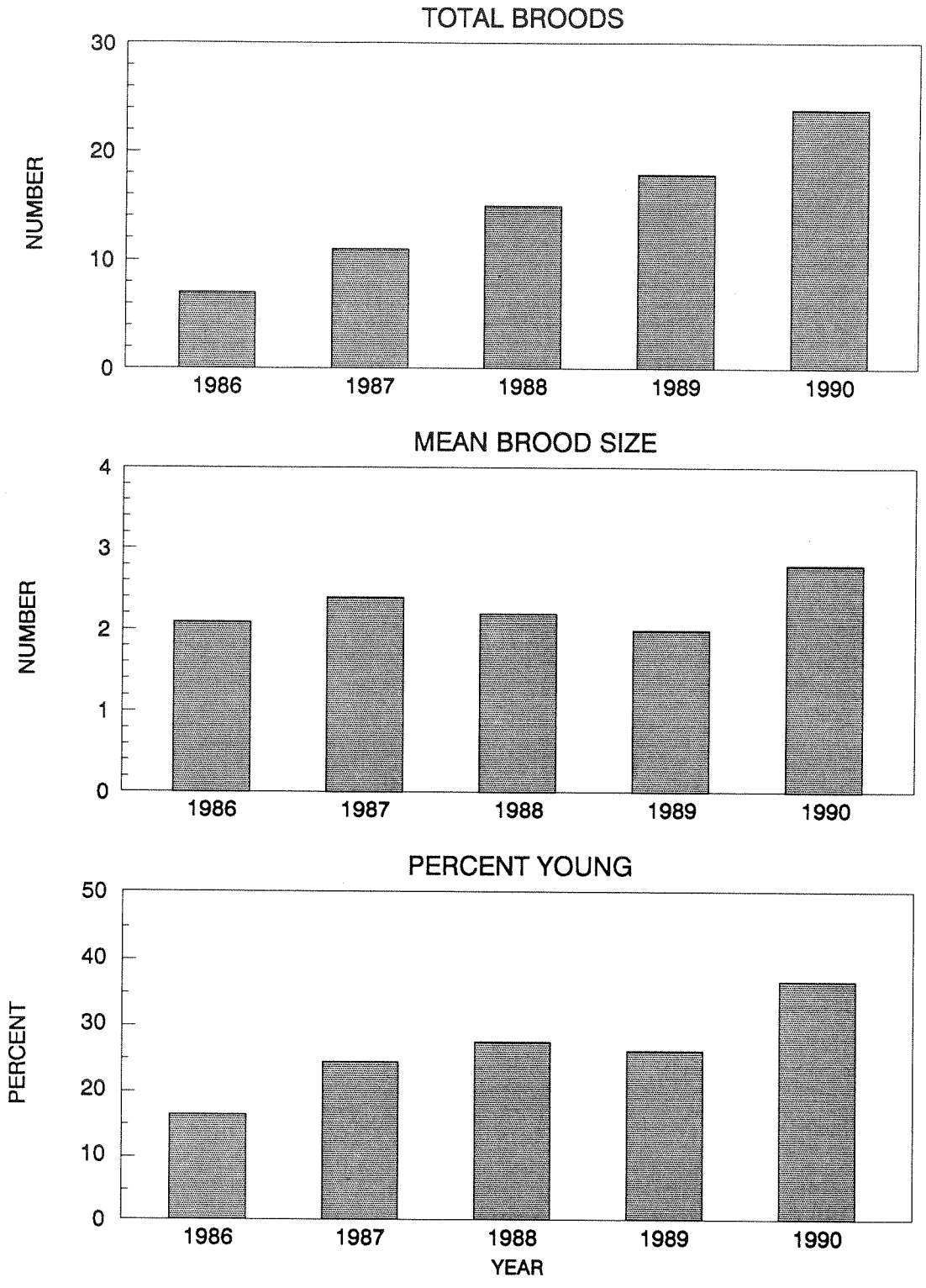

Figure 4. A comparison of total broods, mean brood size, and percent young of Tundra Swans observed during aerial surveys in the Beechey Point B-5 quadrangle (central Kuparuk Oilfield), Alaska, August 1986-1990.

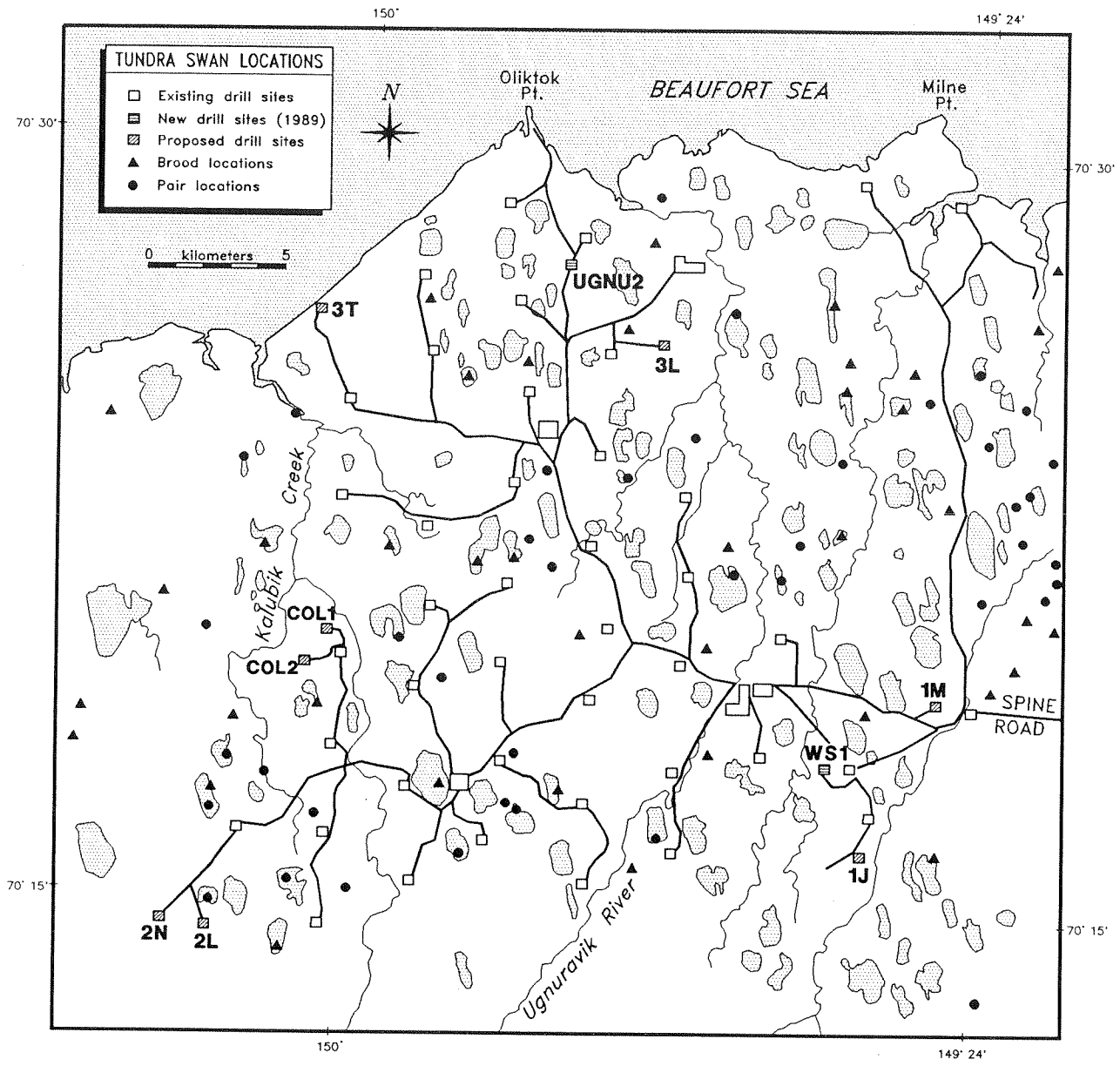

Figure 5. Locations of Tundra Swan pairs and broods observed during aerial surveys in the central Kuparuk Oilfield, Alaska, 19-23 August 1990. (This map does not depict the entire study area nor all locations discussed in the text).

PRUDHOE BAY OILFIELD STUDY AREA

Swan Distribution in June

Eighty-two Tundra Swans were observed at 52 locations in the Prudhoe Bay Oilfield study area during nesting surveys conducted between 21-22 June (Table 8, Appendix Table A7). Twenty-six Tundra Swan nests were located in the study area; nests were located throughout the study area from very near the coast to as far south as 70°08'N. Swans were uniformly distributed wherever large lakes and drained lake basins occurred. Nests were located at elevations from slightly above sea level near the coast to 23 m asl further inland, while swan pairs without nests were found up to 30 m asl.

Densities (per km^2) of nests and adults with nests located during June surveys in the Prudhoe Bay Oilfield Study Area were very similar to those in the Kuparuk/OGL 54 Study Area (Table 9). Densities of adult swans without nests, however, were substantially lower in the Prudhoe Bay unit than in the Kuparuk/OGL 54 study areas.

Swan Productivity and Distribution in August

One hundred sixty-nine Tundra Swans were observed at 55 locations in the study area. These included 108 adults, and 22 broods containing 61 cygnets (Table 10, Appendix Table A8). Forty percent of all adult swans were with broods.

The number and density of adult swans increased 32% between June and August, due largely to an increase of 55% in the number of adults without young. The number of adults with young increased only 8% during the same period.

Twenty-six Tundra Swan nests were located in June and 22 broods were observed in August, indicating approximately 85% nest success. Mean brood size was 2.8 (S.D. $\pm$1.1) and the percent of young in the population was 36% (Table 10). Swan broods were distributed throughout the study area from very near the coast to as far south as 70°08'N. Both broods and pairs without

Table 8. Numbers of Tundra Swans and nests recorded during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, 21-22 June 1990.

Location USGS quadrangle		Adults With Nests	Nests			Adults Without Nests					Total Swans
			With Pair	With Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
Beechey Point	A-3	11	3	5	8	7	6	1	3	23	34
	A-4	3	0	3	3	3	4	0	0	10	13
	B-3	18	7	4	11	2	1	0	0	5	23
	B-4	8	4	0	4	0	1	1	3	4	12
TOTAL		40	14	12	26	12	12	2	6	42	82

Table 9. Densities of Tundra Swans and nests (per km^2) recorded during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, during June and August 1990.

Location USGS quadrangle		Nesting Survey (June)				Productivity Survey (August)					
		Adults With Nests	Nests	Adults Without Nests	Total Swans	Adults With Broods	Broods	Young	Adults Without Broods	Total Adults	Total Swans
Prudhoe Bay Oilfield											
Beechey Point	A-3	0.03	0.03	0.07	0.11	0.05	0.03	0.08	0.05	0.10	0.19
	A-4	0.03	0.03	0.09	0.11	0.03	0.02	0.03	0.10	0.13	0.17
	B-3	0.07	0.04	0.02	0.08	0.05	0.03	0.07	0.11	0.16	0.24
	B-4	0.11	0.06	0.06	0.17	0.11	0.06	0.16	0.10	0.21	0.37
TOTAL		0.05	0.03	0.05	0.11	0.06	0.03	0.08	0.08	0.14	0.22

Table 10. Numbers of Tundra Swans and broods recorded during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, 19-24 August 1990.

Location USGS Quadrangle		Adults With Broods	Broods			Total Young	Mean Brood Size	Adults Without Broods					Total Adults	Total Swans	Percent Young
			With Pair	With Single Adult	Total			Pairs	Singles	Flocks	Flocked Swans	Total			
Beechey Point	A-3	16	8	0	8	26	3.3	5	1	2	6	17	33	59	44.1
	A-4	4	2	0	2	4	2.0	3	2	1	3	11	15	19	21.1
	B-3	15	7	1	8	20	2.5	8	4	3	10	30	45	65	30.8
	B-4	8	4	0	4	11	2.8	3	1	0	0	7	15	26	42.3
TOTAL		43	21	1	22	61	2.8	19	8	6	19	65	108	169	36.1

broods were located at elevations from very near sea level at the coast to 23 m asl further inland.

As was the case in June, swan densities in August in the Prudhoe Bay unit were very similar to those in the Kuparuk/OGL 54 Study Area for all categories except adults without broods (Table 9). In this category, densities were substantially lower (0.08 compared to 0.12) in the Prudhoe Bay unit.

DISCUSSION

Except for nonbreeding birds, the numbers of Tundra Swans in all parts of the study area were substantially higher in 1990 than in 1988 and 1989. This was due mainly to a larger number of adults attending nests in June, as well as higher nesting success and a larger mean brood size than recorded in previous years. Two factors probably contributed to these increases. The first was the mild spring in 1990, which resulted in suitable nesting habitat being available early, and probably reduced competition for nest sites. Timing of spring has been identified as a major factor influencing the productivity of Tundra Swans (Lensink 1973, McLaren and McLaren 1984). The second factor was the large number of potential breeders available in the population, due to good productivity in previous years. Numbers of swans and brood sizes on the Colville River were also substantially higher in 1990 than in 1989 (ADF&G 1990).

For all categories except adults without broods, the densities of swans in August were higher in the Kuparuk Oilfield than in OGL 54. Possible reasons for this apparent difference include emigration of adults and broods from OGL 54 into the Kuparuk Oilfield, and lower detectability of swans in OGL 54. It is also possible that swan densities were higher in the Kuparuk Oilfield due to more favorable habitat conditions in this area, which contains more coastal habitats than OGL 54. Canadian studies have shown higher densities of swans in coastal lowlands (McLaren and McLaren 1984, Stewart and Bernier 1989).

Even with the substantial increase in 1990, densities of both breeding and nonbreeding swans in the Kuparuk Oilfield and OGL 54 were low compared to those reported elsewhere in northern Alaska (King 1979, Hawkins 1983, Platte and Brackney 1987, ADF&G 1990, Campbell and Rothe 1990). Furthermore, the density of adults without nests was substantially lower in Prudhoe Bay than in the rest of the study area, for unknown reasons. The Kuparuk Oilfield and OGL 54 area has been described as having a low density

of swans (0.2 - 0.9 swans/km^2, USFWS, Distribution and Abundance of Swans in Alaska [map], no date). However, mean brood sizes from 1988 to 1990 were similar to those reported elsewhere in northern Alaska (Colville River delta, 1982-1990 [Hawkins 1983, Campbell and Rothe 1990, ADF&G 1990]; ANWR, 1981-1985 [Bartels and Doyle 1984, Platte and Brackney 1987]; Foggy Island Bay to the Colville River delta, 1982-1988 [Conant and Cain 1987, R. King, pers. comm.]) and similar to or higher than those reported for Tundra Swans in the northern part of their range in Canada (1.6 - 2.5, Boothia Peninsula, McLaren and McLaren 1984; 1.5 - 1.6, Canadian Eastern Arctic [Stewart and Bernier 1989]). The proportion of cygnets was within the range reported for other Alaskan and Canadian populations of Tundra Swans (McLaren and McLaren 1984, Platte and Brackney 1985, Wilk 1988, Stewart and Bernier 1989, ADF&G 1990) and mean brood size was similar to historical estimates for the Arctic Coastal Plain (King 1970).

The swans nesting in the study area are part of the eastern population of Tundra Swans (Johnson and Herter 1990), which grew substantially between 1960 and 1982 may also have increased more recently (Stewart and Bernier 1989). The survey data for the study area from 1986-1990 suggest an upward trend, although little is known about long-term variation in the swan population in this area. Swan populations in other areas are known to fluctuate; for example, 9 years of survey results for the Colville River delta show more variation than our study area, but no clear trend (ADF&G 1990). The nesting habitat in the Kuparuk Oilfield/OGL 54 study area is probably less favorable than that on the Colville River delta, but is also less saturated. Additional years of data collection will be necessary to determine trends in the swan population of the Kuparuk Oilfield/OGL 54 study area.

The survey technique used in this study was useful for providing a general census of Tundra Swans using the Kuparuk Oilfield/OGL 54 study area. However, some swans, nests and broods were undoubtedly missed. Ground surveys by the U. S. Fish and Wildlife Service indicated that site-specific

evaluation of swan use, especially in the vicinity of a proposed drill site (DS 3L), would require a more intensive sampling technique than the one employed in this study.

PART 2: REGIONAL BRANT SURVEYS

METHODS

AERIAL SURVEYS

Aerial surveys were used to locate Brant nests in June, and to locate brood-rearing areas and count adults and goslings in July (Table 11). Brant nests were located using a Cessna 185 with a pilot and two observers. A "Supercub" PA-18 with a pilot and one observer was used for brood-rearing surveys. In most areas, surveys were flown at approximately 100-150 m above ground level (agl) and at approximately 80-100 km/h airspeed. Over preferred Brant nesting habitats, one or two lower passes (~50 m agl) were made. These preferred habitats, consisting of lakes or wetlands with numerous islets (Einarsen 1965, Bergman et al. 1977, Derksen et al. 1979), were identified from examination of aerial photos and USGS maps, and marked on navigational maps prior to surveys. Because nesting Brant often are difficult to count from the air, and the number of low passes in nesting areas was limited to avoid unduly disturbing the birds, counts were conservative.

During the nesting survey (22 June), each observer scanned an area approximately 800 m wide on one side of the aircraft, while the pilot navigated and scanned ahead of the aircraft. The flightline and all observations were recorded on a set of 1:63,360 USGS topographic maps. Sightings were reported to the observer in the right front seat, who was responsible for plotting all Brant observations. Each observation included estimated numbers of adults and nests. A nest was recorded if either a distinctive down-filled bowl or an adult in a concealment or incubation posture was observed.

Generally, the survey aircraft was flown between selected lakes within broad east-west transects (~3.2 km). Surveys extended inland to approximately 70°10'N west of the Sagavanirktok River and to approximately 70°15'N east of the river. Because river deltas often contain habitats that are

Table 11. A summary of Brant aerial surveys conducted along the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June - July 1990.

Survey Type	Date(s)	Location[1]	Aircraft	Technique	Observers[2]
Brant nests	22-23 June	Miluveach R. to Staines R. inland to 10 km	C-185	Circuitous route, through suitable habitat, 0.8 km transects of river deltas.	RJR, JGK
Brant brood-	18 July	Kuparuk Delta and coastline (Back Pt. to Storkerson Pt.)	PA-18	Transect along coastline and delta channels	JGK
	26 July	Coastline, Miluveach R. to Staines R.	PA-18	Transect along coastline (approximately 0.8 km inland)	RJR
	26 July	All Brant nest areas identified during June surveys and adjacent water-bodies	PA-18	Circuitous route, waterbody to waterbody	RJR
	29-30 July	Resurvey of coast-line (Kadleroshilik R. to Miluveach R.)	PA-18	Transect along coastline	RJR

[1] Locations are mapped on Figure 1.

[2] Observers: RJR = Robert J. Ritchie
JGK = James G. King

important for Brant nesting (Bellrose 1978), parallel transects 800 m wide were flown over the Kuparuk, Kadleroshilik, and Kavik river deltas. In addition, all nest locations identified in 1988 and 1989 were revisited.

Two brood-rearing surveys were conducted (26 and 29-30 July) after most broods had congregated in preferred coastal habitats. The survey route followed the coastline as closely as possible, extending inland to include embayments and the outer reaches of river deltas. During these surveys, nest locations recorded in June were also revisited, to determine the extent of use of these areas for brood-rearing.

In addition, a survey was conducted between the Putuligayuk River and the west side of the Kuparuk River Delta on 18 July (Sections 3 and 4). The purpose of this flight was to provide additional information on Brant distribution near the Kuparuk River delta during oil boom deployment training.

Small (< 50) groups of Brant were counted directly; large (> 50) groups were counted from aerial photos. The aircraft circled over brood-rearing groups and photographs were taken using a 35 mm SLR camera with 135 mm lens and Ektachrome (160-200 ASA) color slide film. Transparencies were projected onto white paper, and adults and goslings were counted.

Numbers of Brant per kilometer (excluding inland observations) were determined for the five coastline sections defined in Figure 1. Distances used to compute these linear densities were derived from measurements of the coastline on USGS 1:63,360 maps; all major bays and intrusions were included. The proportion of goslings in the total number of Brant was calculated for each section and for the region as a whole.

GROUND SURVEYS

Ground surveys were used to collect information on phenology, nest success and productivity of the Howe Island colony. Additional productivity information was collected from a number of other colonies including Duck Island, Surfcote, and the Kuparuk River delta, and along the road systems in

the Kuparuk Oilfield.

Brant Nesting Phenology

Information on the use of Howe Island and the outer Sagavanirktok River delta (Section 2) by Brant from 1985-1988 was collected opportunistically in conjunction with an ongoing monitoring program for Snow Geese (see Burgess et al. 1990). In 1989, field studies were implemented specifically to collect more detailed information on the distribution and productivity of Brant. In 1986-1990, data on the phenology of use of Howe Island by Brant were obtained through daily scans from an observation blind located on high dunes 700 m directly south of the island (Figure 6), using a variable-power spotting scope (20-45x).

Estimated distributions of dates of nest initiation and hatching in 1989 and 1990 were based on observations of broods dispersing from the Howe Island colony. The date of hatching of each brood was assumed to be one day before its dispersal (Barry 1956). The date of initiation of each nest was calculated by subtracting the combined incubation (24 days; Barry 1956) and laying periods from the estimated hatching date. The laying period was estimated by multiplying the brood size at dispersal by the rate of laying (1.3 days/egg; Barry 1956).

Brant Productivity

Post-hatch ground censuses of nests were conducted in mid-July on Howe Island in 1985-1990, and on Duck Island (Section 2) in 1985-1987 and 1989-1990. Both islands were searched for nests of Brant and Snow Geese, as well as other species. Nest locations were mapped on an acetate overlay of a high altitude vertical photograph (Howe Island: all years; Duck Island: 1989-1990) and nest contents were examined to estimate nesting success (Girard 1939). Because Brant nest contents are vulnerable to destruction by gulls and wind (the down blows away), estimates of nest numbers and success

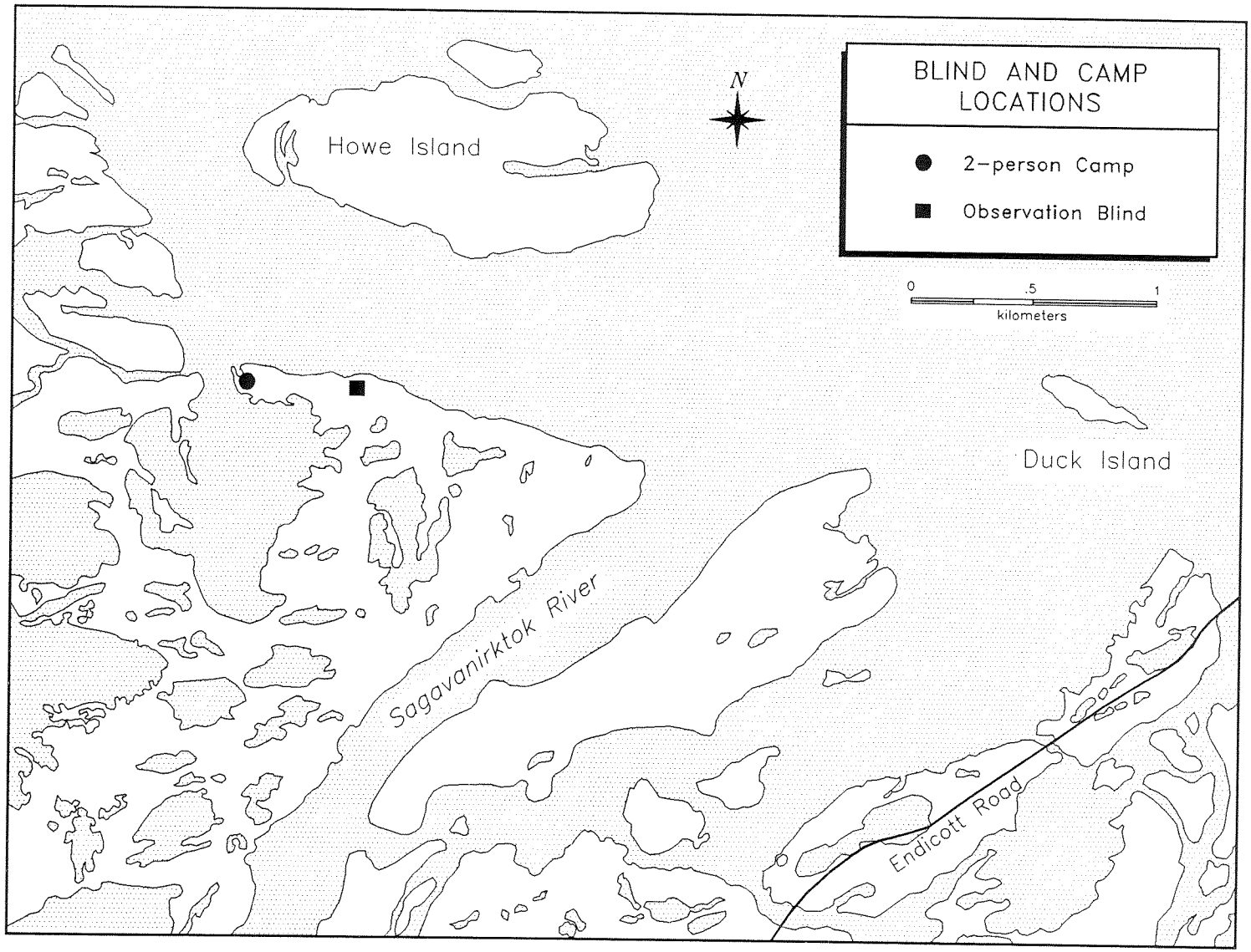

Figure 6. Location of camp and blind for observations of Brant in the Howe Island colony, Alaska.

derived from post-hatch censuses are conservative. On Duck Island, large numbers of incubating Common Eiders (*Somateria mollissima*) and brooding Glaucous Gulls were present during the census. All nests were located and mapped, but active eider nests were not examined. Some abandoned Brant nests may have been missed in the counts because they had been taken over by eiders.

Previous observations suggested that Brant broods from Howe and Duck islands mix with broods hatched at other locations, especially at the mouth of the Putuligayak River (B. A. Anderson, ABR, pers. comm.). Estimation of gosling survival therefore required data on the number of goslings hatched in the entire region between the Kadleroshilik River and Pt. McIntyre (Sections 1, 2, and the eastern half of 3; Ritchie et al. 1990). The range for the number of goslings hatched on Howe Island was calculated by multiplying the mean observed size of broods dispersing from the island by both the minimum and maximum estimated numbers of successful nests. The minimum value included only known successful nests, while the maximum value included both successful nests and those of unknown fate.

Productivity of Brant nesting in the Surfcote colony (Section 3) was determined from examination of nest contents after hatching. Productivity was estimated for Brant nesting in other locations (Duck Island, the Niakuk Islands, Foggy Island, inland areas of the Sagavanirktok River delta, and the upper Putuligayuk River). The number of nests at each of these locations was multiplied by the average nesting success (for the Howe Island and Surfcote colonies combined) to estimate the number of successful nests. This was multiplied by the mean brood size (for Howe Island) to estimate the total number of goslings hatched.

Gosling survival was estimated by comparing the numbers of adults and goslings at hatching with those observed during an aerial survey of the region on 30 July. It was assumed that failed breeders or nonbreeders observed in the area in late June remained there throughout the brood-rearing period, so counts

of nonbreeders made during June surveys were subtracted from the total count of adults made in July. Survival rates of individual broods proved impossible to calculate due to brood mixing.

Ground surveys were also conducted along the road system in the Kuparuk Oilfield (Section 4). Lakes and lake complexes where Brant nested in 1989 were visited in mid-June 1990 to assess nesting activity. Other lake complexes along the roads were also observed for possible nesting activity. In mid-July, nest censuses were conducted at selected nesting locations identified by either ground or aerial survey in June. Information collected during each census included the number of nests of Brant and other species, and an assessment of the fate of each nest. This was a reconnaissance study; neither phenological assessment of Brant use of the area nor an estimate of overall productivity was possible.

RESULTS

NESTING BRANT

Abundance and Distribution

Ground and aerial surveys in 1990 indicated that at least 517 Brant nests were present at 61 locations between the Miluveach River and the Staines River (Table 12; Figure 7, Appendix B). During aerial surveys, 182 of these nests were identified at 57 locations (21 solitary nest sites and 36 sites with ≥ 2 nests). Ground crews located nesting Brant at 4 additional sites: 17 nests in the Surfcote Colony in the LDA and 240 on the central Sagavanirktok River delta (the Howe Island and Duck Island colonies and one solitary nest). At the time of the aerial surveys, some nests and nesting locations probably had failed already; therefore our regional estimate is conservative.

No new large Brant colonies were located in the study area, but nesting Brant were recorded for the first time on Tigvariak Island and on islands in the Kadleroshilik and Staines river deltas. Nests were often found singly (37% of nests recorded on aerial surveys), but at least 14 locations had $\geq$ 5 nests (Figure 8). All surveys combined indicated that at least 1489 adult Brant were present in the region, including 477 Brant recorded in areas without nests and assumed to be nonbreeders (Tables 12, 13). Approximately 75% of these nonbreeders occurred in 10 large flocks, ranging in size from 18-60 birds ($\bar{x}$ = 36.6). A similar number (468) of adults without nests was recorded in 1989. In both years, groups of nonbreeders were observed on the coast in areas later used by brood-rearing and staging Brant.

Most Brant nests were located in wet tundra vegetation types including islets in ponds and lakes, flooded tundra in basin-complexes, and flooded, low-center polygons on islands in river deltas. Six nests were found on offshore islands and a gravel spit. As in 1989, nesting locations (colonies and isolated nest sites) were between 0.1 km and 23 km from the coast. Fifty-four percent of nesting locations were within 5 km of the coast. Mean distance to

Table 12. Distribution of Brant nesting locations and nests and their distances from the coast in sections of the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1990 and June 1989. Sections are as delineated in Figure 1.

Section of Study Area	1990							1989						
	Aerial Survey		Ground Survey		Combined			Aerial Surveys		Ground Surveys		Combined		
	No.	Loc.	No.	Loc.	No.	Loc.	(%)	No.	Loc.	No.	Loc.	No.	Loc.	(%)
1: Brownlow Pt. to Sagavanirktok R.	19	6	-	-	19	6	(4)	11	5	-	-	11	5	(3)
2: Sagavanirktok R. Delta	1	1	240	3	241	4	(46)	4	4	166	3	170	7	(44)
3: Heald Point to Kuparuk R.	24	8	17	1	41	9	(8)	21	6	16	5	37	11	(10)
4: Kuparuk R. to Kalubik Ck.	130	38[1]	143	13	208	38	(40)	151	39	-	-	151	39	(40)
5: Kalubik Ck. to Miluveach R.	8	4	-	-	8	4	(2)	13	5	-	-	13	5	(3)
Total	182	57	400	17	517[2]	61	(100)	200	59	182	8	382	67	(100)

1 Includes 13 nest locations also surveyed on the ground.
2 Total is probably conservative because more nests were found on ground surveys, but not all locations checked from the air were resurveyed on the ground.

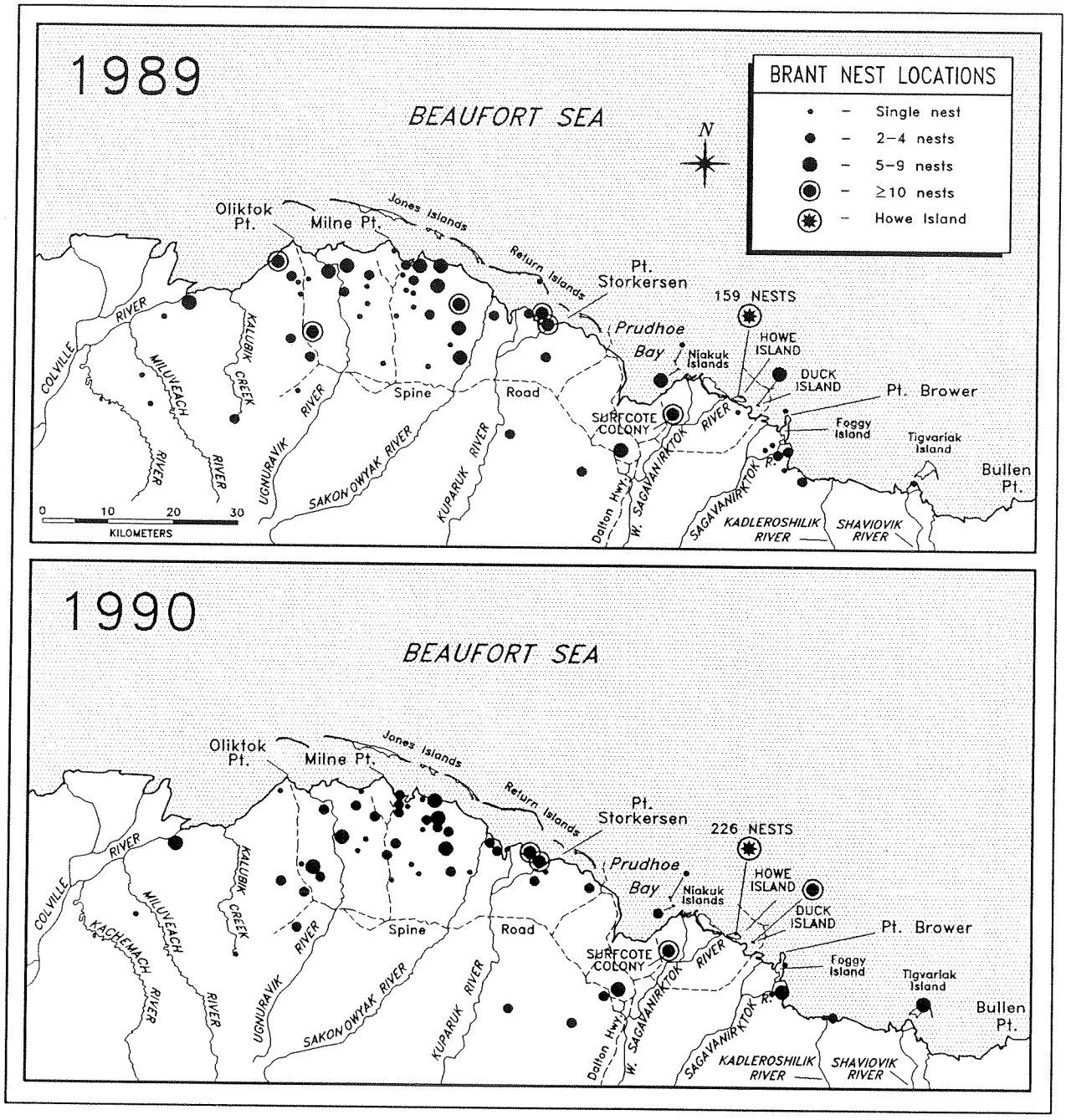

Figure 7. Locations (and sizes) of Brant colonies and solitary nests on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1989-1990.

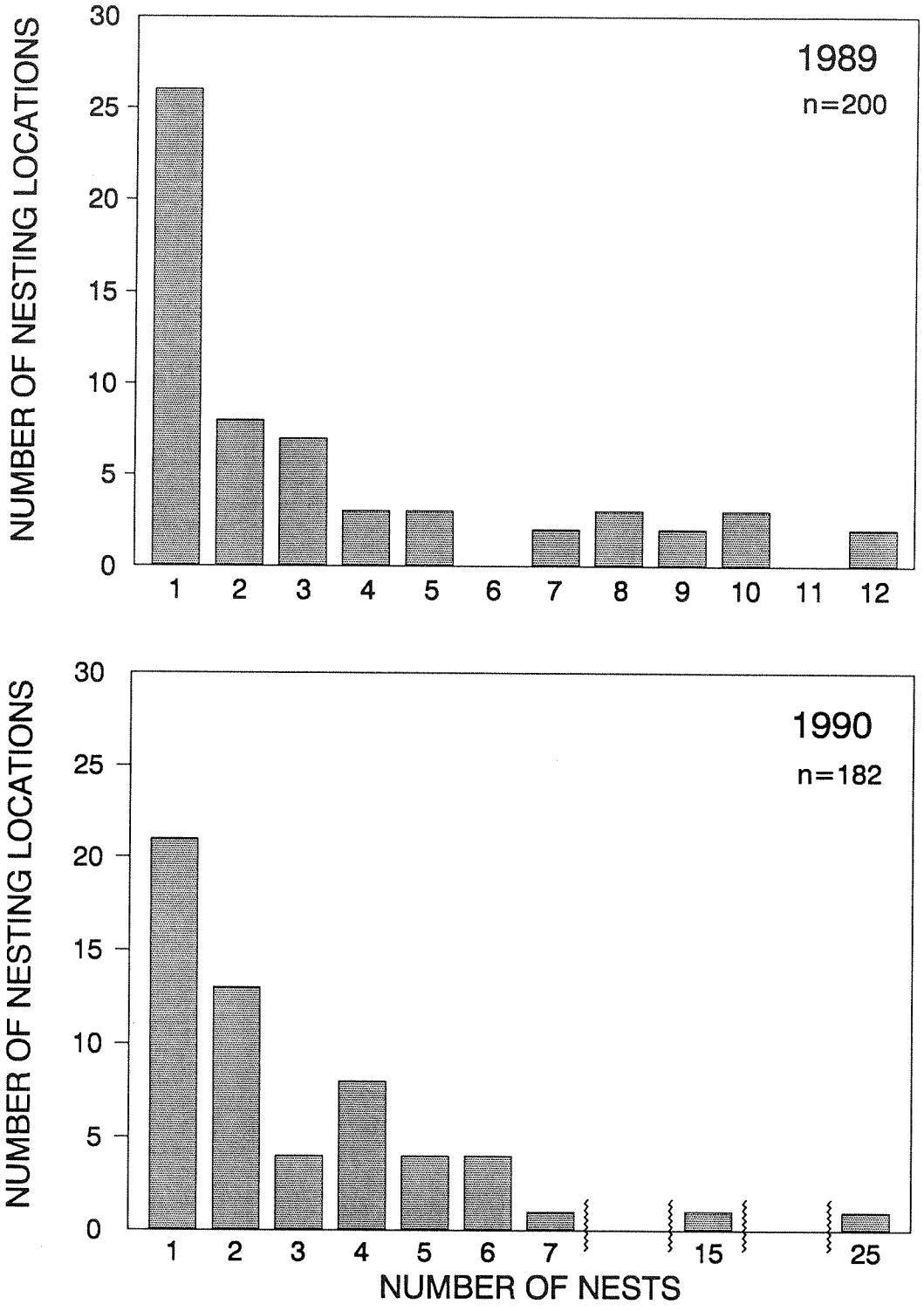

Figure 8. Frequency of occurrence of solitary nest sites and colonies of various numbers of Brant nests, as determined from aerial surveys between Brownlow Point and the Miluveach River, Alaska, June 1989-1990.

Table 13. Distribution of adult Brant on sections of the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1990 and June 1989. Sections are as delineated in Figure 1.

Section of Study Area	Nonbreeding Adults - 1990					Nonbreeding Adults - 1989				
	No.	(%)	$\bar{x}$ Flock Size	n	SD	No.	(%)	$\bar{x}$ Flock Size	n	SD
1: Brownlow Pt. to Sagavanirktok R.	46	(9.6)	9.2	5	11.8	101	(21.6)	14.4	7	14.3
2: Sagavanirktok R. Delta[1]	98	(20.5)	12.3	8	9.2	85	(18.2)	28.3	3	44.8
3: Heald Point to Kuparuk R.	57[2]	(11.9)	28.5	2	9.2	73	(15.6)	12.2	6	10.9
4: Kuparuk R. to Kalubik Ck.	176	(36.9)	11.7	15	18.7	124	(26.4)	9.5	13	14.7
5: Kalubik Ck. to Miluveach R.	100	(21.0)	50.0	2	14.1	85	(18.2)	42.5	2	21.9
TOTAL	477	(100.0)	14.9	32	17.5	468	(100)	15.1	31	19.5

[1] Does not include nonbreeders at large colonies on Howe and Duck islands or in the Lisburne Development Area.

[2] Includes ground count of nonbreeders at mouth of the Putuligayak River.

the coast for all nest locations was 5.4 km (SD = 5.6 km). Table 12 provides information on the abundance and distribution of Brant colonies and nests in each section of the Brant study area.

Section 1: Staines River (Brownlow Point) to Sagavanirktok River. Nineteen nests (10.4% of nests recorded on aerial surveys) were found at 6 locations in this region; all were within 2 km of the coast. Brant nests had been reported at 2 of these locations in 1989. Nesting had not been recorded previously at the remaining 4 locations, which included islands in the Kadleroshilik and Staines River deltas, and Tigvariak Island. Fewer nonbreeding adults were recorded on the Kadleroshilik River delta in 1990 (46) than in 1989 (101; Table 13).

Section 2: Sagavanirktok River Delta. Only 1 Brant nest (on a gravel spit east of Point Brower) was located during aerial surveys in this region. Solitary nests recorded at 5 other sites in 1989 apparently were not re-occupied in 1990. One nest was also identified by ground observers near the Endicott Road. Ninety-eight nonbreeding Brant were recorded at 8 widely scattered locations on the outer delta.

The Howe and Duck island colonies contained 239 Brant nests in 1990 compared to 165 in 1989. The number of nests on Howe Island has increased from 33 in 1984 to 226 in 1990 (Figure 9). In all years for which data exist (1984-1990), Brant nests were primarily distributed on the western half of Howe Island.

On Duck Island, the number of Brant nests decreased from 23 in 1984 to 6 in 1989, but increased to 13 in 1990 (Figure 9). Nesting on Duck Island appeared to be restricted entirely to the vegetated eastern half of the island.

Section 3: Heald Point to Kuparuk River. Twenty-four Brant nests (13.2%) were recorded at 8 locations during aerial surveys. As in 1989, nest locations

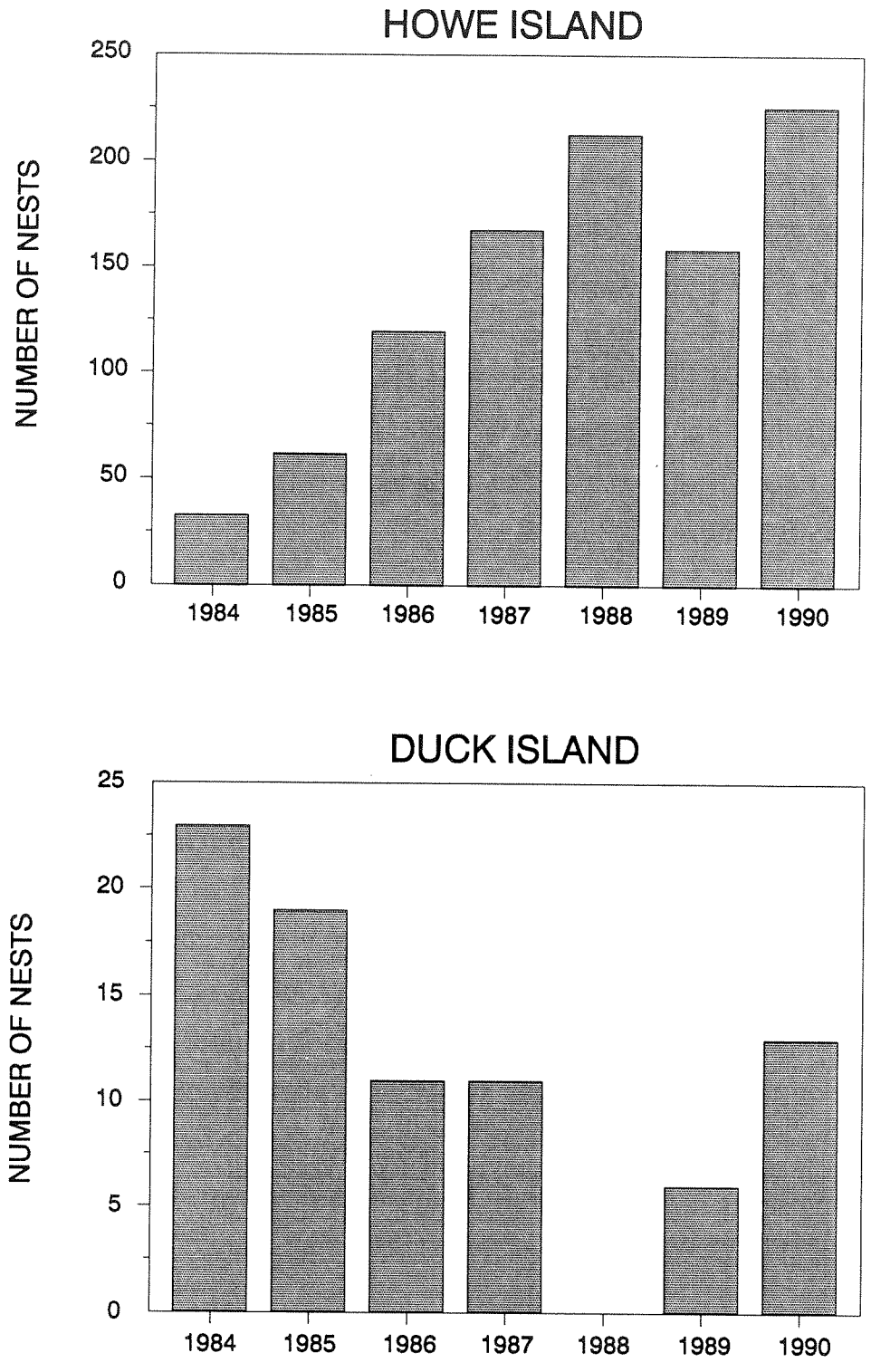

Figure 9. The number of Brant nests in the Howe and Duck island colonies, Alaska, 1984-1990.

included the Niakuk islands and lakes associated with the upper Putuligayuk River. Six of the 8 locations had also been occupied in 1989. A small colony was discovered in 1990 in wetlands south of Storkerson Point. A few nests were also located on a lake south of the Spine Road (near the Lake Coleen security checkpoint) that had been occupied in 1988. Thirty-five nonbreeding Brant were recorded near Storkerson Point and ground observers recorded 22 nonbreeders at the mouth of the Putuligayuk River (B.A. Anderson, pers. comm.)

An additional 17 nests were located by ground observers at the Surfcote Colony in the LDA, an increase over 1988 and 1989 (12 nests). This colony has varied between 12 and 28 nests since it was first monitored in 1983 (Murphy et al. 1990).

Section 4: Kuparuk River to Kalubik Creek. The majority of nesting locations (38, 67%) and nests (130, 71%) identified on aerial surveys were located in this section. The distribution, locations, and abundance of nests were similar to those reported in 1989. Most nests were dispersed on islands in small lakes within 10 km of the coast, but a large colony occurred on a few islands on the Kuparuk River delta. One hundred sixty-one nonbreeding Brant were recorded at 6 locations on the coast and 15 nonbreeders were recorded on inland lakes.

Within the Kuparuk Oilfield, 13 nesting locations were searched on the ground. At 6 locations along the road system in the Kuparuk River Unit and 5 locations along the Milne Point road system a total of 58 nests was found. The number of nests per nesting location ranged from 2 to 20 in the Kuparuk River Unit ($\bar{x}$ = 8.6 nests) and from 1 to 4 ($\bar{x}$ = 1.6) along the Milne Point road system. In addition, nest censuses were conducted on two small islands in the Kuparuk River delta, where 27 and 58 nests were found (Table 14).

Ground censuses were used to compare the actual numbers of nests at these nesting locations with the aerial survey results (assuming all nests were found during ground censuses) (Table 14). In general, the aerial counts were

Table 14. Number of nests, and percent success, located by ground surveys in the Kuparuk Oilfield, Alaska, in comparison with aerial survey counts of the same nesting locations.

Colony	No. of Nests	% Success	Aerial Survey Counts
Milne Point #1	4	75	2
Milne Point #2	1	100	1
Milne Point #3	1	100	0
Milne Point #4	1	100	-
Milne Point #5	1	100	1
Kuparuk Delta #1	58	84	25
Kuparuk Delta #2	27	59	15
KRU CPF-3	20	65	8
KRU 3B/2W	4	75	4
KRU 3N	5	40	0
KRU PIT E	9	0	0
KRU 1Y	10	40	4
KRU 2C	2	100	2
TOTAL	143	67	62

consistent with the actual nest numbers for locations with less than 10 nests, but tended to underestimate colonies with 10 or more nests. Two nesting locations (KRU 3N and KRU Pit E) in which no nests were detected by aerial surveys apparently suffered total failure sometime after the initial ground visits.

Section 5: Kalubik Creek to Miluveach River. Eight Brant nests were recorded at 4 locations between Kalubik Creek and the Colville River. All but one of these locations had been used in 1989. Islands in the Colville delta were not surveyed. As was the case in 1989, most Brant in this area were in large nonbreeding groups (Table 13).

Phenology, Productivity, and Gosling Survival

Early snow melt on the North Slope made nesting habitat available to Brant earlier in 1990 than in previous years, although persistent lake ice may have delayed nesting in some areas. Nest success estimates ranged from 0% (1 colony in the Kuparuk Oilfield, Section 4) to 94% (Surfcote colony, Section 3). Average brood sizes at hatch were similar in 1989 (2.9) and 1990 (3.0) (Howe Island data).

Brant nesting on Howe Island (Section 2) occurred somewhat earlier in 1990 than in previous years due to early snow melt. The first Brant arrived on 29 May, and Howe Island and the Sagavanirktok River delta were snow free at that time. Nest site selection began almost immediately after arrival, with peak nest initiation occurring between 30-31 May, compared to 7 June in 1989 (Figure 10). The estimated date of peak hatching was 30 June, a week earlier than the peak in 1989. Most Brant dispersed from Howe Island by 6 July.

Estimated nest success on Howe Island in 1990 ranged between 79% (including only successful nests) and 98% (including both successful nests and nests with unknown fates). In each year since 1986, nest success on Howe Island has been >75%, except for 1987 (54%; Figure 11). The average brood size observed at dispersal was 3.0 goslings (SD = 1.0, n = 134 broods).

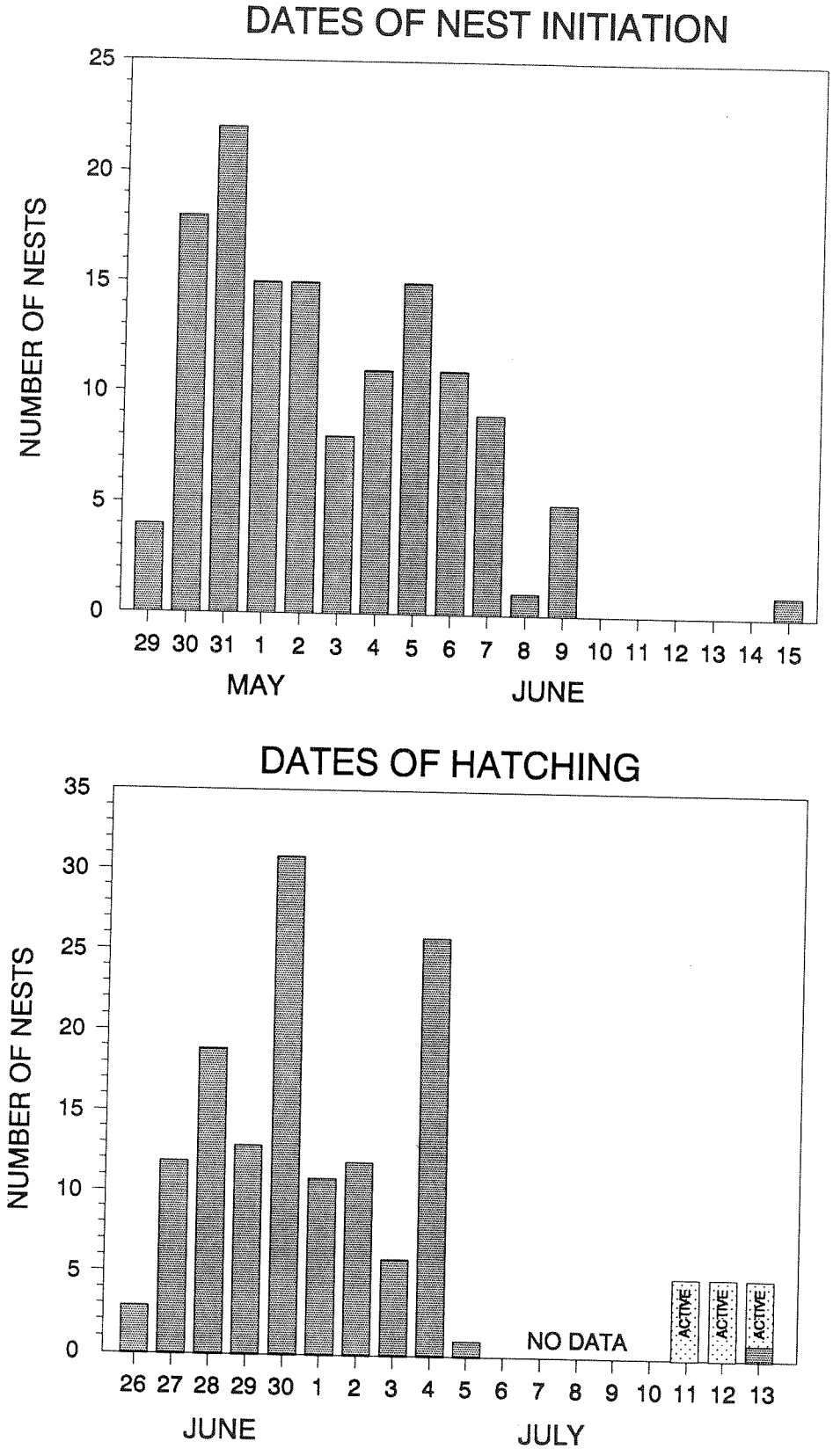

Figure 10. Dates of initiation and hatching for Brant nests on Howe Island, Alaska, 1990.

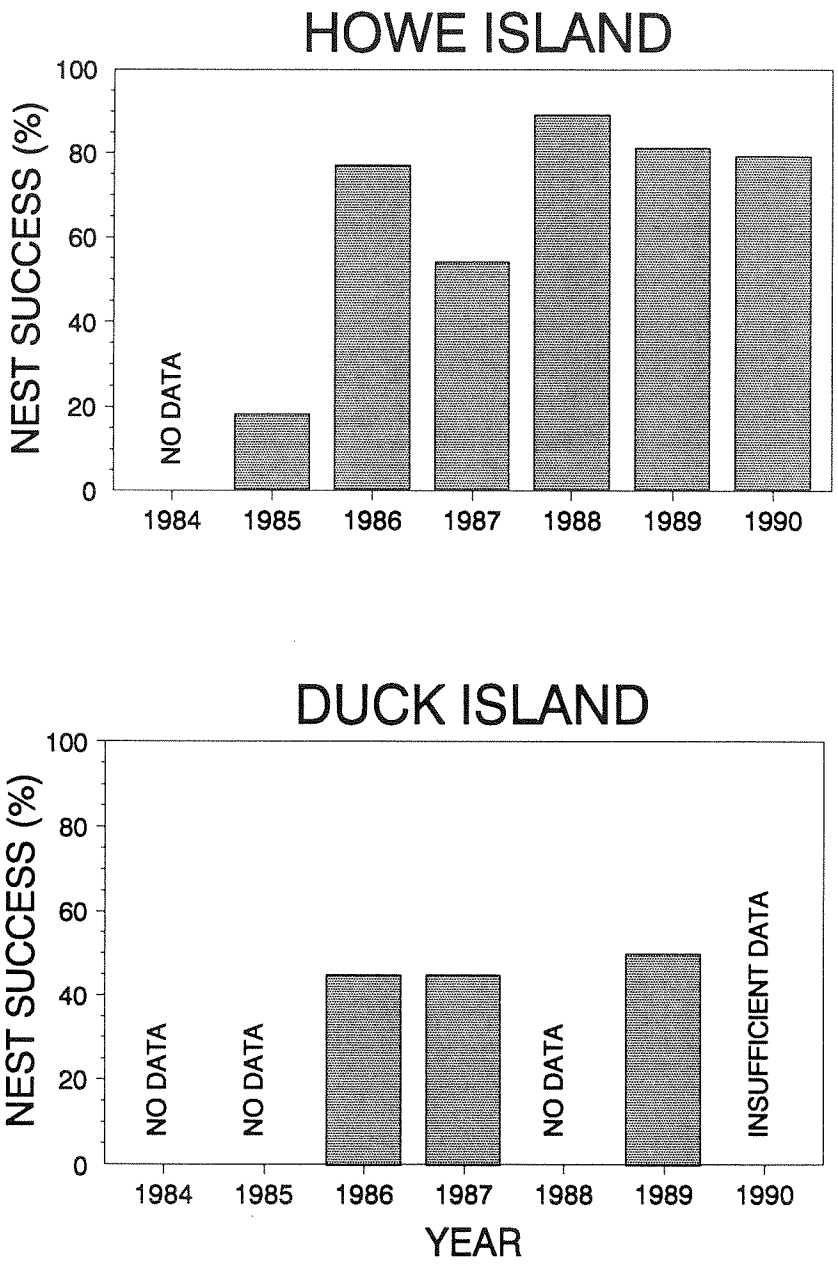

Figure 11. Nest success for Brant in the Howe and Duck island colonies, Alaska, 1984-1990.

Based on estimated brood size, the estimated number of goslings produced on Howe Island in 1990 was between 534 (using only successful nests) and 666 (including nests of unknown fate).

Causes of nest failure on Howe Island could not be determined from examination of nest contents. Glaucous Gulls were active in the colony throughout incubation in all years and probably destroyed some nests. Other predators that might have influenced nest success and productivity in 1990 included Snowy Owls (*Nyctea scandiaca*) and Peregrine Falcons (*Falco peregrinus*).

Nesting success of Brant was lower on Duck Island than on Howe Island for all years for which there were data (Figure 11). In 1990, fate could not be determined for 9 of 13 nests. The lower productivity of Duck Island in all years was undoubtedly due to the presence of a large Glaucous Gull colony on the island (32 nests in 1990).

In 1990, the lake at the Surfcote colony (Section 3) was ice-free earlier and water levels were lower than in the previous four years, making more habitat available for nesting (B.A. Anderson, ABR, pers. comm.). Nest success in the Surfcote colony ranged from a low of 0% in 1987 to a high of 95% in 1986; nest success in 1990 was estimated at 94%.

It was estimated that there were 296 nests between the Kadleroshilik River delta and Pt. McIntyre. Using the combined nesting success for the Howe Island and Surfcote colonies and the average brood size for Howe Island, it was estimated that 721-867 goslings were produced by the 592 adults in this area. At the end of July, there were 610 goslings and 595 adults in the same area (when nonbreeders were subtracted from total adults). Thus, mortality of goslings was estimated at 15-20% (Table 15).

Casual observations suggested that nesting phenology of Brant in the Kuparuk Oilfield (Section 4) lagged behind that of the Howe Island and Surfcote colonies, possibly due to persistent ice in many lakes through mid-June. Average success for all nesting locations searched in this area was 67%. For

Table 15. Estimated numbers of adult Brant and goslings at hatching in the region between Point McIntyre and Foggy Island Bay, Alaska, compared to the estimated numbers of adult Brant and goslings during brood-rearing.

Location	Hatching			Location	Brood-rearing[4]	
	No. Of Adults	No. of Goslings[1] (Low)	No. of Goslings[2] (High)		No. of Adults	No. of. Goslings
Howe Island	452	534	666	Sagavanirktok River Delta	99	99
Surfcote Colony	34	48	48	Heald Pt. to Pt. McIntyre	406	279
Duck Island[3]	25	~34	~37	Kadleroshilik River Delta	251	227
Central Sagavanirktok[3] River Delta	4	~6	~6	Coleen Lake	5	5
				Total Adults	761	610
East of Sagavanirktok[3] River Delta	24	~31	~35	Non- or Failed Breeders	166	
Prudhoe Bay[3] (excluding Surfcote)	32	~42	~46			
Niakuk Islands[4]	20	~26	~29			
Total Breeding Population	**592**	**721**	**867**	**Total Breeding Population**	**595**	**610**

1. Low estimates for Howe Island include only known successful nests.
2. High estimates for Howe Island include both successful and unknown fate nests.
3. No. of goslings estimated by using the combined average nesting success for Howe Island and Surfcote colony (87%-96%) and the average brood size at hatch for Howe Island (3.0 goslings)
4. Information from photographs and aerial survey made on 30 July 1990.

the 6 nesting locations visited in the Kuparuk River Unit, the nesting success ranged from 0-100%, while the nesting success for the 5 locations along the Milne Point Road ranged from 75-100%. For the two islands censused in the Kuparuk River delta, nesting success was 59% and 84%.

Causes of nest failures could not be determined, but probably included Glaucous Gulls and arctic foxes (*Alopex lagopus*). Five of the 6 nesting locations searched in the Kuparuk River Unit had at least one associated Glaucous Gull nest (range = 1-17 nests), and arctic foxes were regularly seen between CPF-3 and Oliktok Point. Three of the 5 nesting locations along the Milne Point road system had 1 Glaucous Gull nest each. No arctic foxes were observed at these locations, but they probably occurred in the area.

BROOD-REARING/MOLTING BRANT

Abundance and Distribution

Aerial surveys and photo censuses indicated that a minimum of 3200 Brant used coastal habitats between the Staines and Colville rivers in late July 1990 (Table 16, Appendix B). Nearly half of these (49%) were goslings. Average counts in 1990 represented an 83% increase in adults and a 158% increase in goslings over 1989 counts (Table 17). The proportion of goslings for the entire region was 0.48 in 1990 compared to 0.40 in 1989.

Most Brant (>98% of adults and goslings) were observed at 21 coastal locations (Figure 12). All of these sites were in or near arctic salt-marsh vegetation on tidal flats, lagoons, creek mouths, and river deltas within 0.8 km of the coast (Burgess and Ritchie 1989; Murphy et al. 1989). As was the case in 1989, few Brant were recorded in inland portions of the study area (21 adults and 20 goslings at four locations).

Areas used by large brood-rearing groups of Brant were similar in 1989 and 1990 (Figure 12). The largest groups were recorded near the mouth of the Putuligayuk River, and at creek mouths and embayments along Simpson Lagoon (especially near the mouth of the Ugnuravik River and Milne Point).

Table 16. The distribution, size, and composition of brood-rearing groups of Brant, as determined by two aerial surveys on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, 26 July and 29-30 July 1990.

Location	Km of Coastline	26 July Survey				29-30 July Survey			
				Linear Density				Linear Density	
		Adults	Goslings	Adults/ km	Gosling/ km	Adults	Goslings	Adults/ km	Gosling/ km
Coastal Sections									
1: Brownlow Pt. to Sagavanirktok R.	97	293	283	3.1	3.0	274	246	2.9	2.6
2: Sagavanirktok R. Delta	32	75	66	2.3	2.1	99	99	3.1	3.1
3: Heald Point to Kuparuk R.	45	444	334	9.9	7.4	434	295	9.6	6.6
4: Kuparuk R. to Kalubik Ck.	80	638	731	8.0	9.1	730	671	9.1	8.4
5: Kalubik Ck. to Miluveach R.	48	188	195	3.9	4.1	163	210	3.4	4.1
Subtotal (coast)	302	1638	1609	5.4	5.3	1700	1521	5.6	5.0
Inland Regions									
Kuparuk (inland)	na[4]	17	15	na	na	----------	not surveyed		----------
Prudhoe Bay (inland)	na	4	5	na	na	----------	not surveyed		----------
Subtotal (inland)	na	21	20	na	na	----------	not surveyed		----------
TOTAL	302	1659	1629	5.4	5.3	1700	1521	5.6	5.0

[1] Numbers are counts from photos and aerial counts (if photos were not available).
[2] Coastal sections are as shown in Figure 1.
[3] GOS:AD = Gosling:Adult ratio.
[4] na = Not applicable.

Table 17. A comparison of average counts of brood-rearing Brant (as determined by two late July aerial surveys) for the coastal regions between Brownlow Point and the Miluveach River, Alaska, 1989 and 1990.

Location	Average No. Adults			Average No. Goslings		
	1989	1990	(% Change)	1989	1990	(% Change)
1. Brownlow Point to Sagavanirktok R.	113	286	153	33	265	712
2. Sagavanirktok R. Delta	50	87	74	73	83	14
3. Heald Point to Kuparuk R.	234	439	88	121	315	161
4. Kuparuk R. to Kalubik Cr.	406	684	69	294	701	139
5. Kalubik Cr. to Miluveach R.	109	176	61	87	203	134
TOTAL	912	1672	83	608	1567	158

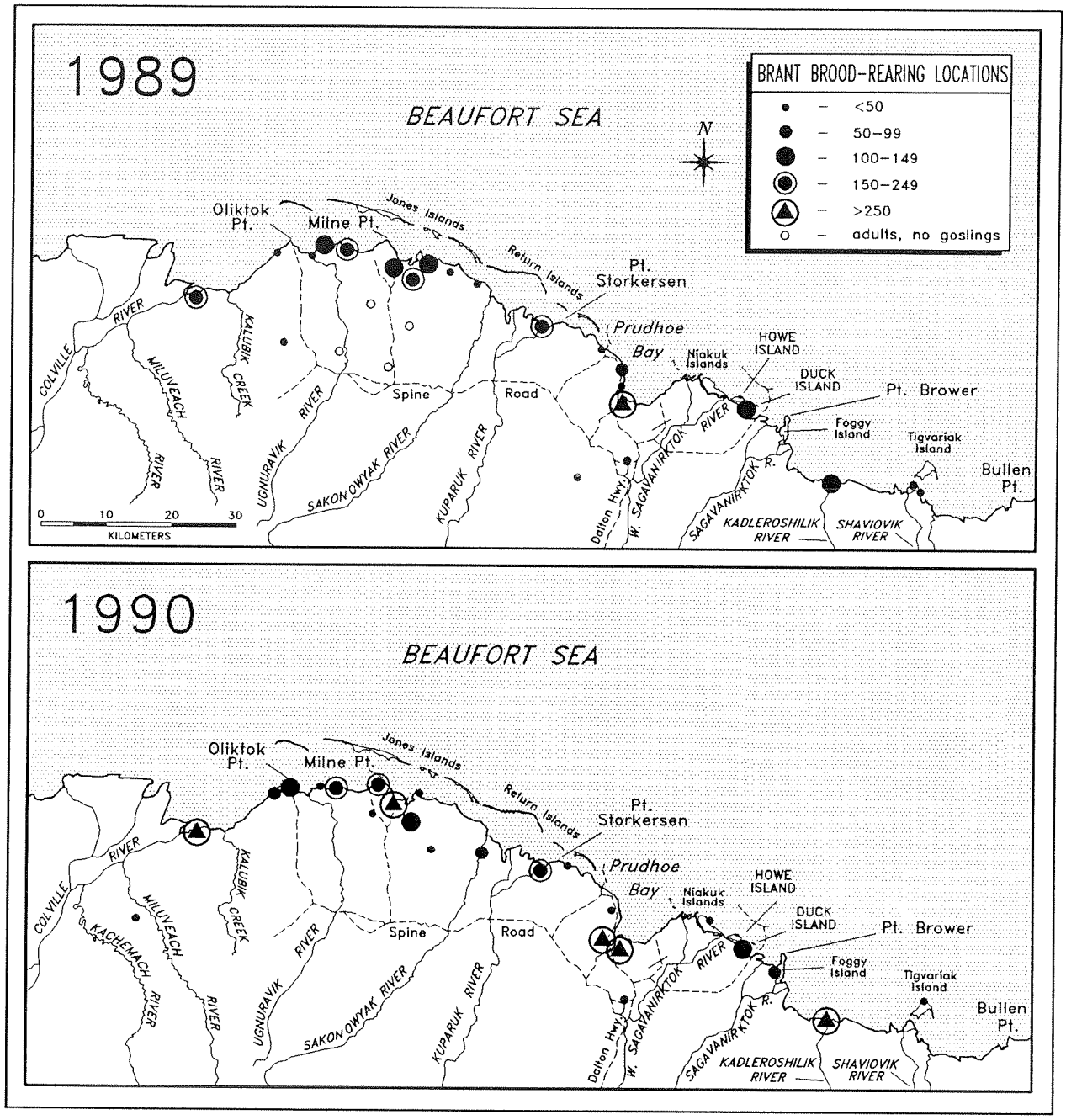

Figure 12. Locations and sizes of Brant brood-rearing groups on the Arctic Coastal Plain between Brownlow Point and Miluveach River, Alaska, July 1989-1990.

Brood-rearing locations first identified in 1990 were the mouth of the Sakonowyak River, the western shoreline of Foggy Island, and Tigvariak Island.

Densities of adult Brant were higher in 1990 than in 1989 (5.5 birds vs. 3.0 birds/km of coast) (Figure 13), and the number of goslings increased even more sharply (5.2 goslings/km in 1990 compared to 2.0 goslings/km in 1989). The highest densities of Brant occurred on the southwestern shoreline of Prudhoe Bay, within 10 km of Milne Point, and on the Kadleroshilik River delta. Brant were not recorded east of the Shaviovik River delta.

Section 1: Staines River (Brownlow Point) to Sagavanirktok River. Five hundred eighty-one Brant (293 adults and 283 goslings, approximately 17% of total) were observed in lagoons associated with the Kadleroshilik River delta on 26 July 1990 (Table 16, Figure 12). A smaller group (520 Brant) occupied the same lagoons on 30 July. Brant were also recorded on Tigvariak Island (23 adults,19 goslings) on 30 July. During aerial surveys for Snow Geese (Endicott Snow Goose Monitoring Program) on 23 July, similarly sized groups were observed in both areas.

The average number and density of Brant increased substantially along this section of coast in 1990 compared to 1989 (Table 17, Figure 13). The 712% increase in numbers of goslings was the largest recorded for any section (Table 16, Figure 13). However, this section had the second-lowest densities of adults and goslings. The proportion of goslings (0.48) was identical to that for the entire region, but higher than the proportion for this section in 1989 (0.23).

Section 2: Sagavanirktok River delta. Brood-rearing groups were recorded at three locations on tidal mudflats in the Sagavanirktok River delta on 26 and 29 July (Figure 12). These groups totalled 198 Brant (99 adults, 99 gosling: 5% of totals) on the 29 July survey (Table 16), but only 141 on 26 July. Brant were also recorded in these general locations during a Snow Goose survey on

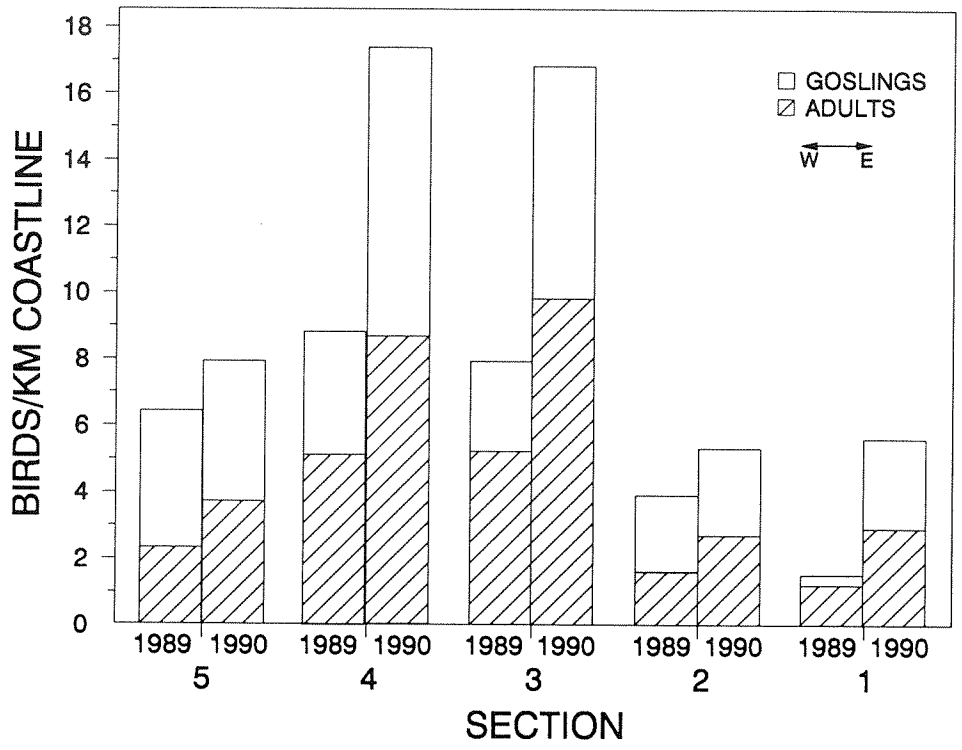

Figure 13. Linear densities of Brant in July in each of the coastal sections of the study area between Brownlow Point and Miluveach River, Alaska, 1989-1990. (Sections are as follows: 1 = Brownlow Point to Sagavanirktok River, 2 = Sagavanirktok River delta, 3 = Heald Point to Kuparuk River, 4 = Kuparuk River to Kalubik Creek, 5 = Kalubik Creek to Miluveach River.)

23 July (Burgess et al., in prep.).

Although the Sagavanirktok River delta supports the largest Brant colony in the study area, densities of brood-rearing Brant were relatively low in this section overall (2.7 adults and 2.6 goslings/km) (Figure 13). However, the level of use of this area in 1990 was similar to that in 1989. The proportion of goslings (0.49) was similar to that for the whole study area.

Section 3: Heald Point to Kuparuk River. More than 700 Brant (434-444 adults, 295-334 goslings: approximately 26% of all adults and 20% of all goslings) were recorded at three general locations in late July (Table 16, Figure 12). Most Brant (~83%) in this section were observed at the mouth of the Putuligayuk River, an area which was also used heavily in 1989. During an aerial survey on 18 July, approximately 450 Brant (210 adults, 245 goslings) were recorded at the mouth of the Putuligayuk River. Small brood-rearing groups of Brant were observed near Pt. Storkersen and along the northwest coast of Prudhoe Bay during the surveys (Figure 12). In addition to coastal locations, Brant (4 adults, 5 goslings) were observed 6 km inland at Lake Coleen, on 26 July. This site was also used in 1989.

The number of Brant recorded in this section was substantially higher than in 1989 (Table 17). As in 1989, this section had the highest density of adult Brant and the second highest density of goslings among the five sections surveyed (9.8 adults and 7.0 goslings/km; Figure 13). The proportion of goslings (0.42) was the lowest among the five sections (Table 16).

Section 4: Kuparuk River delta to Kalubik Creek. Approximately 1400 Brant (41% of all adults and 45% of all goslings) were observed at 11 locations in this section during aerial surveys in late July (Table 16, Figure 12). Principal areas of use in this section included a large embayment immediately east of the Kuparuk River, the area near Milne Point, and areas adjacent to the mouth of the Ugnuravik River (Figure 12). Most Brant near the coast were in salt-marsh

vegetation fringing these areas, as was the case in 1989. Two groups (7 adults, 7 goslings) were located on 26 July at inland sites (2.5 to 6.5 km from the coast) which had been identified as Brant nesting areas during June surveys.

Numbers, and consequently densities, increased substantially between 1989 and 1990 (69% more adults, 139% more goslings; Table 17). The average density of Brant goslings was higher between the Kuparuk River and Kalubik Creek than in any of the other coastal sections (8.7 goslings/km; Figure 13). The proportion of goslings (0.51) was similar to, but slightly higher than, the ratio for all sections combined (0.48).

No brood-rearing groups were recorded in the Kuparuk River delta or coastal areas and embayments west to Back Point on 18 July. No brood-rearing Brant were recorded in these areas in 1989, either. On 26 July, three groups (30 adults/25 goslings, 2 adults, 48 adults/58 goslings) were observed between the eastern channel of the Kuparuk River and a point approximately 4.8 km to the east. These groups probably combined to form the group using tidal areas immediately east of the Kuparuk River in late July (see Figure 12).

Section 5: Kalubik Creek to Miluveach River. One large group of Brant (163-188 adults and 195-210 goslings: approximately 11% of all adults, 13% of all goslings) was recorded on late July aerial surveys (Table 16). This group occupied large tidal flats adjacent to the east channel of the Colville River which were also used in 1989. A small group (10 adults, 8 goslings) also was recorded on 26 July at a large lake approximately 6.4 km from the coast, which had been identified as a nesting area in June.

Increases from 1989 were similar to those recorded in the Kuparuk region to the east (61% more adults, 134% more goslings; Table 17). The average density of adults and goslings ranked third among the coastal sections studied (3.7 adults and 4.2 goslings/linear km; Figure 13). The proportion of goslings (0.54) was slightly higher than that recorded for the whole study area.

DISCUSSION

NESTING

More Brant nested in the study area in 1990 than in 1989, but the numbers of nonbreeding birds present during nesting were similar in the two years. The increase in nesting effort was primarily due to larger numbers of nests in the existing large colonies rather than establishment of new colonies, although some new nesting locations were identified in 1990. More Brant nests were recorded on Howe Island in 1990 than in any previous year since monitoring began in 1984. Nest numbers in the Duck Island and Surfcote colonies were higher than in the previous 2-3 years. However, at locations in the Kuparuk Oilfield where ground searches were made, nest numbers in 1990 were similar to those in 1989 and lower than in 1988 (Hampton et al. 1988).

The number of solitary nests located by aerial surveys in 1990 was lower than in 1989. Solitary nests are difficult to locate from the air, even with extensive survey coverage, and their numbers may have been underestimated. Aerial surveys also tended to underestimate numbers of nests in larger colonies (>10 nests).

Reasons for the increased nesting effort in 1990 probably included a mild spring with early snow melt, lower than normal water levels, and reduced ice cover in some wetlands. Temperatures in May and June were 3 and 1.4°C above the 6-year means, respectively, compared to nearly average temperatures for the same months in 1989 (Burgess et al. in prep). Most nesting habitat was snow-free and available by the time Brant arrived on the North Slope in late May, and low water levels meant that more nest sites were available than in other years.

Barry (1962) concluded that nesting effort by Brant would be reduced in late years with persistent snow, and this has previously been documented for Snow Geese (Uspenski 1965) and Ross' Geese (Ryder 1967). Nesting by both Brant and Snow Geese on Howe Island was reduced in the late spring of

1989 (Ritchie et al. 1990, Burgess et al. 1990), and increased in response to early snow melt in 1990. Phenology of nesting by both species was advanced by 5-7 days in 1990 compared to 1989 (Burgess et al., in prep).

There may also have been more adult Brant available to nest in the area in 1990 than in 1989. Since 1986, the large colony on Howe Island has had reasonably good productivity (54-89% nesting success), the Surfcote colony has varied between 0 and 98% nesting success, and Duck Island has achieved at least 45-50% nesting success in 3 years. Moderate to good productivity in the past 4 years may have created a large pool of first-time breeders able to capitalize on the favorable nesting conditions in 1990.

Nesting success appeared to be high in 1990 for most parts of the study area. Successful nests constituted 94% of the nests on Howe Island whose fate could be determined; the percentage was 79% when all nests were considered. The higher estimate of Brant nesting success from the known nests was similar to the estimate for Snow Geese (Burgess et al. in prep.). West of the study area, the number of nests in the Colville River delta increased 43% from 1989, and nest success was over 90% (R. Meehan, USFWS, unpubl. data). The only part of the study area where nest success appeared to be lower than elsewhere in the region was along the road system in the Kuparuk River Unit, where most of the nesting locations were inland. Inland areas on the Yukon-Kuskokwim delta have been recognized as having lower nesting success than coastal nesting locations (Pacific Waterfowl Flyway Council 1981).

Average brood size did not increase in response to the favorable conditions, in contrast to Barry's (1962) findings in the Anderson River delta. However, the total number of goslings produced in the study area was higher than in previous years because of the large number of successful nests.

BROOD-REARING

Ritchie et al. (1989) summarized information on use of this portion of the Arctic coast by brood-rearing Brant. Only limited data were available, but a few

general points emerged:

- At least some lagoons and creek mouths were used repeatedly over several years. These included the mouths of the Ugnuravik, Putuligayuk and Kadleroshilik rivers, and the lagoons near Milne Point.

- Use of inland areas by Brant late in the brood-rearing period was limited.

- Brood-rearing Brant made little use of areas east of the Kadleroshilik River.

Surveys in 1990 continued to support these generalizations. The distribution of brood-rearing Brant was very similar to that seen in 1989 and in previous years (Ritchie et al. 1990)

The most striking observation in 1990 was that numbers of both adults and goslings were much higher than in 1989. The increase is attributable mainly to a combination of higher numbers of breeding Brant and high nesting success (discussed above), and high gosling survival. Approximately 80-85% of Brant goslings survived the first month after hatching in 1990, in contrast to an estimated survival rate of 50% for the same period on 1989. This may have been partly due to reduced predation by arctic foxes; predation was frequently observed during aerial surveys in 1989, but was less evident in 1990. Although accurate estimates of fox populations in the two years are not available, most observations suggested lower regional fox populations in 1990 than in 1989 (E. Follman, Univ. Alaska, pers. comm).

Productivity of Snow Geese on Howe Island was also higher in 1990 than in any other year since monitoring began. Productivity of Tundra Swans increased over 1989 levels in the Kuparuk Oilfield and OGL 54 areas (this report), and on the Colville River delta (T. Rothe, ADF&G, pers. comm.). Productivity of Tundra Swans in the LDA was similar to that in previous years

(B. A. Anderson, ABR, pers. comm.).

There was also an increase in Brant numbers in the study area during brood rearing compared to the total number of adults in June. There were three possible sources for this increase. First, not all solitary nests were located during the nesting surveys and these were probably the largest contributors to the increase. Second, nesting locations with >10 nests were often underestimated during aerial surveys. Third, brood-rearing Brant may have immigrated into the study area. In particular, the number of Brant observed in Section 5 (west of Oliktok Point) increased from June to July, with most of the increase probably due to Brant moving in from the Colville Delta.

The large increase in Brant numbers between 1989 and 1990 was probably not unusual; extreme yearly variation in productivity has been reported in other Brant populations (Barry 1962, Pacific Flyway Council 1981). Numbers of Brant on fall staging areas in southwestern Alaska have also differed widely among years (Conant 1989), reflecting annual variation in productivity in the western Arctic. Continued monitoring will be required to determine the range within which Brant populations in the study area can be expected to fluctuate. A longer-term data base will be needed in order to determine where the 1989 and 1990 numbers fall within that range.

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APPENDIX A

Appendix Table A1. Aerial survey coverage of USGS quadrangles in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 1990.

Location (USGS quadrangle)		Transect Length (km)	Aerial Coverage (km^2)	Percent* Coverage
Kuparuk Oilfield				
Beechey Point	A-4	172	275	100
	A-5	181	290	45
	B-4	283	453	100
	B-5	390	624	100
	C-4	1	1	100
	C-5	8	13	100
Harrison Bay	A-1	168	269	42
	B-1	260	417	100
	B-2	41	65	100
OGL 54				
	A-2	214	342	86
	A-3	63	101	100
Umiat	C-1	47	75	22
	C-2	102	163	50
	C-3	94	150	100
	D-1	65	104	90
	D-2	337	539	85
	D-3	228	365	100
Kuparuk Oilfield Total		1504	2407	
OGL 54 Total		1150	1839	
Total		2654	4246	

* Estimated survey coverage of the total area in the quadrangle within the boundaries of the study area.

Appendix Table A2. Aerial survey coverage of USGS quadrangles in the Prudhoe Bay Oilfield Study Area, Alaska 1990.

Location (USGS quadrangle)		Transect Length (km)	Aerial Coverage (km^2)	Percent* Coverage (%)
Beechey Point	A-3	198	318	100
	A-4	73	115	100
	B-3	173	275	100
	B-4	44	70	100
Total		484	778	

* Estimated survey coverage of the total area in the quadrangle within the boundaries of the study area.

Appendix Table A3. Numbers of Tundra Swans and Tundra Swan nests recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 17-22 June 1990.

Location (USGS quadrangle)		Quarter Quad	Adults With Nests	Nests			Adults Without Nests					Total Swans
				With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
Beechey Point	A-4	*NE	0	0	0	0	0	1	0	0	1	1
		SE	-	-	-	-	-	-	-	-	-	-
		*SW	0	0	0	0	1	1	0	0	3	3
		NW	15	6	3	9	5	1	0	0	11	26
		Total	15	6	3	9	6	3	0	0	15	30
	A-5	NE	1	0	1	1	2	1	0	0	5	6
		SE	0	0	0	0	1	0	0	0	2	2
		SW	0	0	0	0	1	0	1	4	6	6
		NW	0	0	0	0	1	0	0	0	2	2
		Total	1	0	1	1	5	1	1	4	15	16
	B-4	*NE	6	3	0	3	4	1	0	0	9	15
		*SE	4	1	2	3	0	4	0	0	4	8
		SW	12	6	0	6	2	7	0	0	11	23
		NW	22	9	4	13	2	6	0	0	10	32
		Total	44	19	6	25	8	18	0	0	34	78
	B-5	NE	14	5	4	9	2	5	0	0	9	23
		SE	6	2	2	4	4	5	2	6	19	25
		SW	4	1	2	3	4	8	0	0	16	20
		NW	8	3	2	5	3	2	0	0	8	16
		Total	32	11	10	21	13	20	2	6	52	84
	C-4	NE	-	-	-	-	-	-	-	-	-	-
		SE	-	-	-	-	-	-	-	-	-	-
		SW	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	0	0	0	0	0

Appendix Table A3. Continued.

Location (USGS quadrangle)		Quarter Quad	Adults With Nests	Nests			Adults Without Nests					Total Swans
				With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
	C-5	NE	-	-	-	-	-	-	-	-	-	-
		SE	0	0	0	0	0	1	0	0	1	1
		SW	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	1	0	0	1	1
Harrison Bay	A-1	NE	3	1	1	2	3	1	0	0	7	10
		SE	0	0	0	0	0	0	0	0	0	0
		SW	0	0	0	0	0	0	0	0	0	0
		NW	2	1	0	1	1	2	0	0	4	6
		Total	5	2	1	3	4	3	0	0	11	16
	A-2	*NE	8	3	2	5	0	2	0	0	2	10
		SE	8	3	2	5	2	2	0	0	6	14
		*SW	14	6	2	8	3	0	0	0	6	20
		*NW	0	0	0	0	0	0	0	0	0	0
		Total	30	12	6	18	5	4	0	0	14	44
	A-3	NE	-	-	-	-	-	-	-	-	-	-
		*SE	4	2	0	2	0	0	0	0	0	4
		*SW	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-
		Total	4	2	0	2	0	0	0	0	0	4
	B-1	NE	0	0	0	0	3	3	0	0	9	9
		SE	10	4	2	6	4	7	0	0	15	25
		*SW	10	4	2	6	5	2	0	0	12	22
		*NW	2	1	0	1	3	0	0	0	6	8
		Total	22	9	4	13	15	12	0	0	42	64

Appendix Table A3. Continued.

Location (USGS quadrangle)		Quarter Quad	Adults With Nests	Nests			Adults Without Nests					Total Swans
				With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
	B-2	NE	-	-	-	-	-	-	-	-	-	-
		*SE	3	1	1	2	1	5	0	0	7	10
		SW	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-
		Total	3	1	1	2	1	5	0	0	7	10
Umiat	C-1	NE	0	0	0	0	0	1	0	0	1	1
		SE	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-
		NW	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	0	1	0	0	1	1
	C-2	NE	0	0	0	0	2	0	0	0	4	4
		SE	-	-	-	-	-	-	-	-	-	-
		*SW	0	0	0	0	0	0	0	0	0	0
		NW	10	4	2	6	2	2	0	0	6	16
		Total	10	4	2	6	4	2	0	0	10	20
	C-3	*NE	7	3	1	4	4	2	1	4	14	21
		*SE	0	0	0	0	0	0	0	0	0	0
		SW	-	-	-	-	-	-	-	-	-	-
		*NW	0	0	0	0	0	0	0	0	0	0
		Total	7	3	1	4	4	2	1	4	14	21
	D-1	NE	0	0	0	0	0	0	0	0	0	0
		SE	0	0	0	0	0	0	0	0	0	0
		SW	0	0	0	0	0	0	0	0	0	0
		NW	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	0	0	0	0	0	0

Appendix Table A3. Continued.

Location (USGS quadrangle)		Quarter Quad	Adults With Nests	Nests			Adults Without Nests					Total Swans
				With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
	D-2	NE	2	1	0	1	2	0	0	0	4	6
		SE	0	0	0	0	3	2	0	0	8	8
		SW	3	1	1	2	8	2	0	0	18	21
		NW	15	5	5	10	6	2	1	49	63	78
		Total	20	7	6	13	19	6	1	49	93	113
Umiat	D-3	NE	5	2	1	3	2	4	0	0	8	13
		SE	6	3	0	3	7	1	0	0	15	21
		*SW	-	-	-	-	-	-	-	-	-	-
		*NW	0	0	0	0	0	0	1	3	3	3
		Total	11	5	1	6	9	5	1	3	26	37
Grand Total			204	81	42	123	93	83	6	66	335	539

* Partial coverage; entire quadrangle not included in the study area.

Appendix Table A4. Distances of new and proposed drill sites from Tundra Swan nests, broods and pairs without broods located during aerial surveys in June and August 1990.

Drill Site	June		August	
	Distance to Nearest Nest (km)	Distance to Nearest Pair (km)	Distance to Nearest Brood (km)	Distance to Nearest Pair (km)
West SAK[a]	1.0	3.4	2.1	6.5
UGNU[a]	3.2	4.3	3.3	4.1
COL 1	3.4	4.2	3.4	2.4
COL 2	1.5	2.7	1.6	3.5
1 J	2.2	2.5	2.8	7.3
1 M	3.2	1.4	2.1	4.1
2 L	2.5	1.0	2.8	0.7
2 N	4.8	2.7	3.7	2.2
3 L	1.4	1.8	1.5	2.5
3 T	6.2	4.5	4.1	4.5
Mean	2.9	2.9	2.7	3.8
S.D.	±1.6	±1.2	±0.9	±1.9

[a] New drill sites as of 1989.

Appendix Table A5. Numbers of Tundra Swans and Tundra Swan broods recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and the Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-23 August 1990.

Location (USGS Quadrangle)		Quarter Quad	Breeding Adults	Broods					Nonbreeding Adults							
				With Pair	With Single Adult	Total	Total Young	Mean Brood Size	Pairs	Flocked Singles	Flocked Flocks	Flocked Swans	Flocked Total	Total Adults	Total Swans	Percent Young
Beechey Point	A-4	*NE	0	0	0	0	0	0	1	1	0	0	3	3	3	0
		SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		*SW	0	0	0	0	0	0	1	2	0	0	4	4	4	-
		NW	8	4	0	4	11	2.8	8	2	0	0	18	26	37	29.7
		Total	8	4	0	4	11	2.8	10	5	0	0	25	33	44	25.0
	A-5	NE	0	0	0	0	0	0	1	1	2	7	10	10	10	0
		SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SW	0	0	0	0	0	0	1	0	0	0	2	2	2	0
		NW	0	0	0	0	0	0	1	0	0	0	2	2	2	0
		Total	0	0	0	0	0	0	3	1	2	7	14	14	14	0
	B-4	*NE	2	1	0	1	4	4.0	2	0	2	15	19	21	25	16.0
		*SE	6	3	0	3	8	2.7	4	1	0	0	9	15	23	34.8
		SW	20	10	0	10	24	2.4	6	3	2	7	22	42	66	36.4
		NW	17	8	1	9	19	2.1	12	7	1	6	37	54	73	26.0
		Total	45	22	1	23	55	2.4	24	11	5	28	87	132	187	29.4
	B-5	NE	14	7	0	7	20	2.9	5	5	1	3	18	32	52	38.5
		SE	9	4	1	5	17	3.4	4	4	1	3	15	24	41	41.5
		SW	14	7	0	7	21	3.0	9	6	0	0	24	38	59	35.6
		NW	10	5	0	5	9	1.8	3	4	1	3	13	23	32	28.1
		Total	47	23	1	24	67	2.8	21	19	3	9	70	117	184	36.4
	C-4	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table A5. Continued.

Location (USGS Quadrangle)		Quarter Quad	Breeding Adults	Broods			Total Young	Mean Brood Size	Nonbreeding Adults					Total Adults	Total Swans	Percent Young
				With Pair	With Single Adult	Total			Pairs	Singles	Flocked Flocks	Swans	Total			
	C-5	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harrison Bay	A-1	NE	2	1	0	1	2	2.0	4	0	0	0	8	10	12	16.7
		SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NW	4	2	0	2	8	4.0	3	0	0	0	6	10	18	44.4
		Total	6	3	0	3	10	3.3	7	0	0	0	14	20	30	33.3
	A-2	*NE	8	4	0	4	13	3.3	3	0	0	0	6	14	27	48.1
		SE	10	5	0	5	15	3.0	2	3	0	0	7	17	32	42.9
		*SW	8	4	0	4	12	3.0	6	1	1	5	18	26	38	31.6
		*NW	0	0	0	0	0	0	1	0	0	0	2	2	2	0
		Total	26	13	0	13	40	3.1	12	4	1	5	33	59	99	40.4
	A-3	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		*SE	4	2	0	2	3	1.5	1	0	0	0	2	6	9	33.3
		*SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total	4	2	0	2	3	1.5	1	0	0	0	2	6	9	33.3
	B-1	NE	5	2	1	3	9	3.0	3	2	2	6	14	19	28	32.1
		SE	14	7	0	7	20	2.9	6	1	0	0	13	27	47	42.6
		*SW	8	4	0	4	14	3.5	4	4	1	12	24	32	46	30.4
		*NW	4	2	0	2	8	4.0	2	1	1	3	8	12	20	40.0
		Total	31	15	1	16	51	3.2	15	8	4	21	59	90	141	36.2

Appendix Table A5. Continued.

Location (USGS Quadrangle)		Quarter Quad	Breeding Adults	Broods			Total Young	Mean Brood Size	Nonbreeding Adults					Total Adults	Total Swans	Percent Young
				With Pair	With Single Adult	Total			Pairs	Singles	Flocked Flocks	Swans	Total			
	B-2	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		*SE	4	2	0	2	5	2.5	5	2	2	8	20	24	29	17.2
		SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Total	4	2	0	2	5	2.5	5	2	2	8	20	24	29	17.2
Umiat	C-1	NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C-2	NE	0	0	0	0	0	0	1	0	0	0	2	2	2	0
		SE	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		*SW	0	0	0	0	0	0	0	0	0	0	0	0	0	-
		NW	6	3	0	3	10	3.3	13	1	0	0	27	33	43	23.3
		Total	6	3	0	3	10	3.3	14	1	0	0	29	35	45	22.2
	C-3	*NE	2	1	0	1	1	1.0	5	1	0	0	11	13	14	7.1
		*SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SW	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		*NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	2	1	0	1	1	1.0	5	1	0	0	11	13	14	7.1
	D-1	NE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table A5. Continued.

Location (USGS Quadrangle)		Quarter Quad	Breeding Adults	Broods: With Pair	Broods: With Single Adult	Broods: Total	Total Young	Mean Brood Size	Nonbreeding Adults: Pairs	Nonbreeding Adults: Singles	Nonbreeding Adults: Flocked Flocks	Nonbreeding Adults: Flocked Swans	Nonbreeding Adults: Flocked Total	Total Adults	Total Swans	Percent Young
Umiat	D-2	NE	0	0	0	0	0	0	4	0	0	0	8	8	8	0
		SE	0	0	0	0	0	0	2	1	0	0	5	5	5	0
		SW	6	3	0	3	10	3.3	8	2	1	6	24	30	40	25.0
		NW	6	3	0	3	9	3.0	22	2	2	12	58	64	73	12.3
		Total	12	6	0	6	19	3.2	36	5	3	18	95	107	126	15.1
	D-3	NE	12	6	0	6	23	3.8	4	1	0	0	9	21	44	52.3
		SE	2	1	0	1	1	1.0	11	1	2	8	31	33	34	2.9
		*SW	0	0	0	0	0	0	1	0	0	0	2	2	2	0
		*NW	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Total	14	7	0	7	24	3.4	16	2	2	8	42	56	80	30.0
	Grand Total		205	101	3	104	296	2.8	169	59	22	104	501	706	1002	29.5

* Partial coverage; entire quadrangle not included in the study area.

Appendix Table A6. Summaries of Tundra Swan counts during brood-rearing in a portion of the Kuparuk Oilfield (Beechey Point, B-5 quadrangle), Alaska, August 1986-1990.

Year	Adults With Broods	Broods			Total Young	Mean Brood Size	Adults Without Broods					Total Adults	Total Swans	Percent Young
		With Pair	With Single Adult	Total			Pairs	Singles	Flocks	Flocked Swans	Total			
1986[1]	14	7	0	7	15	2.1	25	8	1	6	64	78	93	16.1
1987[1]	22	11	0	11	26	2.4	18	14	3	10	60	82	108	24.1
1988[2]	29	14	1	15	34	2.3	23	7	1	3	56	85	119	28.6
1988[3]	28	13	2	15	31	2.1	25	3	2	8	61	89	120	25.8
1989[4]	34	16	2	18	36	2.0	31	3	1	4	69	103	139	25.9
1990	47	23	1	24	67	2.8	21	19	3	9	70	117	184	36.4
Mean ($\bar{x}$)	29.0	14.0	1.0	15.0	34.8	2.32	23.8	9.0	1.8	6.7	63.3	92.3	127.2	27.4

[1] USFWS Survey - Conant and Cain 1987
[2] USFWS Survey - R. King, USFWS, pers. comm.
[3] Ritchie et al. 1989
[4] Ritchie et al. 1990

Appendix Table A7. Numbers of Tundra Swans and Tundra Swan nests recorded (by quarter quads) during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, 21-22 June 1990.

Location (USGS quadrangle)		Quarter Quad	Breeding Adults	Nests			Nonbreeding Adults					Total Swans
				With Pair	With Single Adult	Total	Pairs	Singles	No. Flocks	Flocked Swans	Total	
Beechey Point	A-3	NE	9	2	5	7	3	1	0	0	7	16
		SE	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-
		NW	2	1	0	1	4	5	1	3	16	18
		Total	11	3	5	8	7	6	1	3	23	34
	A-4	*NE	3	0	3	3	3	4	0	0	10	13
		SE	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-
		Total	3	0	3	3	3	4	0	0	10	13
	B-3	NE	-	-	-	-	-	-	-	-	-	-
		SE	6	1	4	5	0	1	0	0	1	7
		SW	6	3	0	3	2	0	0	0	4	10
		NW	6	3	0	3	0	0	0	0	0	6
		Total	18	7	4	11	2	1	0	0	5	23
	B-4	*NE	0	0	0	0	0	0	0	0	0	0
		*SE	8	4	0	4	0	1	1	3	4	12
		SW	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-
		Total	8	4	0	4	0	1	1	3	4	12
	Grand Total		40	14	12	26	12	12	2	6	42	82

Appendix Table A8. Numbers of Tundra Swans and Tundra Swan broods recorded (by quarter quads) during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, 19-24 August 1990.

Location (USGS quadrangel)		Quarter Quad	Adults With Broods	Broods			Adults Without Broods						Total Adults	Total Swans
				With Pair	With Single Adult	Total	Young	Pairs	Singles	Flocks	Flocked Swans	Total		
Beechey Point	A-3	NE	10	5	0	5	15	3	1	0	0	7	17	32
		SE	-	-	-	-	-	-	-	-	-	-	-	
		SW	-	-	-	-	-	-	-	-	-	-	-	
		NW	6	3	0	3	11	2	0	2	6	10	16	27
		Total	16	8	0	8	26	5	1	2	6	17	33	59
	A-4	*NE	4	2	0	2	4	3	2	1	3	11	15	19
		SE	-	-	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-	-	-
		Total	4	2	0	2	4	3	2	1	3	11	15	19
	B-3	NE	-	-	-	-	-	-	-	-	-	-	-	-
		SE	12	6	0	6	15	1	1	0	0	3	15	30
		SW	3	1	1	2	5	7	2	2	6	22	25	30
		NW	0	0	0	0	0	0	1	1	4	5	5	5
		Total	15	7	1	8	20	8	4	3	10	30	45	65
	B-4	*NE	0	0	0	0	0	1	0	0	0	2	2	2
		*SE	8	4	0	4	11	2	1	0	0	5	13	24
		SW	-	-	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-	-	-
		Total	8	4	0	4	11	3	1	0	0	7	15	26
	Grand Total		43	21	1	22	61	19	8	6	19	65	108	169

Appendix Table A9. Numbers and locations (by USGS quadrangle) of selected species and nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 17-22 June 1990.

Location USGS quadrangle		White-fronted Goose	Brant	Snow Goose	Canada Goose	Goose Species	Glaucous Gull Nests	Pacific Loon	Pacific Loon Nests	Yellow-billed Loon	Loon Species
Kuparuk Oilfield Unit											
Beechey Point	A-4	218	0	0	0	0	2	39	0	0	1
	A-5	187	0	0	0	0	3	30	1	0	14
	B-4	217	22	20	0	60	11	42	1	0	0
	B-5	437	10	0	0	7	12	51	0	0	0
	C-4	0	0	0	0	0	0	0	0	0	0
	C-5	0	75	0	0	0	0	0	0	0	0
Harrison Bay	A-1	194	0	0	12	0	1	13	0	0	0
	B-1	502	0	0	0	0	11	37	0	0	0
	B-2	101	0	0	0	26	0	4	0	0	0
OGL 54 Unit											
Harrison Bay	A-2	667	0	0	0	0	8	38	0	3	0
	A-3	165	0	0	2	5	3	7	0	2	0
Umiat	C-1	40	0	0	0	5	1	3	0	0	0
	C-2	294	0	0	0	0	6	4	0	2	0
	C-3	174	0	0	0	18	5	7	0	0	7
	D-1	39	0	0	0	0	0	2	0	0	0
	D-2	950	0	0	0	0	11	18	1	7	1
	D-3	295	0	0	0	10	11	21	0	0	0
Kuparuk Oilfield Total		1856	107	20	12	86	40	216	2	0	15
OGL 54 Total		2624	0	0	2	45	45	100	1	14	8
Kuparuk/OGL54 Total		4480	107	20	14	131	85	316	3	14	23

Appendix Table A10. Numbers and locations of selected birds and mammals recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 17-22 June 1990.

Location			Sandhill Crane	Rough-legged Hawk	Gyrfalcon	Golden Eagle	Moose	Grizzly Bear
USGS quadrangle		quarter quad						
Beechey Point	A-5	NE	2	0	0	0	0	0
Harrison Bay	A-3	SE	0	0	0	0	1	0
Harrison Bay	B-1	NE	0	0	0	0	0	1
Harrison Bay	B-1	SE	0	0	1	0	0	1
Umiat	C-2	NE	0	2	0	0	0	0
Umiat	C-2	NW	0	0	0	1	0	1
Umiat	C-3	NE	0	1	0	0	0	0
Umiat	D-3	NW	0	1	0	0	2	0
TOTAL			2	4	1	1	3	3

Appendix Table A11. Numbers and locations (by USGS quadrangle) of selected birds and nests recorded during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, 21-22 June 1990.

Location (USGS quadrangle)		White-fronted Goose	Goose Species	Glaucous Gull Nests	Pacific Loon	Pacific Loon Nests	Yellow-billed Loon	Loon Species
Beechey Point	A-3	122	0	3	2	0	0	4
	A-4	88	1	11	1	0	1	5
	B-3	27	7	8	2	1	0	2
	B-4	38	2	2	0	0	0	0
TOTAL		275	10	24	5	1	1	11

Appendix Table A12. Numbers and locations (by USGS quadrangle) of selected species recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-23 August 1990.

Location (USGS quadrangle)		White-fronted Goose	Brant	Snow Goose	Canada Goose	Canada Goose Young	Goose Species	Pacific Loon	Pacific Loon Young	Yellow-billed Loon	Yellow-billed Loon Young	Loon Species
Kuparuk Oilfield Unit												
Beechey Point	A-4	229	0	0	0	0	0	24	6	0	0	2
	A-5	215	0	1	0	0	0	31	5	0	0	0
	B-4	404	12	0	0	0	59	51	8	0	0	0
	B-5	321	0	0	0	0	0	92	3	0	0	0
	C-4	0	0	0	0	0	0	0	0	0	0	0
	C-5	0	0	0	0	0	0	0	0	0	0	0
Harrison Bay	A-1	83	0	0	0	0	0	29	2	0	0	0
	B-1	344	12	0	0	0	0	35	5	0	0	0
	B-2	152	0	0	0	0	0	4	0	0	0	0
OGL 54 Unit												
Harrison Bay	A-2	56	0	0	0	0	0	34	6	4	1	3
	A-3	16	0	0	0	0	0	9	1	0	0	2
Umiat	C-1	10	0	0	0	0	0	4	3	3	0	0
	C-2	110	0	0	0	0	0	6	2	1	0	2
	C-3	76	0	0	0	0	0	10	3	3	0	6
	D-1	57	0	0	0	0	0	2	1	0	0	2
	D-2	217	0	0	0	0	0	48	7	18	0	2
	D-3	118	0	0	2	4	25	53	12	12	0	1
Kuparuk Oilfield Total		1748	24	1	0	0	59	266	29	0	0	2
OGL 54 Total		660	0	0	2	4	25	166	35	41	1	20
Kuparuk/OGL 54 Total		2408	24	1	2	4	84	432	64	41	1	22

Appendix Table A13. Numbers and locations of selected birds and mammals recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-23 August 1990.

Location (USGS quadrangle)		quarter quad	Peregrine Falcon	Golden Eagle	Muskox	Moose
Beechey Point	A-4	SW	0	0	1	0
	A-5	SE	0	0	1	0
Harrison Bay	A-3	SW	1	0	0	0
	A-3	SE	0	0	0	3
Umiat	C-2	NW	0	0	0	1
	C-3	NE	1	0	0	0
	D-2	NW	0	0	0	0
	D-2	NE	2	0	0	0
	D-2	SE	1	1	0	0
	D-3	SE	0	0	4	1
Total			5	1	6	5

Appendix Table A14. Numbers and locations (by USGS quadrangle) of selected species recorded during aerial surveys in the Prudhoe Bay Oilfield Study Area, Alaska, 19-24 August 1990.

Location (USGS quadrangle)		White-fronted Goose	Snow Goose	Snow Goose Young	Goose Species	Pacific Loon	Pacific Loon Young
Beechey Point	A-3	387	2	4	13	22	0
	A-4	90	0	0	0	5	2
	B-3	354	18	0	0	39	4
	B-4	148	0	0	0	3	0
Total		979	20	4	13	69	6

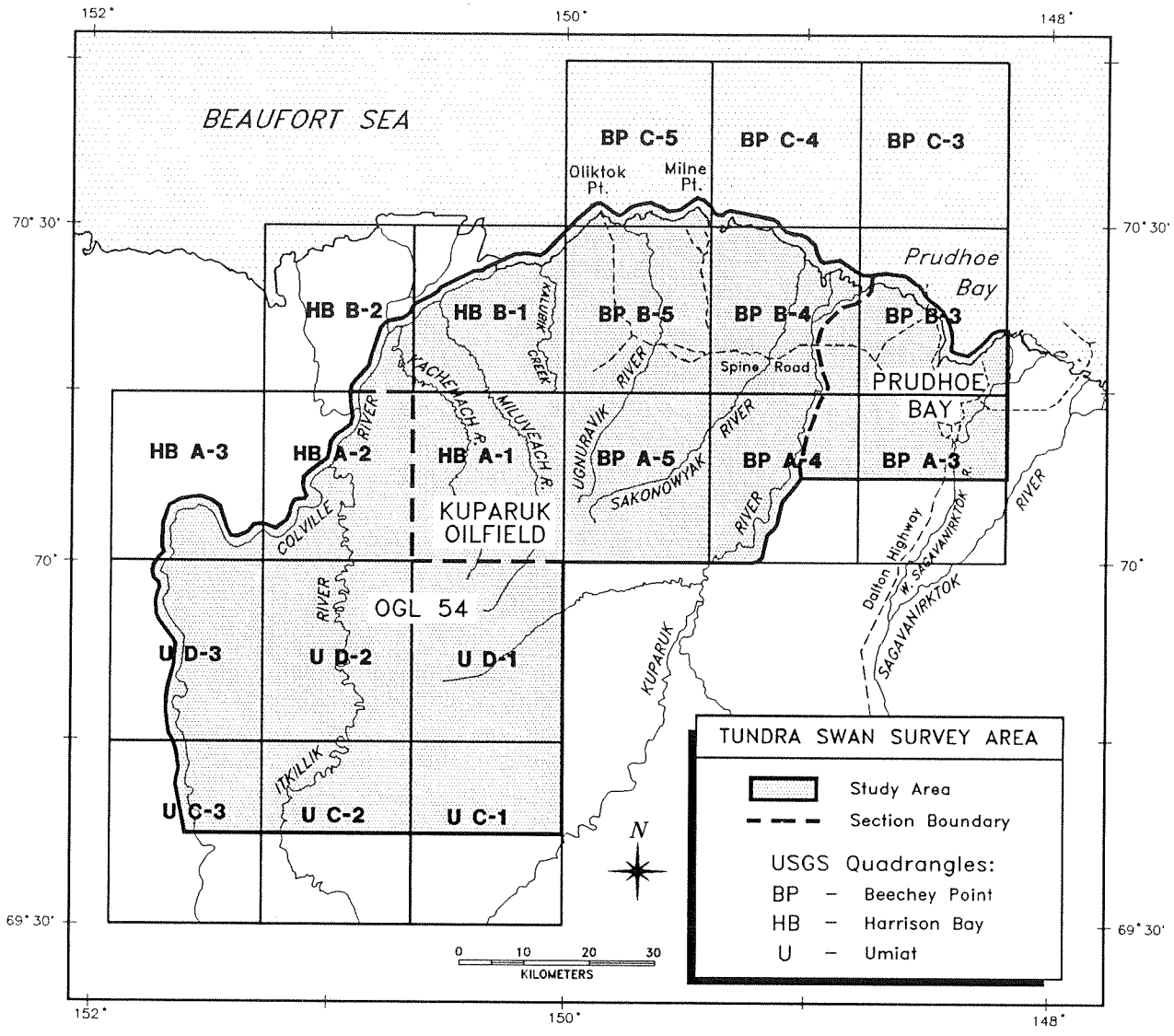


Figure A1. Relationship of USGS quadrangle maps to study area boundaries.

APPENDIX B

Map locations of Brant nests and brood-rearing/staging groups between Brownlow Pt. and Miluveach River, Alaska, as determined from aerial surveys in July, 1990.

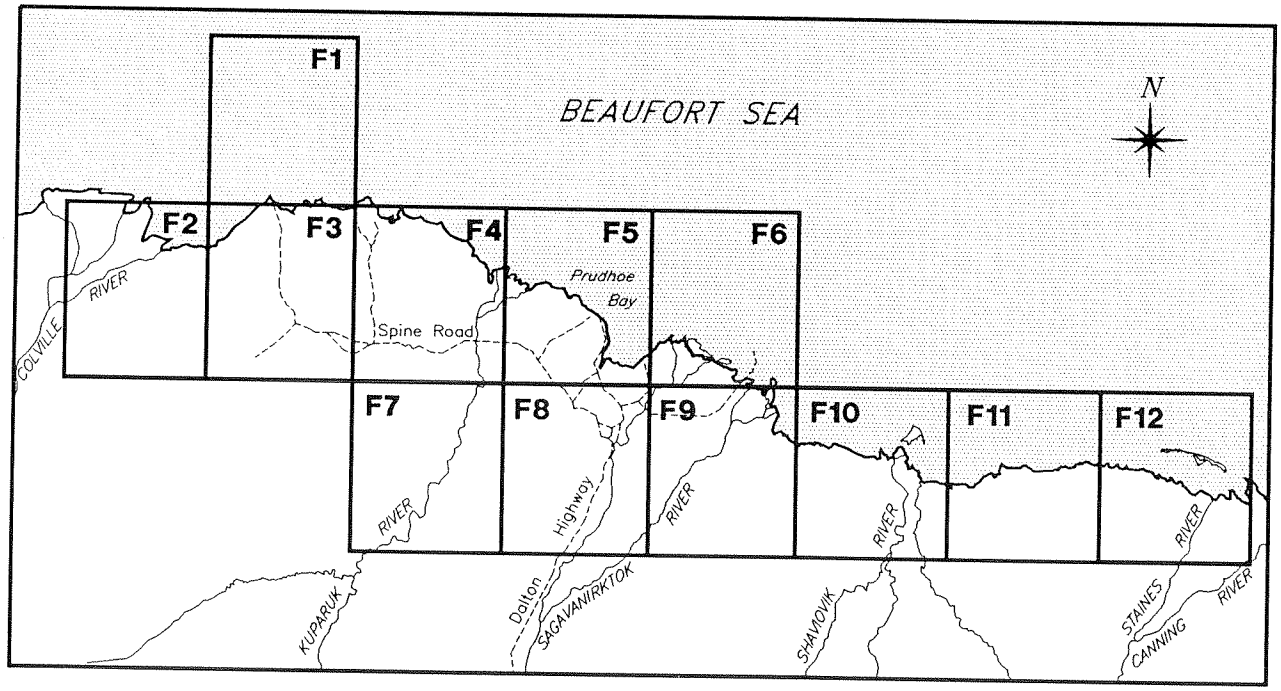
KEY

BROOD-REARING/STAGING AREAS

# (number of adults) # (number of goslings)		26 July 1990 aerial survey
# (number of adults) # (number of goslings)		29-30 July 1990 aerial survey

NEST LOCATIONS

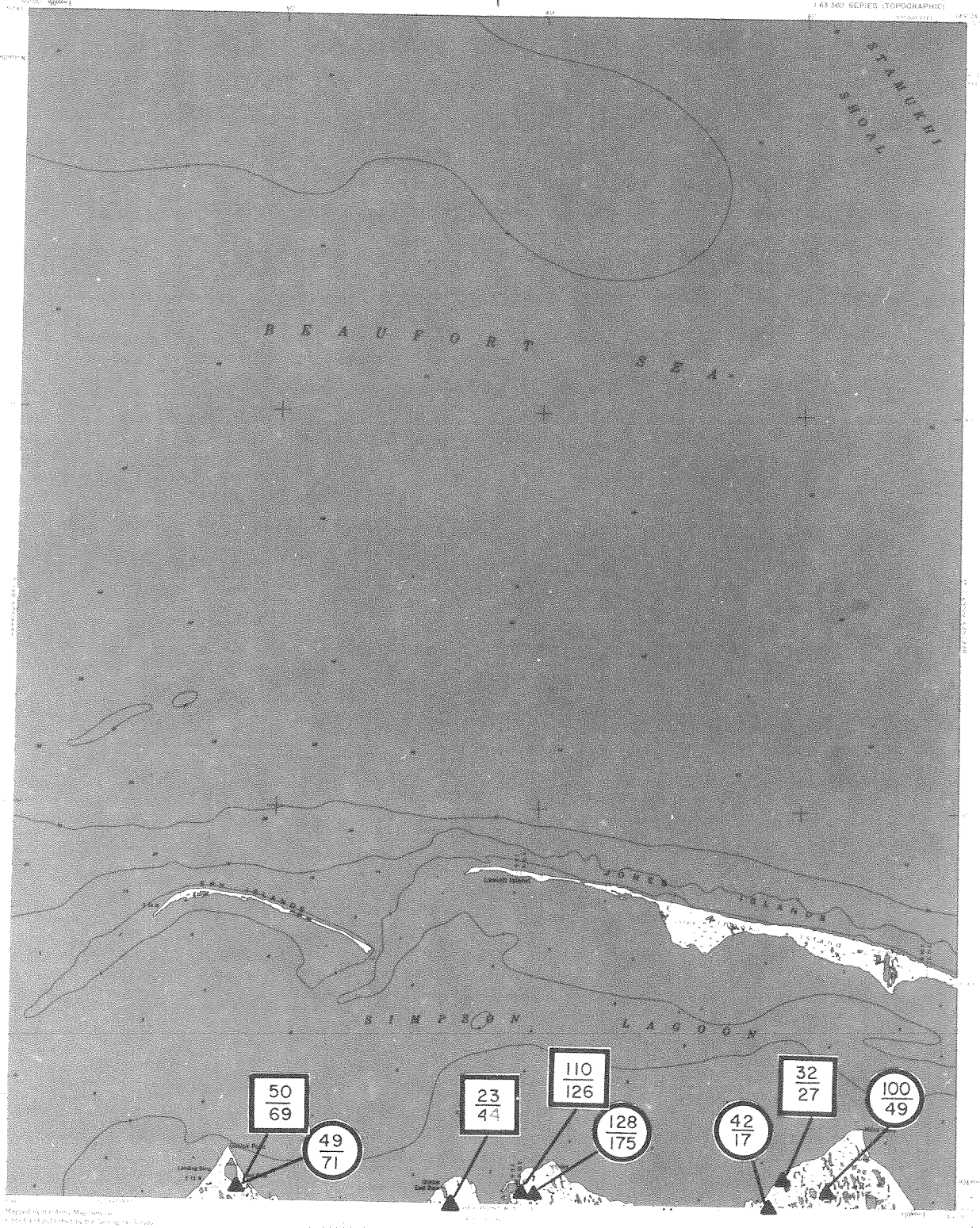
- ● = Single nest
- ●# = Location with >1 nest (e.g., ● 4 = 4 nests)



F 1

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (C-5) QUADRANGLE
ALASKA—NORTH SLOPE BOROUGH
7.63 360 SERIES (TOPOGRAPHIC)

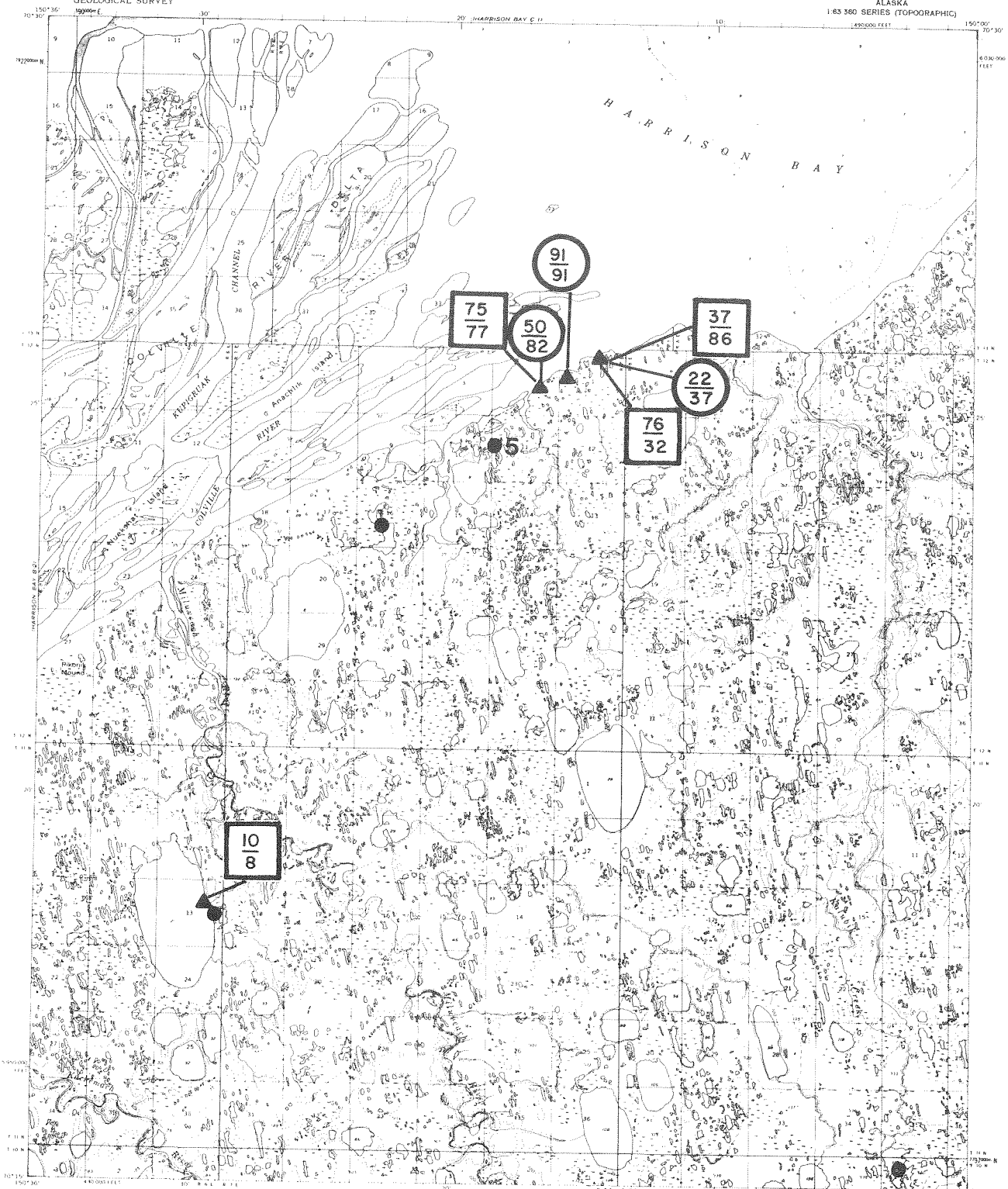


BEECHEY POINT (C-5), ALASKA

F 2

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HARRISON BAY (B-1) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)



Mapped by the Army Map Service
Published for civil use by the Geological Survey

Control by USC&GS and USCE

Topography by photogrammetric methods from aerial photographs taken 1955. Field annotated 1956. Map not field checked

Selected hydrographic data compiled from USC&GS Charts 9470 and 9472 (1956). This information is not intended for navigational purposes

Universal Transverse Mercator projection. 1927 North American datum
10,000 foot grid based on Alaska coordinate system, zone 6
2000 meter Universal Transverse Mercator grid ticks, zone 6, shown in blue

Land lines represent surveyed and unmarked locations predominantly by the Bureau of Land Management
Fixing U. S. Survey Mon-ars
Lake depths are approximate

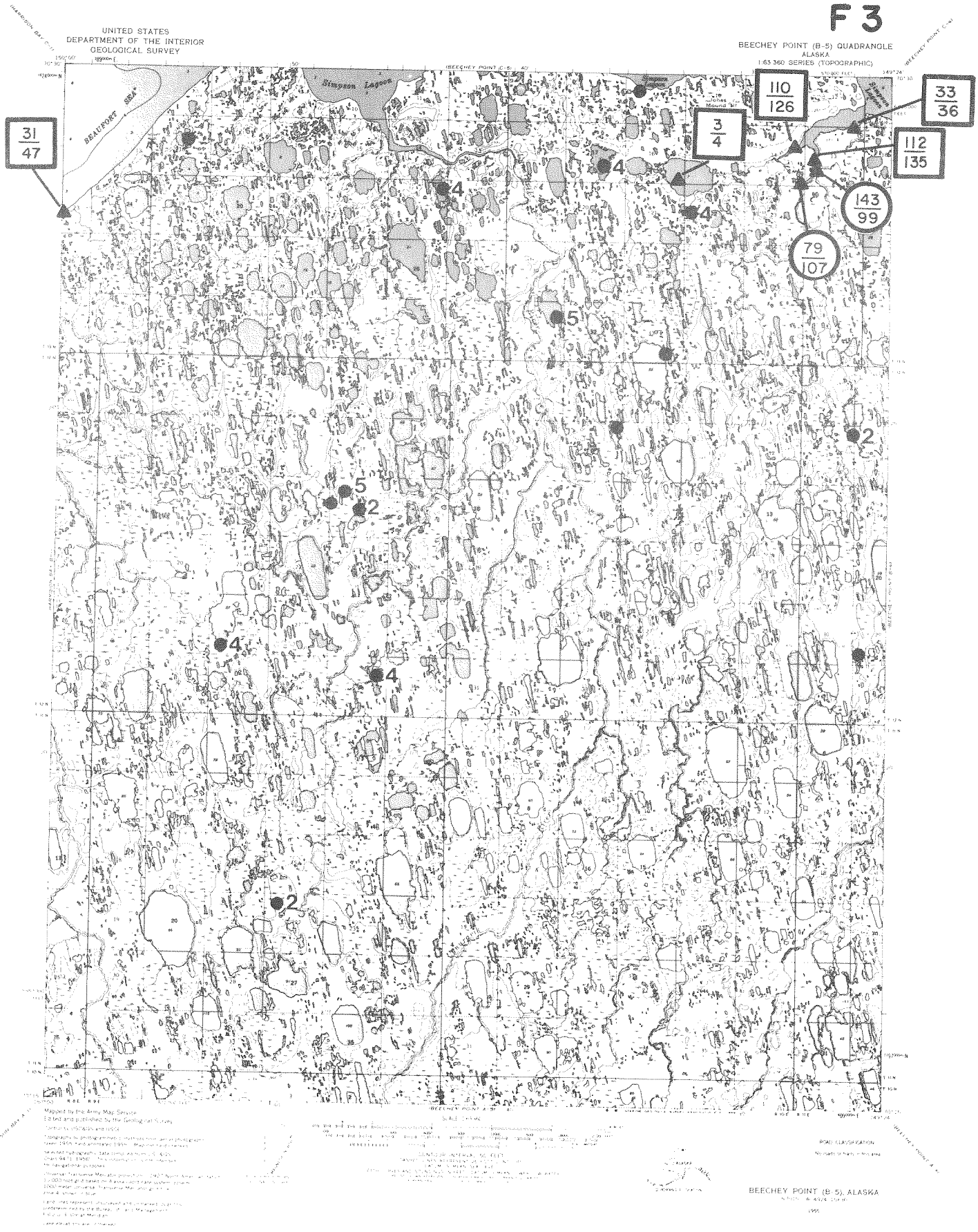
APPROXIMATE MEAN DECLINATION, 1956

CONTOUR INTERVAL 50 FEET
DASHED LINES REPRESENT 25-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY FOUR FEET

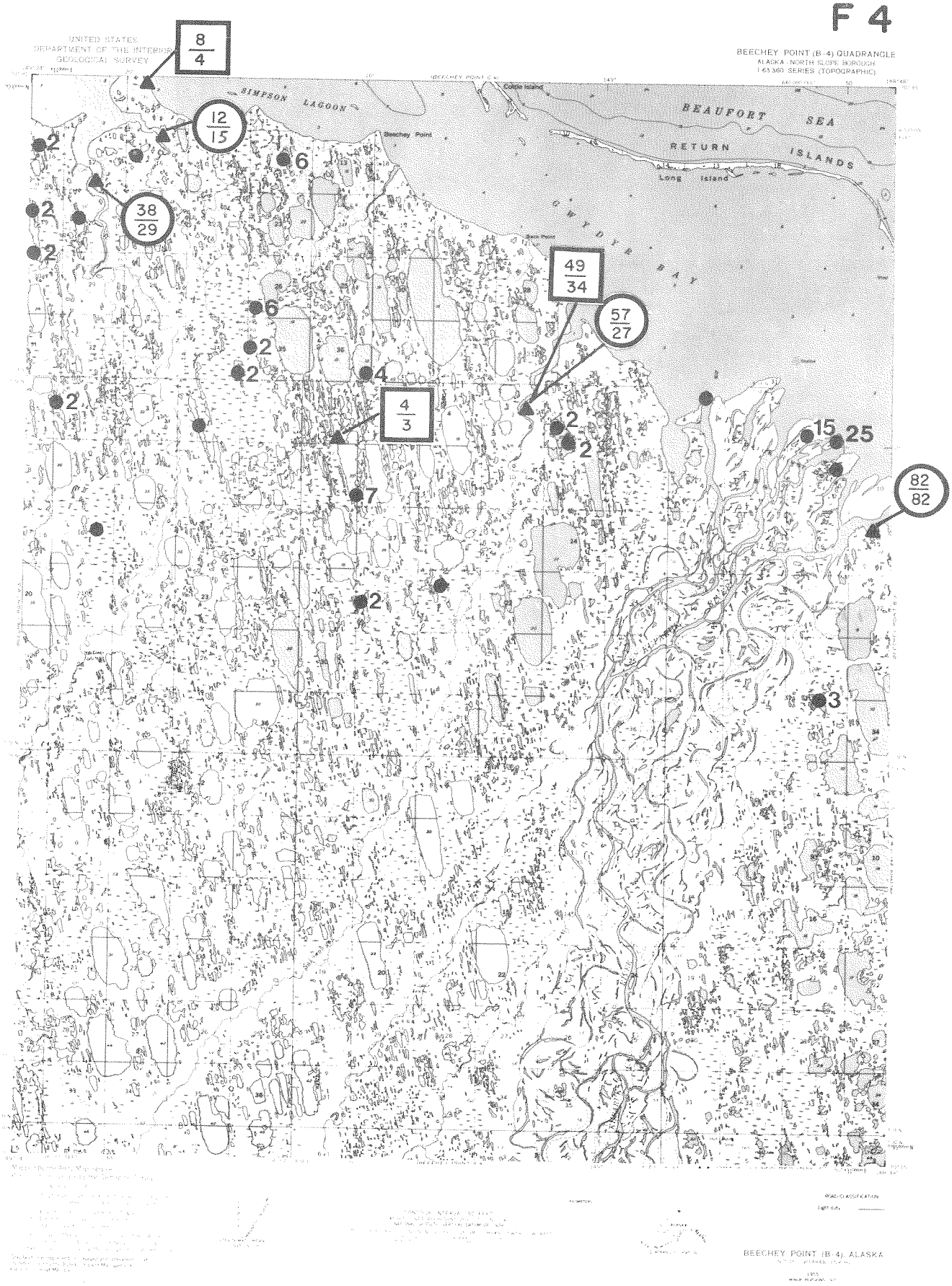
ROAD CLASSIFICATION
No roads or trails in the area

HARRISON BAY (B-1), ALASKA
N7015—W15000/15 x 36

1956


F 3
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (B-5) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
Simpson Lagoon
BEAUFORT SEA
31/47
3/4
110/126
33/36
112/135
143/99
79/107
BEECHEY POINT (B-5), ALASKA

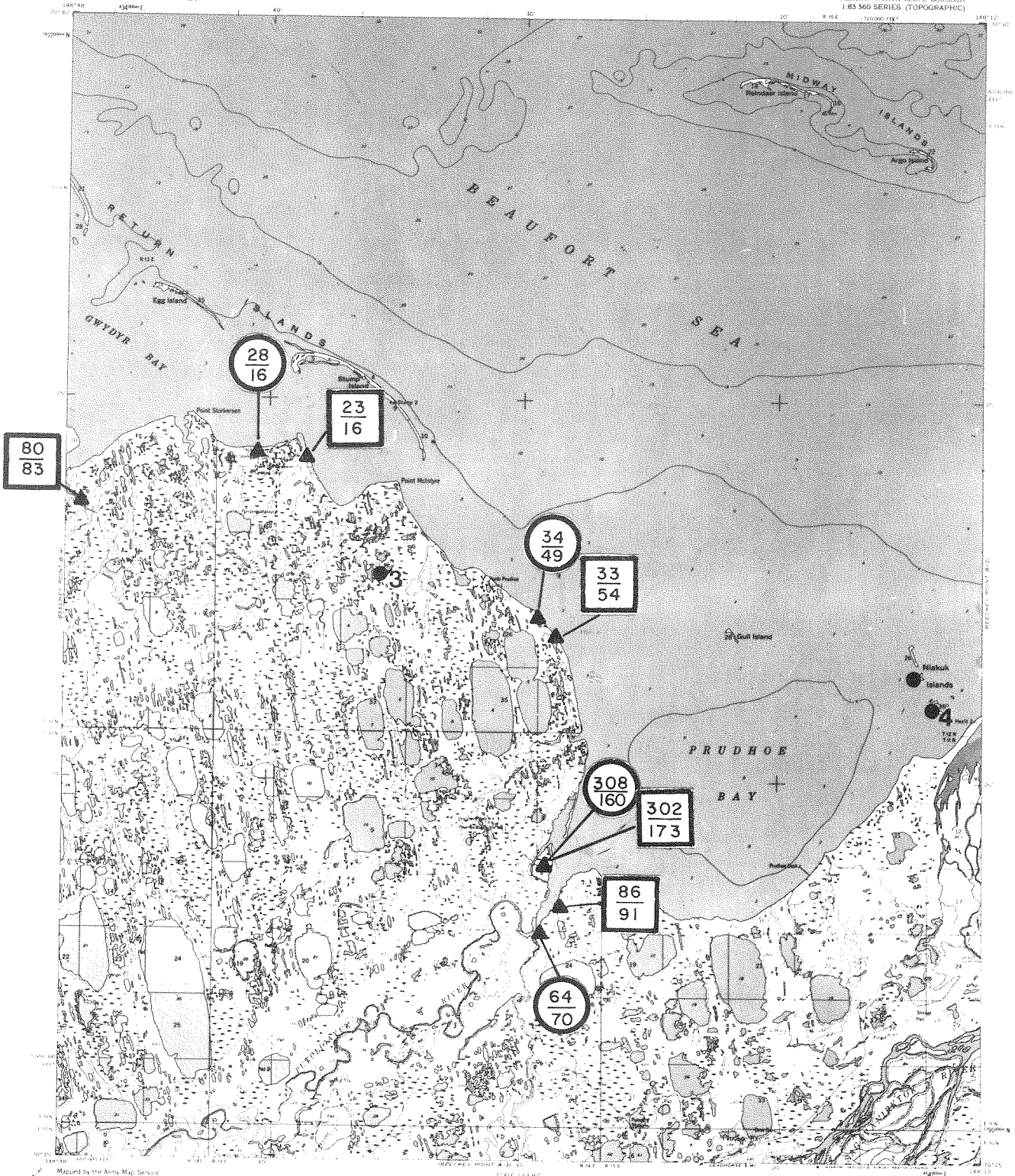
F 4


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (B-4) QUADRANGLE
ALASKA-NORTH SLOPE BOROUGH
1:63,360 SERIES (TOPOGRAPHIC)
8/4
12/15
38/29
49/34
57/27
4/3
82/82
SIMPSON LAGOON
Beechey Point
Cottle Island
BEAUFORT SEA
RETURN ISLANDS
Long Island
GYDOZA BAY
BEECHEY POINT (B-4), ALASKA

F 5

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (B-3) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)



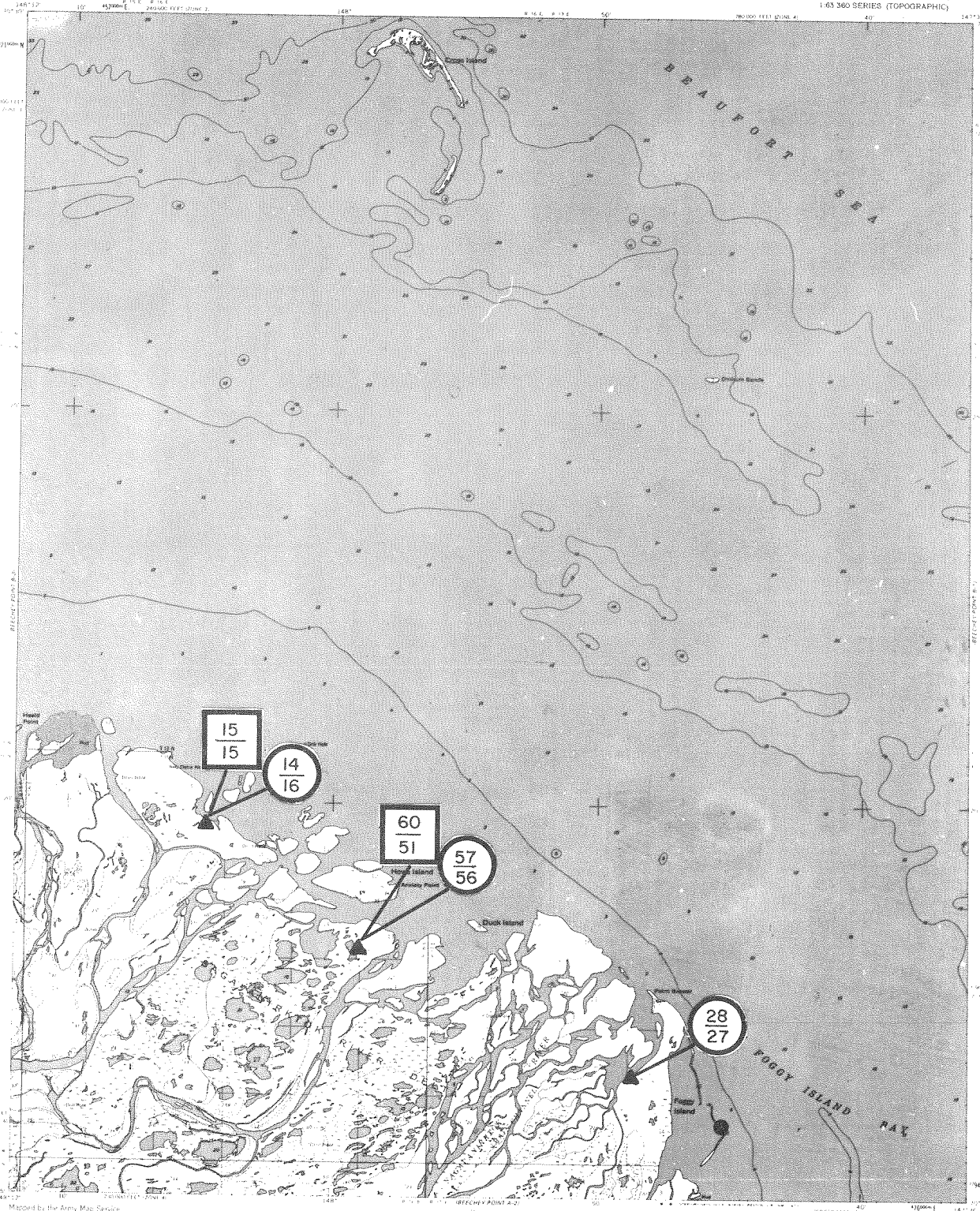
Mapped by the Army Map Service
Edited and published by the Geological Survey

BEECHEY POINT (B-3), ALASKA

F 6

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (B-2) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)



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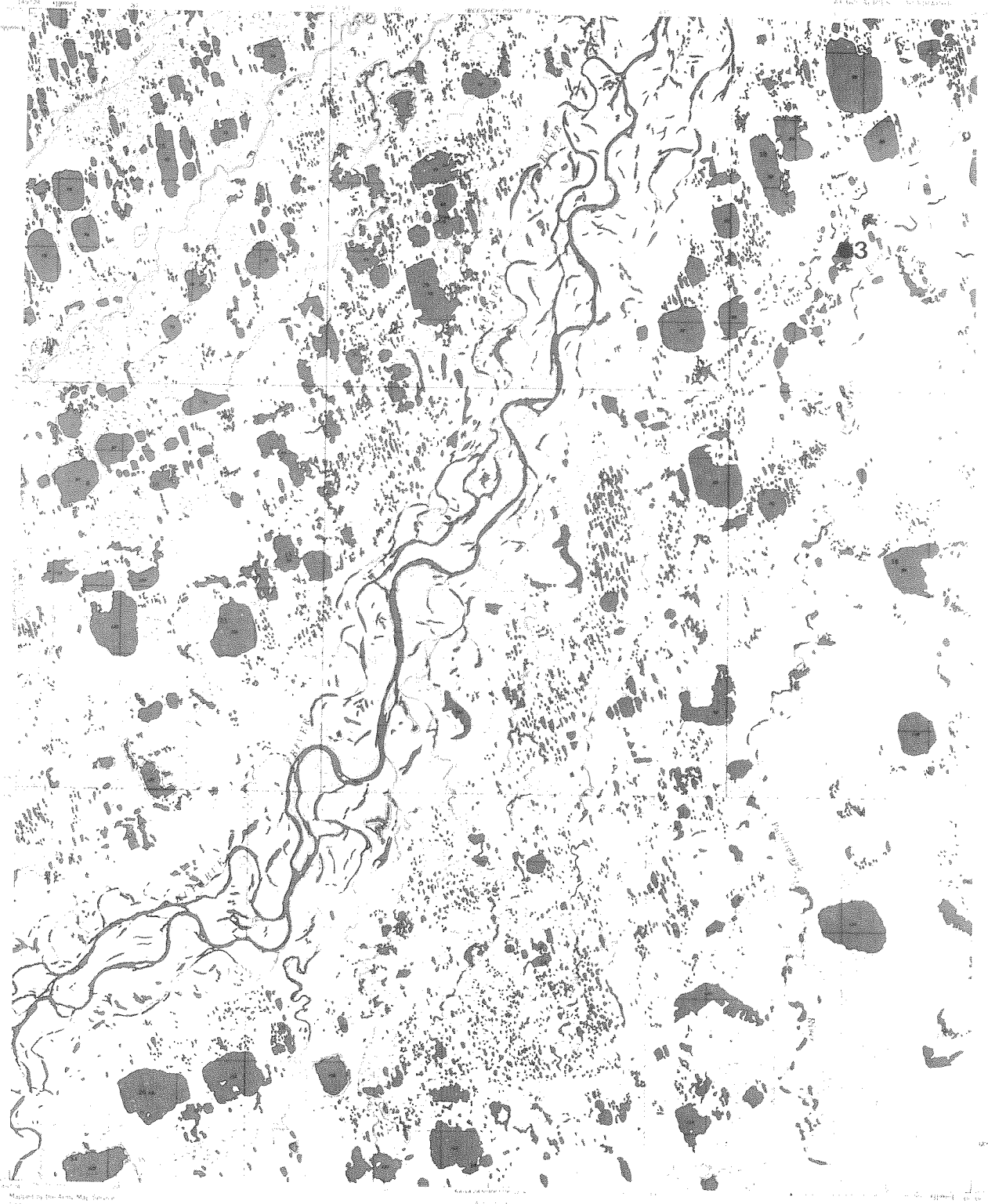
BEECHEY POINT (B-2), ALASKA

1955

F 7

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (A-4) QUADRANGLE



BEECHEY POINT (A-4), ALASKA

F 8

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (A-3) QUADRANGLE
ALASKA NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)

Mapped by the Army Map Service

Edited and published by the Geological Survey

Control by USC&GS and USCE

Topography by photogrammetric methods from aerial photographs taken 1955, field annotated 1955. Map not field checked

Universal Transverse Mercator projection. 1927 North American datum
10,000-foot grid ticks based on Alaska coordinate system, zone 4
1000-meter Universal Transverse Mercator grid ticks
zone 6, shown in blue

Gray land lines represent unsurveyed and unmarked locations predetermined by Bureau of Land Management
Folio U-3, Umiat Meridian

Revisions shown in purple compiled from aerial photographs taken 1975. This information not field checked

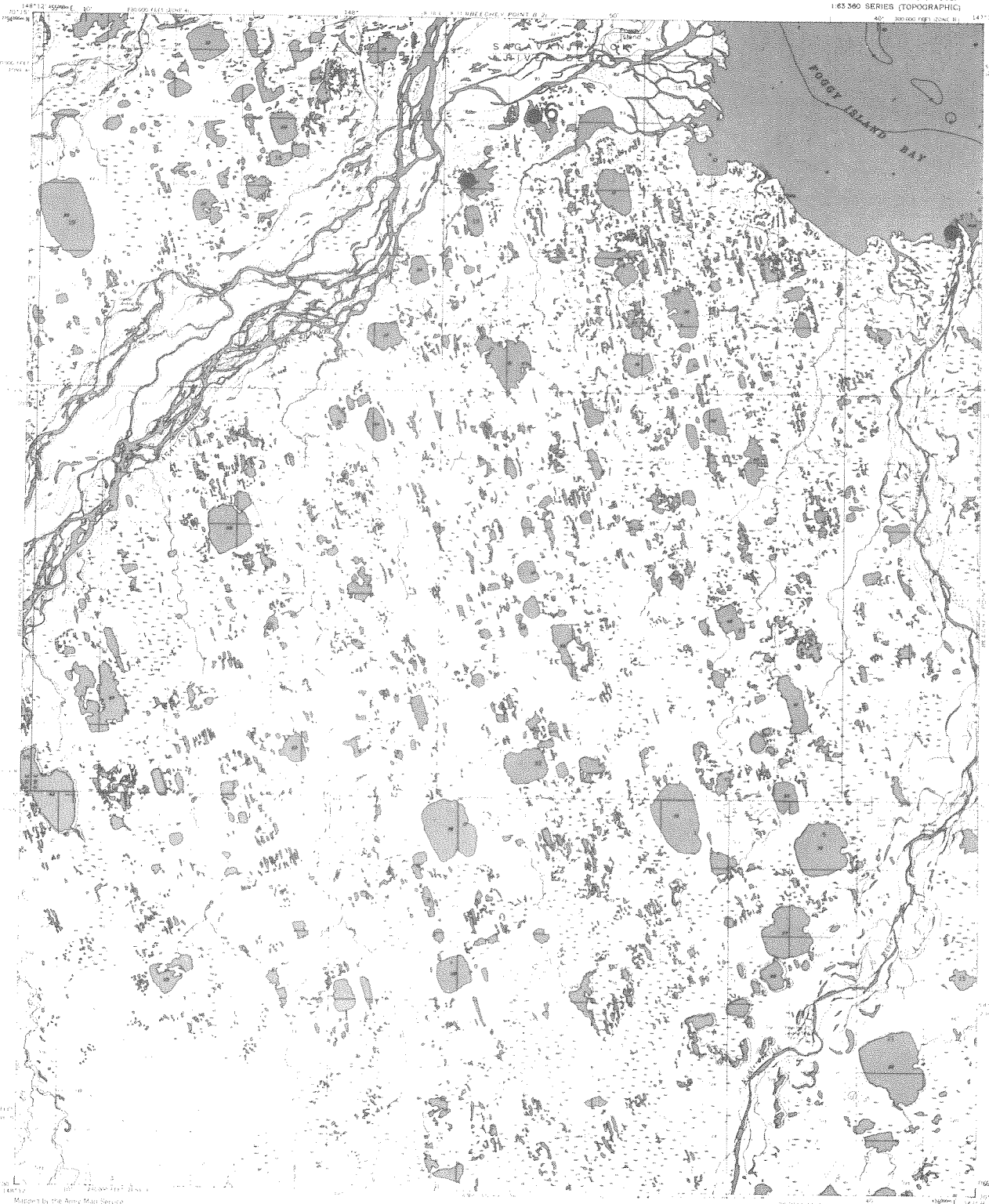
BEECHEY POINT (A-3), ALASKA

PHOTOREVISED 1975

F9

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (A-2) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)



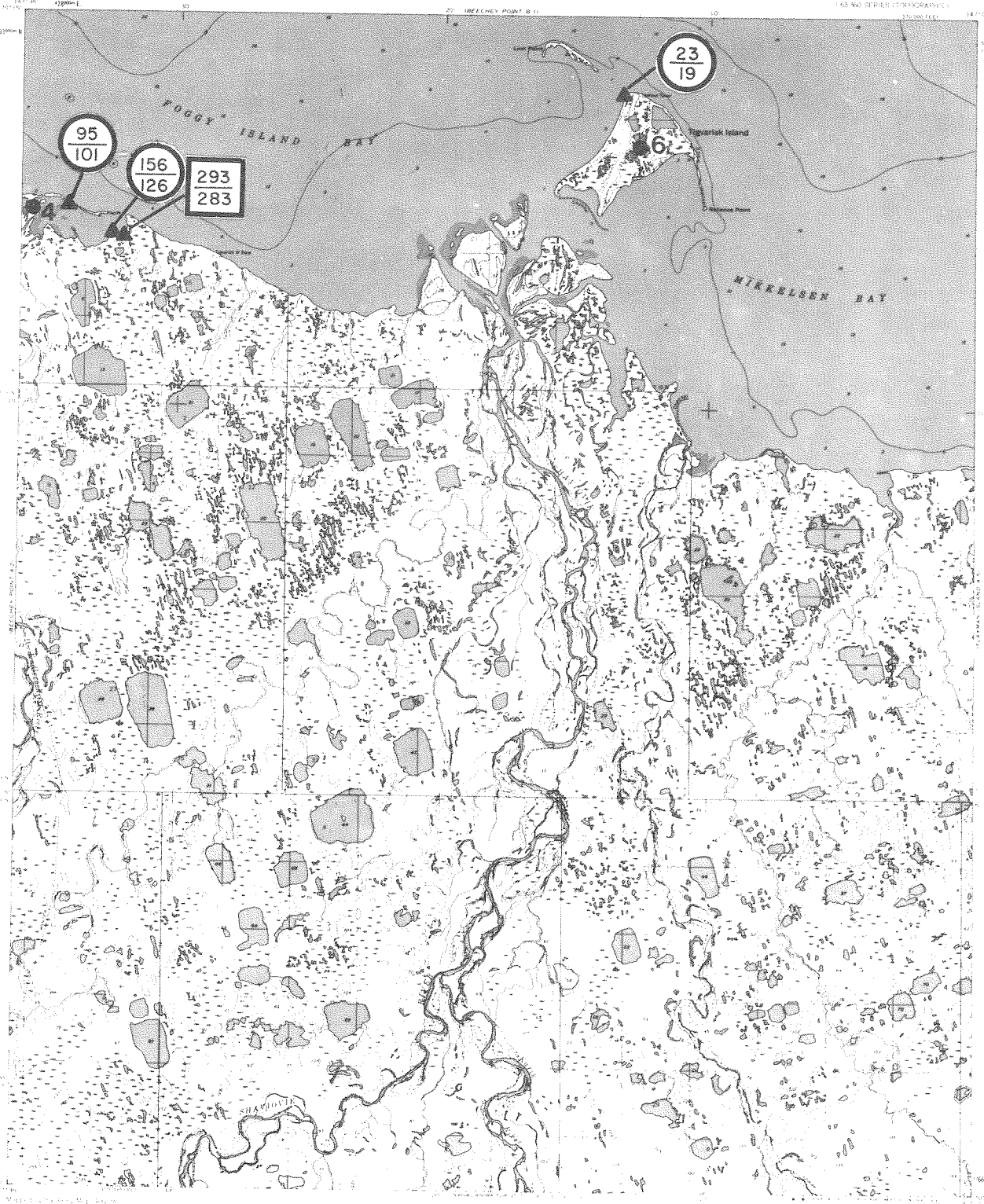
Mapped by the Army Map Service

BEECHEY POINT (A-2), ALASKA

F 10

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (A-1) QUADRANGLE
ALASKA-NORTH SLOPE BOROUGH
7.5 MINUTE SERIES (TOPOGRAPHIC)

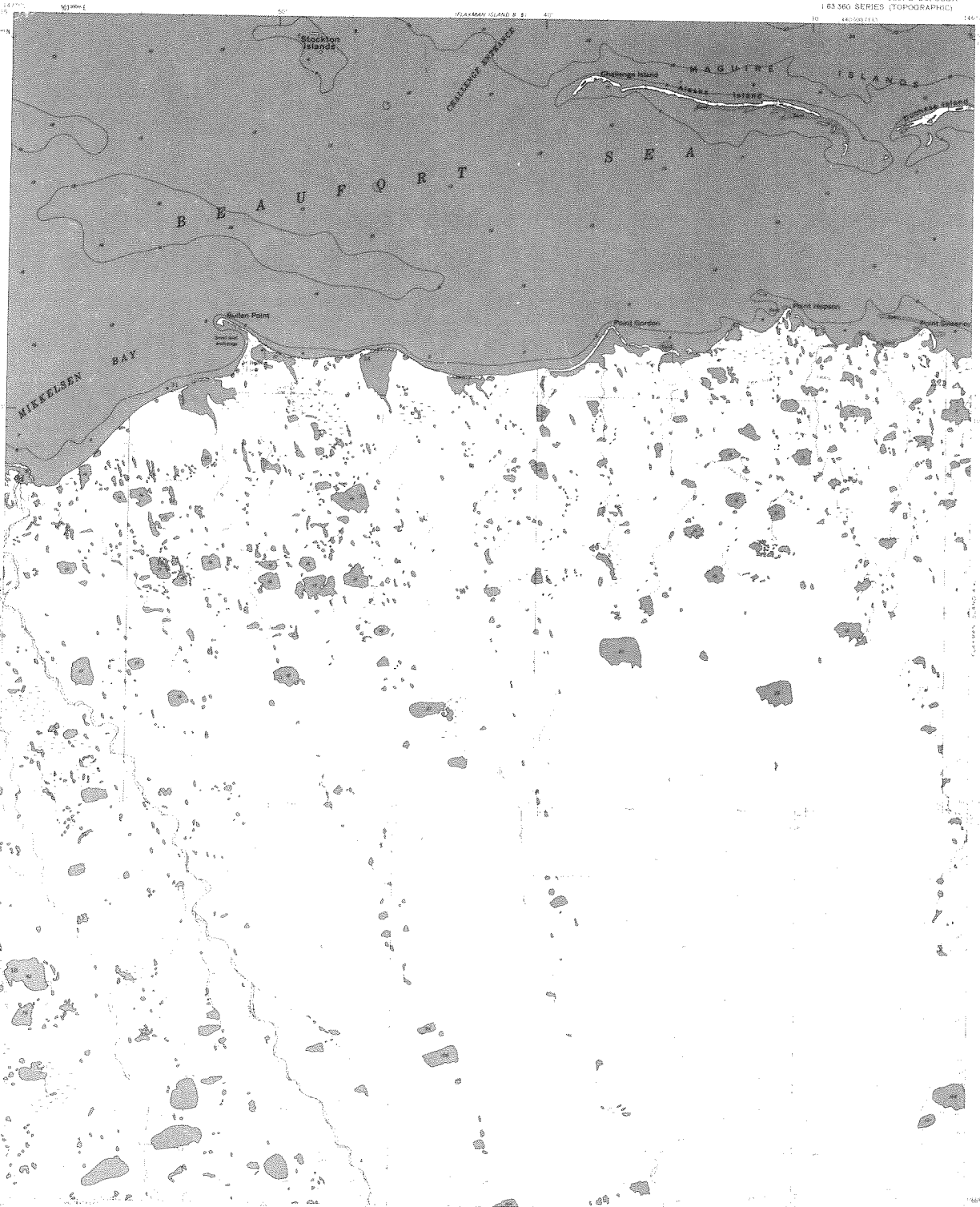


BEECHEY POINT (A-1), ALASKA

F 11

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLAXMAN ISLAND (A-5) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63,360 SERIES (TOPOGRAPHIC)

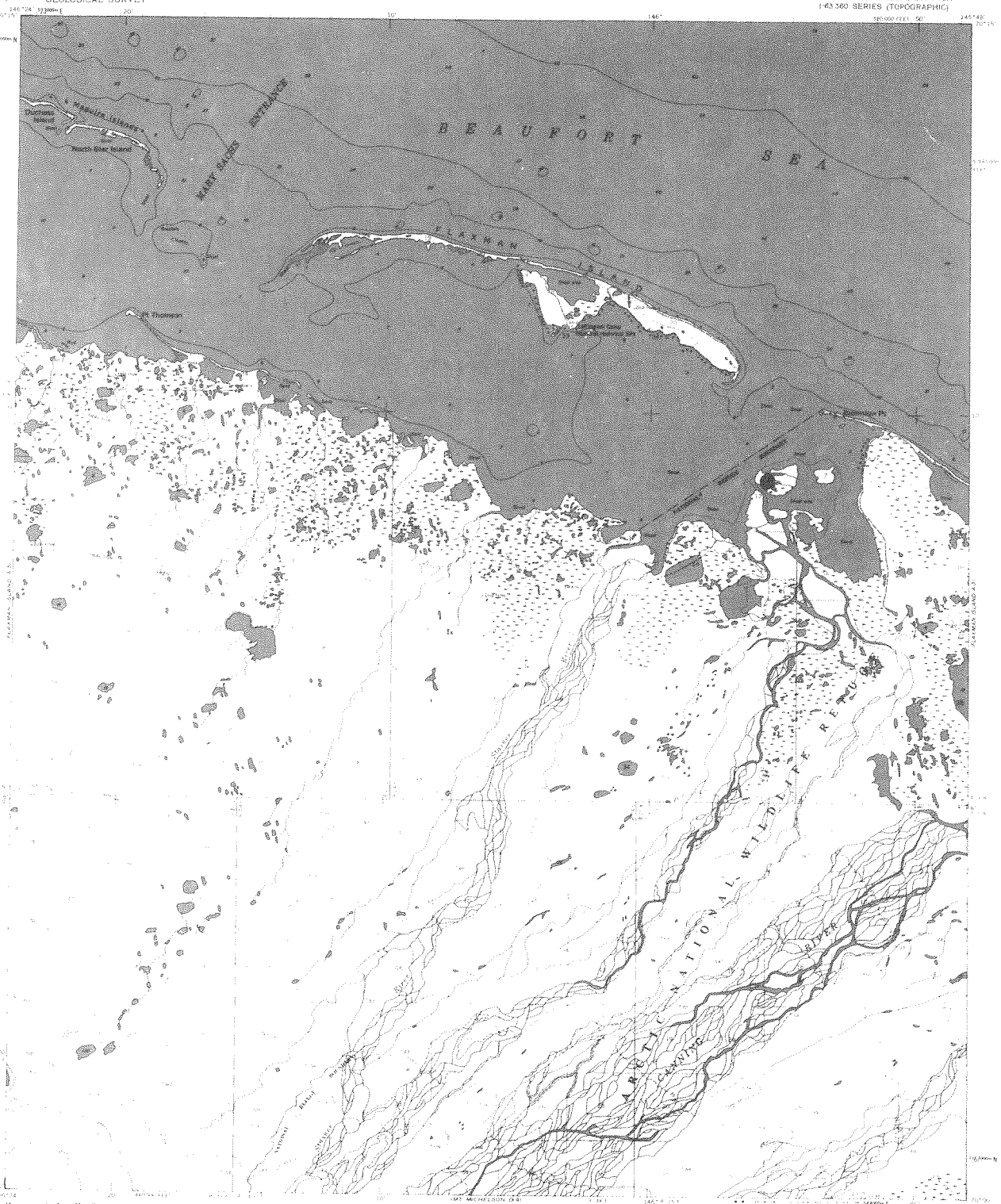


FLAXMAN ISLAND (A-5), ALASKA

F12

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

FLAXMAN ISLAND (A-4) QUADRANGLE
ALASKA—NORTH SLOPE BOROUGH
1:63,360 SERIES (TOPOGRAPHIC)



Mapped by the Army Map Service
Published by the Geological Survey

CONTOUR INTERVAL 50 FEET
DASHED LINES REPRESENT INTERMEDIATE CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOWER LOW WATER

The Alaska Maritime National Wildlife Refuge consists of all public lands in the coastal waters and adjacent seas of Alaska consisting of islands, islets, rocks, reefs, capes and spires.

There may be private inholdings within the boundaries of the National or State reservations shown on this map.

To plot or fix on the year-checked North American Datum 1983 move the projection lines 27 meters north and 111 meters east.

FLAXMAN ISLAND (A-4), ALASKA

1955