FINAL REPORT

TUNDRA SWAN AND BRANT SURVEYS ON THE ARCTIC COASTAL PLAIN, COLVILLE RIVER TO STAINES RIVER, 1989

ROBERT J. RITCHIE
PAUL W. BANYAS
ALICE A. STICKNEY
ROBERT M. BURGESS
JAMES G. KING

PREPARED FOR:

ARCO ALASKA, INC.
AND
KUPARUK RIVER UNIT
P.O. BOX 100360
ANCHORAGE, AK 99510
AND
BP EXPLORATION (ALASKA), INC.
AND
THE DUCK ISLAND UNIT OWNERS
P.O. BOX 196612
ANCHORAGE, ALASKA 99519

PREPARED BY:

ALASKA BIOLOGICAL RESEARCH, INC.
P.O. BOX 81934
FAIRBANKS, AK 99708

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

Final Report

Prepared for

ARCO Alaska, Inc.
and
Kuparuk River Unit
P. O. Box 100360
Anchorage, AK 99510

and

BP Exploration (Alaska), Inc.
and
The Duck Island Unit Owners
P. O. Box 196612
Anchorage, AK 99519

Prepared by

Robert J. Ritchie
Paul W. Banyas
Alice A. Stickney
Robert M. Burgess
James G. King

Alaska Biological Research, Inc.
P. O. Box 81934
Fairbanks, AK 99708

November 1990

EXECUTIVE SUMMARY

Tundra Swans and Brant traditionally have been important in planning oilfield development in northern Alaska. Because site-specific information about these species is limited in some areas, Alaska Biological Research (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 of Brant on the Sagavanirktok River delta. The goal of the Tundra Swan component was to locate Tundra Swans by aerial surveys in the Kuparuk Oilfield and the area covered by the Oil and Gas Lease Sale 54 (OGL 54) and count pairs, flocks, nests, and broods.

The major goals of the cooperative Brant studies were to collect regional information on the distribution and productivity of Brant on the Coastal Plain between the Colville and Staines rivers, and to collect site-specific population and productivity information on the Brant nesting on Howe and Duck islands. Aerial surveys were used to locate Brant nesting colonies and brood-rearing areas between the Colville and Staines rivers. The objectives of the ground surveys on the Sagavanirktok River delta were to document the numbers of Brant and nests, and nest success of the Howe and Duck island colonies, and to identify the routes of dispersal to and use of brood-rearing habitats by Brant from these colonies.

TUNDRA SWAN SURVEYS

A total of 479 Tundra Swans at 289 locations (including 78 nests) was observed in the study area between 19 and 24 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 the 150°40'W in the OGL 54 area. New or proposed drill sites were located from 0.9 to 4.4 km from the nearest Tundra Swan nests.

In June 1989, the densities of Tundra Swans were estimated at 0.02 nests/km^2 and 0.11 swans/km^2. Densities in the study area were similar to those found in 1988. All 1989 estimates were within the range of densities recorded historically for the Coastal Plain.

A total of 670 adult Tundra Swans and 142 cygnets in 64 broods was recorded between 19 and 22 August in the study area. The mean brood size was 2.2 cygnets, similar to that observed in 1988. Densities during August were 0.02 broods/km^2 and 0.16 swans/km^2, similar to estimates made in 1988. New or proposed drill sites were from 1.4 to 6.2 km from the nearest brood locations.

Opportunistic counts were also made of geese, loons, Glaucous Gulls and Snowy Owls. As was the case in 1988, White-fronted Geese were abundant and dispersed through the entire study area.

BRANT SURVEYS

In the region between the Staines and Miluveach rivers, 383 Brant nests in 36 colonies and 32 isolated nest sites were located by aerial and ground surveys. Nesting information for the colonies at Howe and Duck islands and in the Lisburne Development area was collected by ground surveys. Aerial surveys conducted in June 1989 were used to collect information on Brant nests elsewhere in the region. Information on brood-rearing Brant throughout the region was also collected by aerial surveys in July 1989.

AERIAL BRANT SURVEYS

Brant surveys, using fixed-wing aircraft, were conducted between the Staines River and the Miluveach River during nesting (23-26 June) and brood-rearing (24-29 July).

During June surveys, 200 Brant nests (excluding colonies in the Sagavanirktok River delta and in the Lisburne Development area) were located at 33 colonies and 26 isolated nest sites. Most Brant colonies located by aerial surveys were small (mean nests per location = 3.4). In addition, 468 adult Brant, probably nonbreeding birds, were observed at another 31 locations.

Most (84%) nest locations (colonies and individual nest sites) were found on islands in lakes and flooded tundra in drained-lake basins. Nests were also located on river deltas (12%) and offshore islands within 5 km of the coast (4%). Brant colonies and isolated nest sites were between 0.1 km and 23 km from the coast (mean distance = 5.5 km). Most nest locations (66%) and nest sites (76%) were located between the Kuparuk River and Kalubik Creek. The remaining nest locations were in the Prudhoe Bay area, east of the Sagavanirktok River delta, between the Kalubik and Miluveach rivers, and on the Sagavanirktok River delta.

No new large colonies were identified during these surveys. A number of small colonies first located in 1988 were again occupied. Several previously unknown Brant nest locations also were identified in the Kuparuk Oilfield and east of the Sagavanirktok River delta. Brant numbers in the study area appear to have remained fairly stable over the years; however, changes in distribution may have occurred.

Aerial surveys and photo censuses indicated that approximately 840-990 adult Brant with 590-620 goslings were on the coast between the Staines and Colville rivers in late July 1989. Few Brant were recorded inland (33 adults and 22 goslings), and all of these were west of the Sagavanirktok River. Brant were observed at 21 sites along the coast, including salt-marsh areas at the mouths of the Ugnuravik and Putuligayuk rivers, near Milne Point, the Kuparuk River delta, and on the Sagavanirktok and Kadleroshilik river deltas. Brant with goslings were most abundant and dense between Heald Point and Kalubik Creek (approximately 65% of total adults, 67% of total goslings).

Although there are few baseline numbers to compare the magnitude of use over the years, qualitative historical data suggest that the Brant population is using traditional brood-rearing habitats associated with the area's major deltas and salt marshes. Furthermore, estimated numbers of adults and goslings support an earlier contention that this low-density nesting area may produce a large component of the North Slope's annual Brant production.

Canada and White-fronted geese were also abundant along coastal sections of the study area. Canada Geese (1201 adults, 80 goslings) were recorded primarily east of the Sagavanirktok River. This distribution was consistent with the distribution of Canada Goose nests in the study area in June. White-fronted Geese (1077 adults, 391 goslings) were abundant between the Kuparuk and Miluveach rivers, but rare east of the Kuparuk River.

SAGAVANIRKTOK DELTA BRANT SURVEYS

In 1989, 159 Brant nests were located on Howe Island, a decrease from 213 nests in 1988. However, daily scans indicated that the number of Brant on the island was higher than in 1988 and that numbers have been increasing every year since 1986. At least 81% of the Brant nests on Howe Island were successful in 1989. The average brood size during dispersal was 2.9 goslings.

In 1989, there were six Brant nests on Duck Island and only three of these were successful. The average brood size during dispersal was 2 goslings. The number of Brant nests on Duck Island has declined since 1984.

Brant from Howe and Duck islands used brood-rearing areas between Prudhoe Bay and the Kadleroshilik River in 1989. Broods from these and other colonies and isolated nests in the region shared brood-rearing areas. Therefore, estimates of gosling survival were calculated for the regional population, rather than for the individual colonies. In 1989, 47 nests were located in this region (in addition to the Howe Island and Duck Island colonies); for most of these nests no information on productivity was available. The Howe Island, Duck Island, and Surfcote (in the Lisburne Development Area) colonies accounted for

83% of the nests in the region. Productivity for the other nests was estimated by using the combined average nesting success and average brood size at hatching for these three colonies. At hatching, there were 424 adults in this region and the estimated number of goslings was 435. An aerial survey of Brant in the region on 29 July yielded counts of 421 adults and 216 goslings, suggesting substantial post-hatch gosling loss.

In 1989, Brant on the Sagavanirktok River delta were restricted to arctic salt-marsh vegetation types during June and July. Broods from the Howe Island and Duck Island colonies dispersed as far west as Prudhoe Bay and east to the Kadleroshilik River. During dispersal, there was a great deal of fluctuation in daily counts in the salt marshes near Howe and Duck islands, indicating considerable movement through these areas to more distant brood-rearing areas. Within 7-10 days of peak hatch, group numbers stabilized and most long-distance movement ceased. Habitat use by Brant appeared to change slightly between the nesting and brood-rearing periods. Some marshes used during arrival and incubation were avoided by brood-rearing groups, indicating that different factors were involved in selection of brood-rearing habitat.

TABLE OF CONTENTS

EXECUTIVE SUMMARY i

LIST OF TABLES viii

LIST OF FIGURES xi

ACKNOWLEDGEMENTS xiii

INTRODUCTION 1

STUDY AREA 5

PART 1: TUNDRA SWAN SURVEYS 7

METHODS 7

RESULTS 10
SWAN DISTRIBUTION DURING JUNE 10
SWAN PRODUCTIVITY AND DISTRIBUTION DURING AUGUST . . . 13

DISCUSSION 18
SWAN DISTRIBUTION DURING JUNE 18
SWAN PRODUCTIVITY AND DISTRIBUTION DURING AUGUST . . . 19

PART 2: REGIONAL BRANT SURVEYS 22

METHODS 22

AERIAL SURVEYS 22
SAGAVANIRKTOK DELTA BRANT SURVEYS 24
Brant Phenology 24
Brant Productivity 28

RESULTS 30
AERIAL SURVEYS 30
Nesting Brant 30
Abundance 30
Distribution 30
Ground-truthing 38
Brood-rearing/Molting Brant 40
Abundance and Distribution 40
SAGAVANIRKTOK DELTA BRANT SURVEYS 48

Phenology 48
Productivity 50
Howe Island 50
Duck Island 55
Other Brant Colonies and Solitary Nests 55
Gosling Survival 56
Movements and Habitat Use 58

DISCUSSION 69
AERIAL SURVEYS 69
Nesting Brant 69
Abundance 69
Distribution 75
Survey Efficiency 78
Brood-Rearing/Molting Brant 79
Abundance 79
Distribution 79
SAGAVANIRKTOK DELTA BRANT SURVEYS 82
Phenology 82
Population Size 83
Howe Island 84
Duck Island 84
Other Colonies and Isolated Nests 85
Productivity 86
Howe Island 86
Duck Island 87
Other Colonies and Solitary Nests 87
Movements and Habitat Use 88

SUMMARY AND CONCLUSIONS 90
TUNDRA SWANS 90
BRANT 90

LITERATURE CITED 93

APPENDIX A. Aerial survey coverage of the Kuparuk Oilfield and OGL 54 Study Area, Alaska, 1989. 102

APPENDIX B. Numbers of Tundra Swans and nests recorded during aerial surveys, 19-23 June 1989. 103

APPENDIX C Distances of new and proposed drill sites from Tundra Swans during aerial surveys in June and August 1989. 107

APPENDIX D. Numbers of Tundra Swans and Tundra Swan broods recorded during aerial surveys, 19-22 August 1989. . 108

APPENDIX E. The distribution of other birds recorded during Tundra Swan surveys, 1989. 112

APPENDIX F. Locations of Brant nests and brood-rearing groups between Brownlow Point and Miluveach River in June and July, 1989. 124

APPENDIX G. The distribution of other birds recorded during regional Brant surveys. 136

LIST OF TABLES

Table 1.	A summary of Tundra Swan aerial surveys conducted in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June-August 1989.	8
Table 2.	Numbers of Tundra Swans and Tundra Swan nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-24 June 1989.	11
Table 3.	Densities of Tundra Swans and Tundra Swan nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, during June and August 1989.	12
Table 4.	Numbers of Tundra Swans and Tundra Swan broods recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-22 August 1989.	15
Table 5.	Summaries of Tundra Swan counts during brood-rearing in the Kuparuk Oilfield (Beechey Point, B-5 quadrangle), Alaska, 1986-1989.	20
Table 6.	A summary of Brant aerial surveys conducted along the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June - August 1989.	23
Table 7.	Distribution of adult Brant on sections of the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1989.	33
Table 8.	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 1989.	36
Table 9.	Comparison of counts of Brant nests made during aerial and ground surveys at selected locations in the Kuparuk and Prudhoe Bay oilfields, Alaska, 25-26 June 1989.	39

Table 10. The distribution, size, and composition of Brant brood-rearing groups as determined by two aerial surveys on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, 24-26 July and 29 July 1989.

Table 11. The estimated numbers of adult Brant and goslings at hatching in the region between Point McIntyre and Foggy Island Bay, Alaska, compared to the numbers of adult Brant and goslings counted from photographs and an aerial survey made 29 July 1989.

Table 12. Use of areas on the outer Sagavanirktok River delta by Brant during arrival, 2-10 June 1989.

Table 13. Use of areas on the outer Sagavanirktok River delta by Brant during incubation, 11 June - 3 July 1989.

Table 14. Use of areas on the outer Sagavanirktok River delta by Brant during hatching and dispersal from Howe Island, 4-11 July 1989.

Table 15. Use of areas on the outer Sagavanirktok River delta by Brant during brood-rearing, 12-29 July 1989.

Table 16. Records of Brant nesting from Brownlow Point to the Miluveach River, Alaska, (1969-present).

Appendix Table A1. Aerial survey coverage of USGS quadrangles in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 1989.

Appendix Table B1. 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, 19-23 June 1989.

Appendix Table C1. Distances of new and proposed drill sites from Tundra Swan pairs, nests, and broods located during aerial surveys in June and August 1989.

Appendix Table D1.	Numbers of Tundra Swans and Tundra Swan broods recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-22 August 1989.	108
Appendix Table E-1.	Numbers of selected avian and mammalian species and avian nests recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-24 June 1989.	113
Appendix Table E-2.	Numbers of selected species recorded (by quarter quad) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-22 August 1989.	118
Appendix Table G-1.	Glaucous Gull nests located on barrier islands (Spy Island to Kadleroshilik River delta, Alaska) during aerial surveys, 24-26 June 1989.	137
Appendix Table G-2.	Numbers of geese (excluding Brant) and Tundra Swans observed within 0.8 km of the Arctic Coast, between Brownlow Point and the Miluveach River, Alaska, 24-29 July, 1989. Sections are as delineated in Figure 1.	139

LIST OF FIGURES

Figure 1. Study areas for Tundra Swan and Brant investigations in 1989.

Figure 2. Locations of Tundra Swan nests and pairs of swans in the central Kuparuk Oilfield during aerial surveys from 19-24 June, 1989.

Figure 3. Locations of pairs and broods of Tundra Swans in the central Kuparuk Oilfield during aerial surveys from 19-22 August, 1989.

Figure 4. Locations of blinds for observations of Brant in the Howe and Duck island colonies, Alaska.

Figure 5. Locations of brood-rearing areas used by Brant on the Sagavanirktok River delta, Alaska, in 1989.

Figure 6. Locations and sizes of Brant colonies and locations of solitary nests on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1989.

Figure 7. 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.

Figure 8. Distances of Brant nesting locations and nest sites from the coast between Brownlow Point and the Miluveach River, Alaska, June 1989.

Figure 9. Numbers of adult Brant and Brant nests observed in each of five sections of the study area between Brownlow Point and the Miluveach River, Alaska, June 1989.

Figure 10. Locations and sizes of Brant brood-rearing groups on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, July 1989.

Figure 11.	Numbers of adult Brant and goslings in each of five sections of the study area between Brownlow Point and the Miluveach River, Alaska, July 1989.	44
Figure 12.	Linear densities of waterfowl species in each of five coastal sections of the study area between Brownlow Point and the Miluveach River, Alaska, 24-26 July 1989.	45
Figure 13.	Numbers of Brant seen during daily scans of Howe Island, Alaska, 1986-1989.	49
Figure 14.	Dates of initiation and hatching for Brant nests on Howe Island, Alaska, 1989.	51
Figure 15.	Numbers and fates of Brant nests on Howe and Duck islands, Alaska, 1984-1989.	52
Figure 16a.	Distribution of Brant nests on Howe Island, Alaska, 1984-1986.	53
Figure 16b.	Distribution of Brant nests on Howe Island, Alaska, 1987-1989.	54
Figure 17.	Locations of Brant colonies and solitary nests between Point McIntyre and Foggy Island Bay, Alaska, used to estimate gosling survival in 1989.	57
Figure 18.	Use of the outer Sagavanirktok River delta by Brant during arrival, 2-10 June 1989.	61
Figure 19.	Use of the outer Sagavanirktok River delta by Brant during incubation, 11 June - 3 July 1989.	63
Figure 20.	Use of the outer Sagavanirktok River delta by Brant during hatching, 4-11 July 1989.	64
Figure 21.	Use of the outer Sagavanirktok River delta by Brant during brood-rearing, 12-29 July 1989.	68

ACKNOWLEDGEMENTS

These studies were funded by ARCO Alaska, Inc. and BP Exploration (Alaska), Inc. Special thanks and appreciation are due Mike Joyce (ARCO) and Dr. Chris Herlugson (BP) for their support and patience. A number of people reviewed draft versions of this report, but Sue Bishop and Rick Johnson were particularly helpful with the final draft. Ann Svensson was instrumental in packaging the finished product. Finally, Sandy Hamilton, Tamarack Air, Ltd., piloted our survey aircraft and regularly made us laugh.

INTRODUCTION

Tundra Swans (*Cygnus columbianus*) are a conspicuous and important component of waterbird communities in northern Alaska. Arctic Tundra 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, swans typically depart the Coastal Plain at the time of freeze-up in early October (Salter et al. 1980). Numerous surveys have been undertaken on the Coastal Plain (e.g., King 1970, Bartels and Doyle 1984, Conant and Cain 1987), providing 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. 1979a). Brant nesting also occurs on barrier islands associated with river deltas (Gavin 1977, Divoky 1978, Johnson and Richardson 1980).

Because Tundra Swans and Brant have historically been important concerns of regulatory agencies and the oil industry, and because these species may be traditional in their selection of nesting and brood-rearing areas, it is

critical to regularly assess their distribution, productivity, and abundance as development expands. In 1988, Alaska Biological Research, Inc. (ABR) under contract to ARCO Alaska, Inc. (ARCO), conducted intensive aerial surveys of the Kuparuk Oilfield and wetlands in Oil and Gas Lease Sale 54 (OGL 54) (Figure 1), to locate and count Tundra Swans, Brant and other waterfowl. These surveys were flown in cooperation with the U.S. Fish and Wildlife Service (USFWS), which was conducting similar surveys in the area.

These surveys were successful; swan distribution and productivity were determined for the first time for some portions of the Kuparuk Oilfield and the entire OGL 54. In addition, a number of small Brant colonies, not previously described, were identified. In 1989, because of the continued interest in assessing the status of swans and an increasing interest in determining the abundance, distribution, and productivity of Brant (identified as a National Resource species by the USFWS), BP Exploration (Alaska) Inc. joined ARCO in developing and supporting the survey program. Due to the increased level of interest, the scope of work for the 1989 study program was expanded to include:

1) continued intensive surveys of swan nesting and productivity in the Kuparuk Oilfield and OGL 54;

2) aerial survey coverage to locate Brant nesting colonies in the coastal region between the Miluveach River and the Staines River (near Brownlow Point); and

3) aerial survey coverage to locate Brant brood-rearing areas in the coastal region between the Miluveach River and the Staines River.

The scope of work also was increased to provide detailed data on productivity of the Brant colonies on Howe and Duck islands in the Sagavanirktok River delta. These additional tasks included:

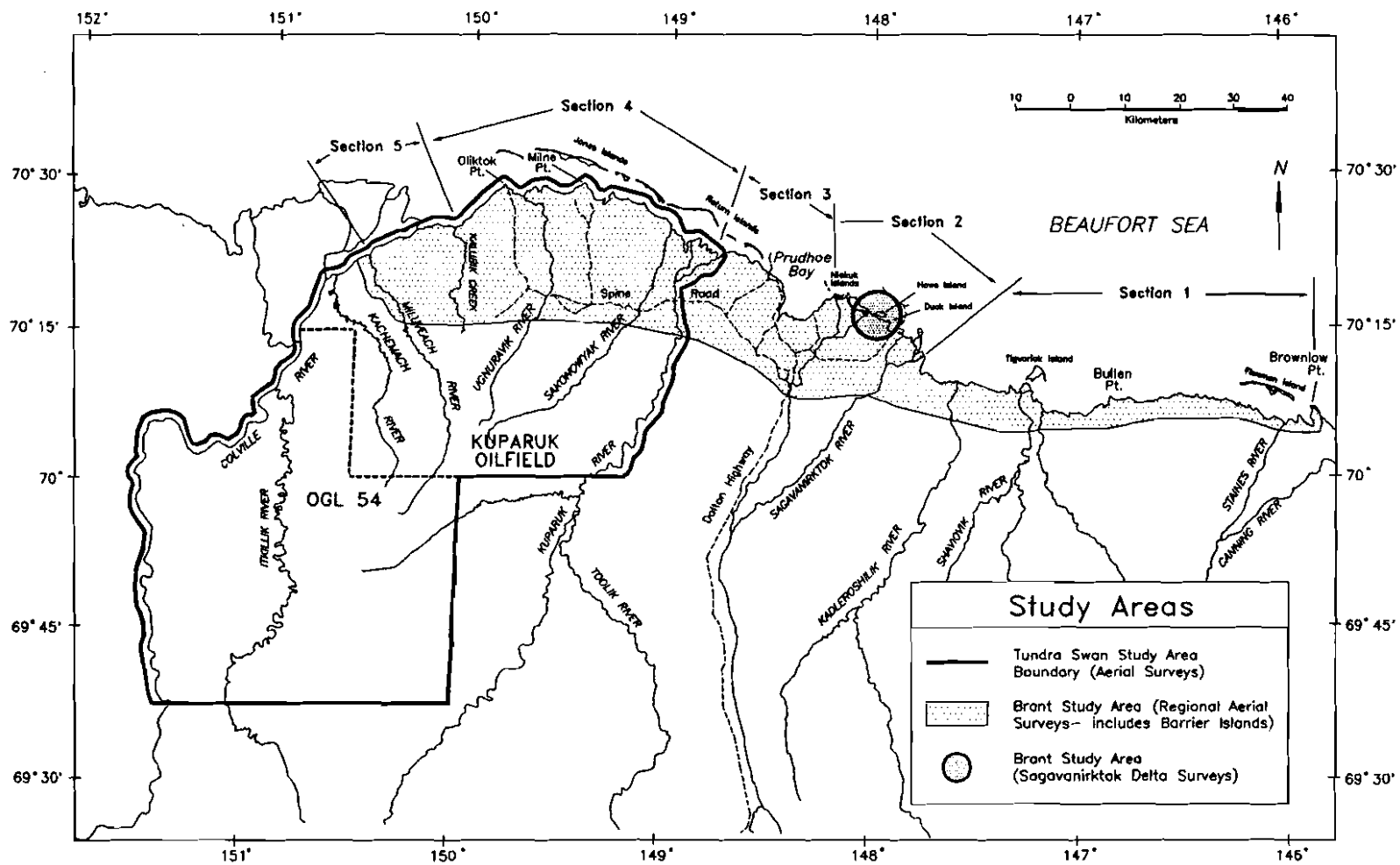


Figure 1. Study areas for Tundra Swan and Brant investigations in 1989.

4) ground censuses of Howe and Duck islands to determine nest numbers, distribution, and success of Brant and other bird species (performed in conjunction with ongoing monitoring of the Snow Goose [*Chen caerulescens*] colonies);

5) monitoring of post-hatch brood movements of Brant from Howe and Duck islands (to the extent practicable) to determine the timing, direction, and rate of dispersal of brood-rearing/molting Brant from the colonies;

6) estimation of Brant numbers, brood sizes at hatching and survival rates; and

7) identification of brood-rearing habitats used by Brant from Howe and Duck islands (to the extent possible).

STUDY AREA

Ground and aerial surveys 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 also were surveyed for Tundra Swans. The region is characteristic of the Arctic Coastal Plain and is dominated by thaw lakes and polygonized tundra (Carson and Hussey 1962). The areal extent of lakes is reduced in the upland areas directly south of the Kuparuk Oilfield and east of the Shaviovik River on the Coastal Plain; the inland areas (the White Hills) are characterized by drier vegetation communities (Wahrhaftig 1965). Land forms and vegetation on the Arctic Coastal Plain have been described in detail by Walker et al. (1980).

Tundra Swan surveys were conducted between the Colville River on the west and the Kuparuk River on the east (Figure 1). The Beaufort Sea coast formed the northern boundary while the southern limit was formed by a line running west from the Kuparuk River approximately 70°10′ N to 150°00′ W, then south to 69°37′ N, then west again to the Colville River. The entire Kuparuk Oilfield and OGL 54 were 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 (Figure 1) on the west. The Simpson Lagoon barrier islands (Spy Island to Stump Island), the Niakuk Islands, gravel spits in Foggy Island Bay, Tigvariak Island, and Flaxman Island were included in survey coverage. Inland surveys included the Kuparuk and Prudhoe Bay oilfields south to approximately 70°10′ N and the area between the Sagavanirktok and Staines rivers within approximately 5 km of 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 are described 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. Section 3 (Heald Point to Kuparuk River) extended from the west channel of the Sagavanirktok River to the east channel of the Kuparuk River, and included the Niakuk Islands and the eastern islands of the Return Islands (Egg and Stump islands). Section 4 (Kuparuk River to Kalubik Creek) included the Kuparuk River delta, the western island of the Return Islands (Long Island), and the Jones Islands, and extended west to Kalubik Creek. Section 5 (Kalubik Creek to Miluveach River) included the area between Kalubik Creek and the Miluveach River, excluding Colville River delta areas west and north of the eastern channel of the Colville River.

Ground censuses and observations of Brant were conducted in the vicinities of Brant colonies on Howe and Duck islands in the Sagavanirktok River delta. The Sagavanirktok delta is located between Heald Point and Foggy Island Bay and consists of two major channels and several smaller distributaries. Vegetated islands, including Howe and Duck islands, occur across the front of the delta (Gallaway and Britch 1983). The Sagavanirktok River delta is among the largest river deltas on the Coastal Plain and includes a wide variety of land forms and vegetation types ranging from the thaw lakes and polygonized wet tundra characteristic of the Arctic Coastal Plain to very dry alpine-like habitats along some river bluffs (Gallaway and Britch 1983). The terrestrial features of the delta have been influenced by thaw lake cycles, aeolian deposition of materials from the river, erosion and sedimentation by the river, and flooding of the coastal shoreline by storm tides (Murphy et al. 1989).

PART 1: TUNDRA SWAN SURVEYS

METHODS

Two aerial survey methods were used: 1) fixed-width (1.6 km) strip transects in regions where wetlands were extensive; and 2) a direct route between bodies of water in areas where wetlands were scattered (King 1973) (Appendix A). Township and section lines on 1:63,360 U.S. Geological Survey (USGS) topographic maps were used as transect centerlines. A Cessna 180 aircraft with a pilot and two observers was used for nesting surveys in June and a Cessna 185 was substituted for brood-rearing surveys in August. Surveys were flown at approximately 150 m above ground level (agl), at an airspeed of approximately 145 km/h.

Data collection for swan observations followed the USFWS Tundra Swan Survey Protocol (USFWS 1987a). 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 were communicated to the observer in the front right seat, who was responsible for plotting 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. Adult Tundra Swans associated with nests or broods were considered to be breeding birds; all others were counted as non-breeders. Whenever possible, observations of Snowy Owl (*Nyctea scandiaca*) and Glaucous Gull (*Larus hyperboreus*) nests as well as all goose and loon locations were recorded by the observer in the left rear seat of the aircraft on a second set of USGS maps.

Survey dates were selected to correspond with previous USFWS surveys in the same area (Table 1). Nesting surveys were conducted between 19 and 24 June, after most Tundra Swan nests had probably been initiated.

Table 1. A summary of Tundra Swan aerial surveys conducted in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June-August, 1989.

Survey Type	Date(s)	Location[1]	Aircraft	Technique	Observers[2]
Tundra Swan nests	19-23 June	Kuparuk Oilfield and OGL 54	C-180	Transects, 1.6 km wide (USFWS 1987a)	RJR, JGK
Tundra Swan brood-rearing	19-22 August	Kuparuk Oilfield and OGL 54	C-185	Transects, 1.6 km wide (USFWS 1987a)	JGK, PWB

[1] Locations are mapped on Figure 1.

[2] Observer: RJR = Robert J. Ritchie
JGK = James G. King
PWB = Paul W. Banyas

Brood-rearing surveys were conducted between 19 and 22 August when most young were fairly large and conspicuous. Approximately 24 and 22 hours of aircraft survey time were used during June and August surveys, respectively. A total of 2654 km of transects was flown on both nesting and brood-rearing surveys. Appendix A includes estimates of survey coverage for each USGS quadrangle.

RESULTS

SWAN DISTRIBUTION DURING JUNE

Aerial surveys in June 1989 provided complete coverage of the Tundra Swan study area, including the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) areas (Figure 1). The Kuparuk Oilfield unit encompassed 57% (2407 km^2) of the study area while the OGL 54 section contained the remaining 43% (1839 km^2) (Appendix A).

A total of 479 Tundra Swans were observed at 289 locations in the study area during nesting surveys conducted in June (Table 2, Appendix B). Swans associated with nests (breeding birds) constituted 26% (123) of all observations, whereas the remaining 74% (356) of swans appeared to be non-breeders. The Kuparuk unit contained 53% (256) of the total number of swans, 57% (70) of the breeding birds, and 52% (186) of the non-breeding birds. The OGL unit contained the remaining 47% (223) of total swans, 43% (53) of the breeding birds, and 48% (170) of the non-breeders (Table 2).

A total of 78 active nests was located in the study area: 56% (44) in the Kuparuk unit and 44% (34) in OGL 54 (Table 2, Appendix B). All swan nests in the Kuparuk Oilfield were located north of 70°08′ N, but nests in the OGL 54 area were found as far south as 69°37′ N. Few sightings of swans were recorded in the upland (White Hills) section of the study area, south of 70°10′ N and east of 150°40′ W.

Densities of swans and nests during June surveys for the entire study area are presented in Table 3. Mean densities in the Kuparuk and OGL 54 units were identical for breeding swans (0.03/km^2) and nests (0.02/km^2) and very similar for non-breeding swans (0.08/km^2 in Kuparuk vs. 0.09/km2 in OGL 54) and total swans (0.11/km^2 in Kuparuk vs. 0.12/km^2 in OGL 54).

New or proposed drill sites evaluated in this study were located between 0.9 and 4.4 km ($\bar{x}$ = 2.5 km) from the nearest active Tundra Swan nests.

Table 2. Numbers of Tundra Swans and Tundra Swan nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-24 June 1989.

Location USGS quadrangle		Breeding Adults	Nests			Non-breeding Adults					Total Swans
			With Pair	With Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
Kuparuk Oilfield											
Beechey Point	A-4	9	4	1	5	6	3	0	0	15	24
	A-5	2	1	0	1	0	2	0	0	2	4
	B-4	18	5	8	13	12	15	0	0	39	57
	B-5	24	10	4	14	19	14	1	4	56	80
	C-4	0	0	0	0	0	0	0	0	0	0
	C-5	1	0	1	1	0	1	0	0	1	2
Harrison Bay	A-1	2	1	0	1	6	3	0	0	15	17
	B-1	11	4	3	7	16	9	2	6	47	58
	B-2	3	1	1	2	5	1	0	0	11	14
OGL 54											
Harrison Bay	A-2	4	1	2	3	14	11	0	0	39	43
	A-3	2	1	0	1	3	4	0	0	10	12
Umiat	C-1	0	0	0	0	0	0	0	0	0	0
	C-2	13	3	7	10	4	9	0	0	17	30
	C-3	2	0	2	2	5	6	0	0	16	18
	D-1	0	0	0	0	3	1	0	0	7	7
	D-2	17	7	3	10	15	8	2	7	45	62
	D-3	15	7	1	8	6	8	1	16	36	51
Kuparuk Oilfield Subtotal		70	26	18	44	64	48	3	10	186	256
OGL 54 Subtotal		53	19	15	34	50	47	3	23	170	223
Kuparuk/OGL 54 Total		123	45	33	78	114	95	6	33	356	479

Table 3. Densities of Tundra Swans and Tundra Swan nests recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, during June and August 1989.

Location USGS quadrangle		Nesting Survey (June)				Productivity Survey (August)					
		Breeding Adults (per km²)	Nests (per km²)	Non-breeding Adults (per km²)	Total Swans (per km²)	Breeding Adults (per km²)	Broods (per km²)	Young (per km²)	Non-breeding Adults (per km²)	Total Adults (per km²)	Total Swans (per km²)
Kuparuk Oilfield											
Beechey Point	A-4	0.03	0.02	0.05	0.09	0.03	0.02	0.03	0.12	0.15	0.18
	A-5	0.01	<0.01	0.01	0.01	0.01	<0.01	<0.01	0.05	0.06	0.06
	B-4	0.04	0.03	0.09	0.13	0.06	0.03	0.08	0.18	0.23	0.32
	B-5	0.04	0.02	0.09	0.13	0.05	0.03	0.06	0.11	0.17	0.22
	C-4	0	0	0	0	0	0	0	0	0	0
	C-5	0.08	0.08	0.08	0.15	0	0	0	0	0	0
Harrison Bay	A-1	0.01	<0.01	0.06	0.06	0.01	<0.01	0.01	0.07	0.08	0.09
	B-1	0.03	0.02	0.11	0.14	0.03	0.01	0.04	0.20	0.23	0.27
	B-2	0.05	0.03	0.17	0.22	0	0	0	0.17	0.17	0.17
OGL 54											
Harrison Bay	A-2	0.01	0.01	0.11	0.13	0.02	0.01	0.02	0.13	0.15	0.17
	A-3	0.02	0.01	0.10	0.12	0.04	0.02	0.04	0.08	0.12	0.16
Umiat	C-1	0	0	0	0	0	0	0	0	0	0
	C-2	0.08	0.06	0.10	0.18	0.06	0.03	0.06	0.10	0.16	0.22
	C-3	0.01	0.01	0.11	0.12	0.03	0.01	0.03	0.17	0.19	0.22
	D-1	0	0	0.07	0.07	0	0	0	0.02	0.02	0.02
	D-2	0.03	0.02	0.08	0.12	0.01	0.01	0.01	0.16	0.18	0.19
	D-3	0.04	0.02	0.10	0.14	0.02	0.01	0.01	0.15	0.17	0.19
Kuparuk Oilfield Mean		0.03	0.02	0.08	0.11	0.03	0.02	0.04	0.13	0.16	0.21
OGL 54 Mean		0.03	0.02	0.09	0.12	0.02	0.01	0.02	0.13	0.15	0.17
Kuparuk/OGL 54 Mean		0.03	0.02	0.08	0.11	0.03	0.02	0.03	0.13	0.16	0.19

These drill sites were located from 1.5 to 7.0 km ($\bar{x}$ = 3.4 km) from observed locations of the nearest swan pairs not associated with nests (Figure 2, Appendix C).

SWAN PRODUCTIVITY AND DISTRIBUTION DURING AUGUST

Aerial surveys in August 1989 also provided complete coverage of the study area. Six hundred seventy adult Tundra Swans and 64 broods containing 142 cygnets were observed during brood rearing surveys (Table 4, Appendix D). Adults associated with broods (breeding adults) accounted for 18% (122) of the total number of adult swans while the remaining 82% (548) without broods appeared to be non-breeding adults. The Kuparuk unit contained 59% (392) of the adult swans, 69% (84) of the breeding adults, and 56% (308) of the non-breeding adults in the study area. The OGL 54 unit contained the remaining 41% (278) of the adults, 31% (38) of the breeding adults, and 44% (240) of the non-breeding adults.

Approximately 82% (64 out of 78) of the Tundra Swan nests found in the study area in June were successful. The Kuparuk unit contained 70% (45) of the total number of broods and 73% (103) of the total number of young while the OGL 54 unit contained the remaining 30% (19) and 27% (39), respectively. Nest success was close to 100% in the Kuparuk Oilfield, but considerably lower (56%) in the OGL 54 area. Mean brood size for the entire study area was 2.2 (SD = 0.9) cygnets with a slightly higher mean in the Kuparuk unit ($\bar{x}$ = 2.3) than in the OGL 54 ($\bar{x}$ = 2.1) (Table 4). Mean brood sizes were considerably larger in Beechey Point B-4 ($\bar{x}$ = 2.7, n = 14), Harrison Bay B-1 ($\bar{x}$ = 2.8, n = 6), and Umiat D-3 ($\bar{x}$ = 2.7, n = 3) quadrangles than in other portions of the study area.

Swan densities in the Kuparuk Oilfield and OGL 54 area were identical for non-breeding and total adults (Table 3). However, the Kuparuk unit had higher mean densities than OGL 54 for breeding adults (0.03/km^2 vs.

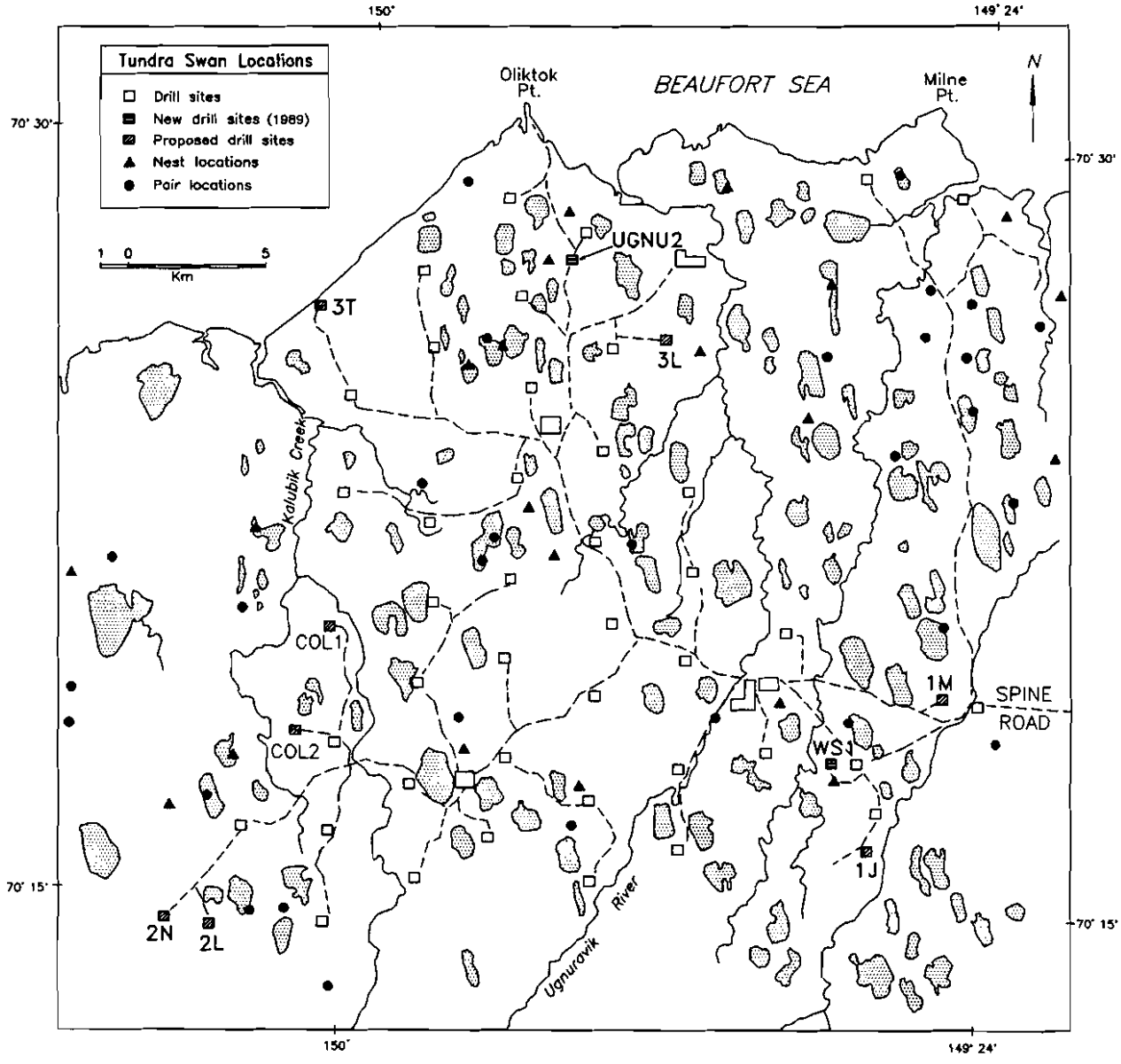


Figure 2. Locations of Tundra Swan nests and pairs of swans in the central Kuparuk Oilfield during aerial surveys from 19-24 June, 1989. (This map does not depict the entire study nor all locations discussed in the text.)

Table 4. Numbers of Tundra Swans and Tundra Swan broods recorded during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-22 August 1989.

Location USGS quadrangle		Breeding Adults	Broods			Total Young	Mean Brood Size	Non-breeding Adults					Total Adults	Total	Percent Young
			With Pair	With Single Adult	Total			Pairs	Singles	Flocks	Flocked Swans	Total			
Kuparuk Oilfield															
Beechey Point	A-4	9	4	1	5	9	1.8	12	5	1	3	32	41	50	18.0
	A-5	2	1	0	1	1	1.0	5	1	1	4	15	17	18	5.6
	B-4	25	11	3	14	38	2.7	25	9	6	21	80	105	143	26.6
	B-5	34	16	2	18	36	2.0	31	3	1	4	69	103	139	25.9
	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	2	1	0	1	2	2.0	6	1	2	6	19	21	23	8.7
	B-1	12	6	0	6	17	2.8	26	6	6	24	82	94	111	15.3
	B-2	0	0	0	0	0	0	5	1	0	0	11	11	11	0
OGL 54															
Harrison Bay	A-2	6	3	0	3	6	2.0	18	3	2	6	45	51	57	10.5
	A-3	4	2	0	2	4	2.0	0	1	2	7	8	12	16	25.0
Umiat	C-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	C-2	10	5	0	5	10	2.0	6	0	1	4	16	26	36	27.8
	C-3	4	2	0	2	4	2.0	7	5	2	6	25	29	33	12.1
	D-1	0	0	0	0	0	0	1	0	0	0	2	2	2	0
	D-2	8	4	0	4	7	1.8	31	7	4	19	88	96	103	6.8
	D-3	6	3	0	3	8	2.7	18	7	3	13	56	62	70	11.4
Kuparuk Oilfield Subtotal		84	39	6	45	103	2.3	110	26	17	62	308	392	495	20.8
OGL 54 Subtotal		38	19	0	19	39	2.1	81	23	14	55	240	278	317	12.3
Kuparuk/OGL 54 Total		122	58	6	64	142	2.2	191	49	31	117	548	670	812	17.5

0.02/km^2), broods (0.02/km^2 vs. 0.01/km^2) and young (0.04/km^2 vs. 0.02/km^2).

New or proposed drill sites evaluated in this study were between 1.4 to 6.2 km ($\bar{x}$ = 3.4 km) from the nearest brood locations (Figure 3). These sites were between 0.6 to 5.0 km ($\bar{x}$ = 2.6 km) from the nearest locations of swan pairs without broods (Appendix C).

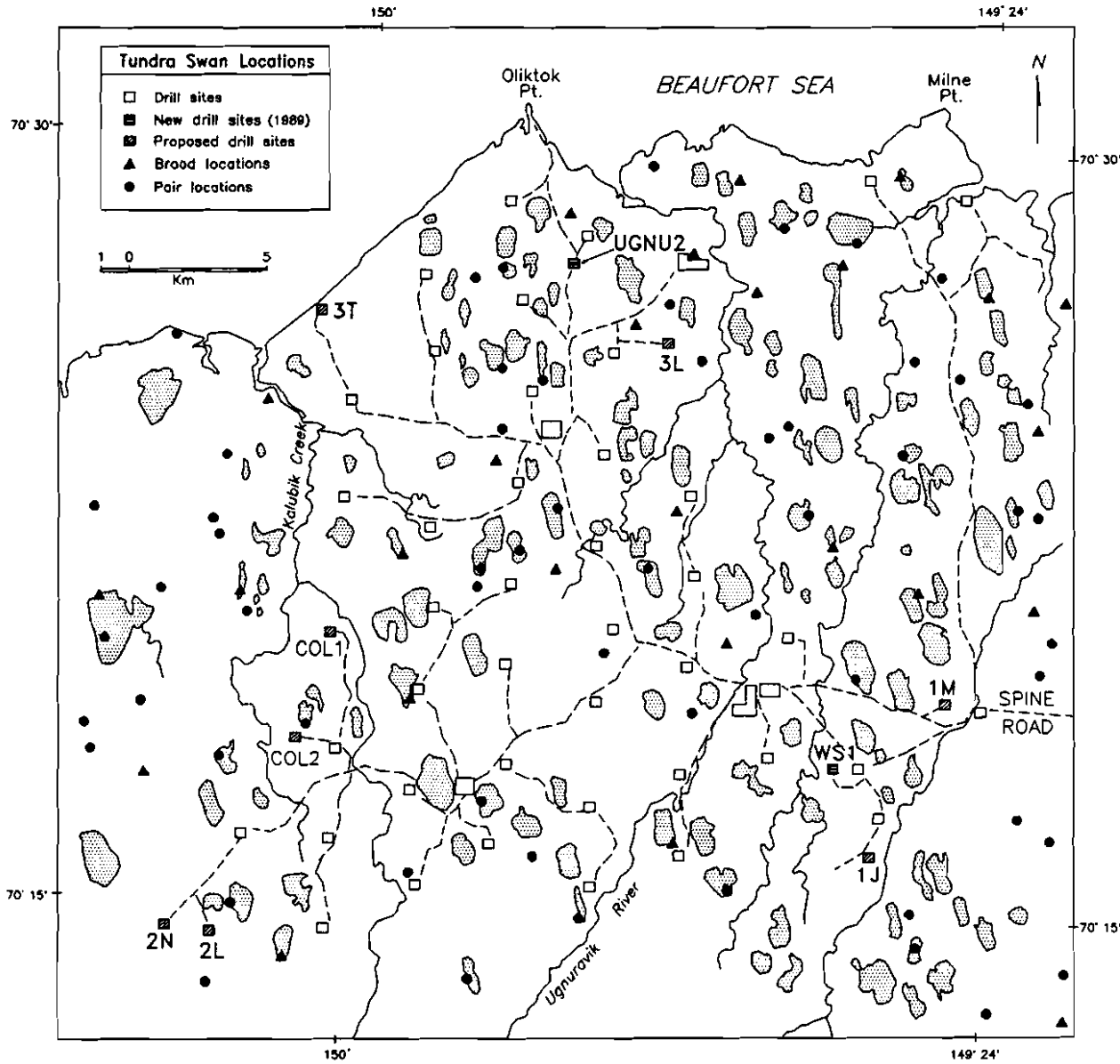


Figure 3. Locations of Tundra Swan pairs and broods in the central Kuparuk Oilfield during aerial surveys from 19-22 August, 1989. (This map does not depict the entire study area nor all locations discussed in the text.)

DISCUSSION

SWAN DISTRIBUTION DURING JUNE

During June 1989, densities of swans and nests were similar in the Kuparuk Oilfield and OGL 54 units of the study area. Densities in OGL 54 in 1989 were similar (0.14 swans and 0.02 nests/km^2) to those found in 1988 (Ritchie et al. 1989). King (1989) observed similar densities (0.15 swans and 0.02/nests km^2) in surveys north of 70°15′ N between the Colville River and Foggy Island Bay (a 2063 km^2 study area that included portions of the Kuparuk study area and coastal regions to the east).

The study area and coastal areas to the east have been described as low density areas for adult swans (0.2 to 0.9 swans/km^2) (USFWS, Distribution and Abundance of Swans in Alaska [map], no date). The coastal region west of the study area, including the Colville River delta, is classified as high (1.0 to 1.9 swans/km^2) to very high (more than 2.0 swans/km^2) density breeding habitat.

Some caution must be exercised in comparing the reported densities of Tundra Swans and swan nests among regions because of differences in the size and habitat composition of various study areas and because of natural fluctuations in abundance between years. However, comparisons with similar investigations in other regions of the North Slope confirm that the densities observed in 1988 and 1989 in the Kuparuk Oilfield and OGL 54 areas were relatively low. Swan densities in the late 1970s ranged from 0.04-0.40 swans/km^2 in the National Petroleum Reserve (west of the Colville River delta) (King 1979). The highest reported densities of swans reported on the Coastal Plain occur on major river deltas. Swan densities on the Colville River delta ranged from 0.19-0.58 swans/km^2 and 0.05-0.10 nests/km^2 in the years 1982-1989 (Hawkins 1983, Campbell and Rothe 1990). On the Canning River delta, mean densities of 0.51 swans and 0.13 nests/km^2 were reported for the years 1983-1985 (Platte and Brackney 1986).

SWAN PRODUCTIVITY AND DISTRIBUTION DURING AUGUST

Although densities of total adult and non-breeding swans were similar between the Kuparuk and OGL 54 units, densities of breeding adults, broods, and young were considerably higher in the Kuparuk unit than the OGL 54 unit. In the Kuparuk unit, the density of breeding birds did not appear to change from June to August. However, densities of non-breeding birds, and consequently total adults, did increase. Similarly, in OGL 54, densities of non-breeding adults and total adults also increased, but the densities of breeding adults decreased considerably. This is presumed to be the result of a high number of nest failures in OGL 54 in 1989.

More broods were observed in the Kuparuk unit during August surveys than could be accounted for by the number of nests located in June; the converse was true for OGL 54. Possible factors that contributed to these discrepancies may have included 1) nests missed during June surveys in the Kuparuk unit, 2) high nesting success in the Kuparuk unit with recruitment of broods from surrounding areas, and 3) poor nesting success in the OGL 54 with possible brood emigration.

The Beechey Point B-5 quadrangle in the central Kuparuk Oilfield (including Oliktok and Milne Point roads) has been surveyed for Tundra Swans during August of each year since 1986 (Table 5). Surveys between 1986 and 1988 were conducted by the USFWS (Conant and Cain 1987, R. King, USFWS, pers. comm.). In 1988, this area was surveyed by ABR (Ritchie et al. 1989). Comparison of results among years suggests a steadily increasing population of breeding swans, from 7 broods and 14 breeding adults in 1986 to 18 broods in 1989. Mean brood sizes between 2.0 (1989) and 2.4 (1987) suggest that productivity of breeding pairs has varied somewhat among years.

Surveys in August confirmed the June indications that the study area supports relatively low densities of Tundra Swans. As noted previously, differences between studies in other areas make comparisons of swan densities difficult. However, other swan surveys of the Coastal Plain have identified river

Table 5. Summaries of Tundra Swan counts during brood-rearing in a portion of the Kuparuk Oilfield (Beechey Point, B-5 quadrangle), Alaska, 1986-1989.

		Broods					Non-breeding Adults							
Year	Breeding Adults	With Pair	With Single Adult	Total	Total Young	Mean Brood Size	Pairs	Singles	Flocks	Flocked Swans	Total	Total Adults	Total Swans	Percent Young
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	34	16	2	18	36	2.0	31	3	1	4	69	103	139	25.9

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

deltas as the areas of highest density of broods and adults during August. The mean density of broods in the Colville River delta from 1982 to 1989 was 0.06/km^2 (range 0.03-0.10) (Campbell and Rothe 1990). Densities as high as 0.13 broods/km^2 were reported in several small river deltas in the Arctic National Wildlife Refuge (ANWR) during 1985 (Platte and Brackney 1987).

Several investigators have used the proportion of cygnets in the population as an index to productivity for regional populations. The proportions of cygnets in the study area in August 1988 and 1989 were very similar; 17.4 and 17.5%, respectively (Ritchie et al. 1989, Table 4). Comparisons of the proportion of cygnets among areas within a regional population also are possible (Table 5), but must be interpreted with caution (e.g., the level of use of different areas by immature birds may differ). The proportion of cygnets in the study area in 1988 and 1989 appeared to be within the range (10-32%) found on the Colville River delta from 1982 to 1989 (Campbell and Rothe 1990). The proportions of cygnets on the Colville River delta in 1989 (16.0%) was quite similar to those in the Kuparuk and OGL 54 areas. Other studies have reported the proportions of cygnets as: 10-13% (Northwest Territories, 1980-1985 [Stewart and Bernier 1989]), 29% (ANWR, 1985 [Platte and Brackney 1987]), and 24-28% (Bristol Bay, 1984-1987 [Wilk 1988]).

Mean brood size has also been used by several investigators as an index to productivity for regional populations. The productivity for successfully breeding pairs in the study area was identical in 1988 and 1989. Mean brood size appeared to be similar (2.0 to 2.8 cygnets) to those reported in other Coastal Plain study areas (Arctic Coastal Plain, 1966 [King 1970], Colville River delta, 1982-1989 [Campbell and Rothe 1990], ANWR, 1981-1985 [Bartels and Doyle 1984, Platt and Brackney 1987], Foggy Island Bay to the Colville River delta, 1982-1988 [Conant and Cain 1987, R. King, pers. comm.]).

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 6). Brant nests were located by aerial survey using a Cessna 180 with a pilot and two observers. A "Supercub" PA-18 with a pilot and one observer was used for aerial surveys to locate brood-rearing areas and to count adults and goslings. In most areas, surveys were flown at approximately 100-150 m agl and at approximately 80 -100 km/h airspeed. Over preferred Brant nesting habitats, as many as 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. 1979a), were identified from examination of aerial photos and USGS maps, and marked on navigational maps prior to surveys. Although nesting Brant are difficult to count from the air, the number of low passes in such areas was limited to avoid undue disturbance of waterfowl.

During the nesting surveys, 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. Sightings were communicated to the observer in the right front seat, who was responsible for plotting all Brant observations. The flightline and all observations were recorded on a set of 1:63,360 USGS topographic maps. Each observation included estimated numbers of adults and nests. An adult in a concealment or incubation posture, or a distinctive down-filled nest bowl, was recorded as a single nest.

Nesting surveys west of the Sagavanirktok River were conducted by flying a direct route between bodies of water within an east-west transect 3.2

Table 6. A summary of Brant aerial surveys conducted along the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June - August 1989.

Survey Type	Date(s)	Location[1]	Aircraft	Technique	Observers[2]
Brant nests	23-26 June	Miluveach R. to Staines R. inland to 10 km	C-180	Circuitous route, through 3 km wide transects; 0.8 km transects of river deltas.	RJR, JGK
	6 July	Simpson Lagoon and Gwydyr Bay Barrier Islands (Jones Islands and Return Islands)	PA-18	Transect along edge of islands	RJR
Brant brood-rearing	24-25 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 July	Resurvey of coast-line Kadleroshilik R. to Miluveach R.	PA-18	Transect along coastline	RJR

[1] Locations are mapped on Figure 1.

[2] Observer: RJR = Robert J. Ritchie
JGK = James G. King
PWB = Paul W. Banyas

km wide. Surveys extended inland to approximately 70°15'N latitude. Because river deltas contain important nesting habitats for Brant (Bellrose 1978), parallel transects 800 m wide were flown on the Kuparuk, Kadleroshilik, and Kavik river deltas. In addition, all colonies located in 1988 were revisited. Small ponds and flooded tundra were not searched unless they occurred along the route described above. East of the Sagavanirktok River, lakes are less numerous and a direct route between predetermined, suitable lakes north of 70°15'N latitude was followed.

Brood-rearing surveys were conducted in late July after most brood groups had congregated in preferred habitats along the coast. The brood-rearing survey route followed the coastline as closely as possible, extending inland to include embayments and the outer reaches of river deltas. In addition, the extensive inland surveys flown in June were repeated, to determine the extent of use of this area for brood-rearing.

Aerial photos were used to assess the accuracy of observer counts and were the primary census technique for large (>100) groups of Brant. The aircraft circled over brood-rearing groups during July counts 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 large sheets of white paper, and adult Brant and goslings were counted.

In another effort to assess the accuracy of our aerial surveys, seven Brant colonies identified during 1988 and 1989 aerial surveys near Prudhoe Bay, the Milne Point Road, and the Oliktok Road were ground-truthed on 26 June. Counts of nests made during ground surveys were compared to counts of nests made on the 25 June aerial survey.

SAGAVANIRKTOK DELTA BRANT SURVEYS

Brant Phenology

Information on the use of the outer Sagavanirktok River delta 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 1986-1989, 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 4). A variable-power spotting scope (20-45x) was used during each scan and the number of Brant in view was recorded, as well as the number of Snow Geese, Glaucous Gulls, Tundra Swans, and other birds.

Estimated distributions of dates of nest initiation and hatching in 1989 were based on observations of Brant 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 incubation period (24 days) (Barry 1956) and the laying period from the estimated hatching date. The laying period was estimated by multiplying the brood size at dispersal by the rate of laying (1.3 eggs/day) (Barry 1956).

Daily scans of foraging habitats on the outer delta provided information on the phenology of habitat use in 1989. Observations of the areas surrounding the blind were made using variable-power spotting scopes between 4 and 11 June and between 20 June and 11 July. Observations of areas in the vicinity of the Endicott Road (Figure 5) were made from vehicles on the road between 28 June and 22 July. During scans at both locations, observers recorded the numbers of adults and goslings and plotted group locations on 1:12,000 scale maps. Additional data on habitat use in roadless areas were obtained during seven aerial surveys of brood-rearing Snow Geese flown between Heald Point and Foggy Island Bay in July (Burgess et al. 1990).

When possible, Brant locations were assigned to the brood-rearing areas (BRA) defined by Burgess et al. (1990) (Figure 5). These BRAs were originally defined for brood-rearing Snow Geese, but many are also used by Brant. For the purposes of this report, a BRA is defined as a general area within which the

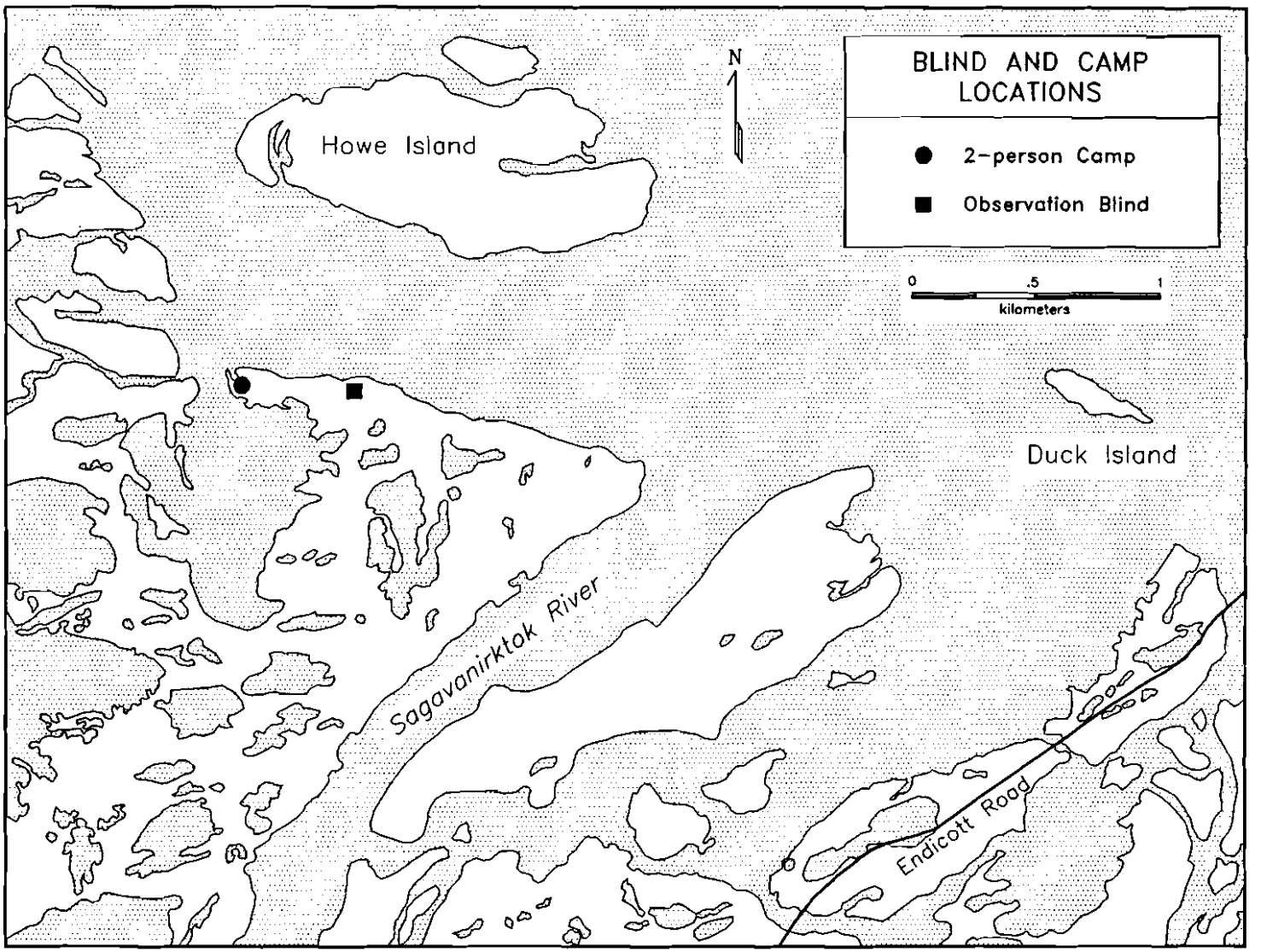


Figure 4. Locations of blinds for observations of Brant in the Howe and Duck island colonies, Alaska, 1989.

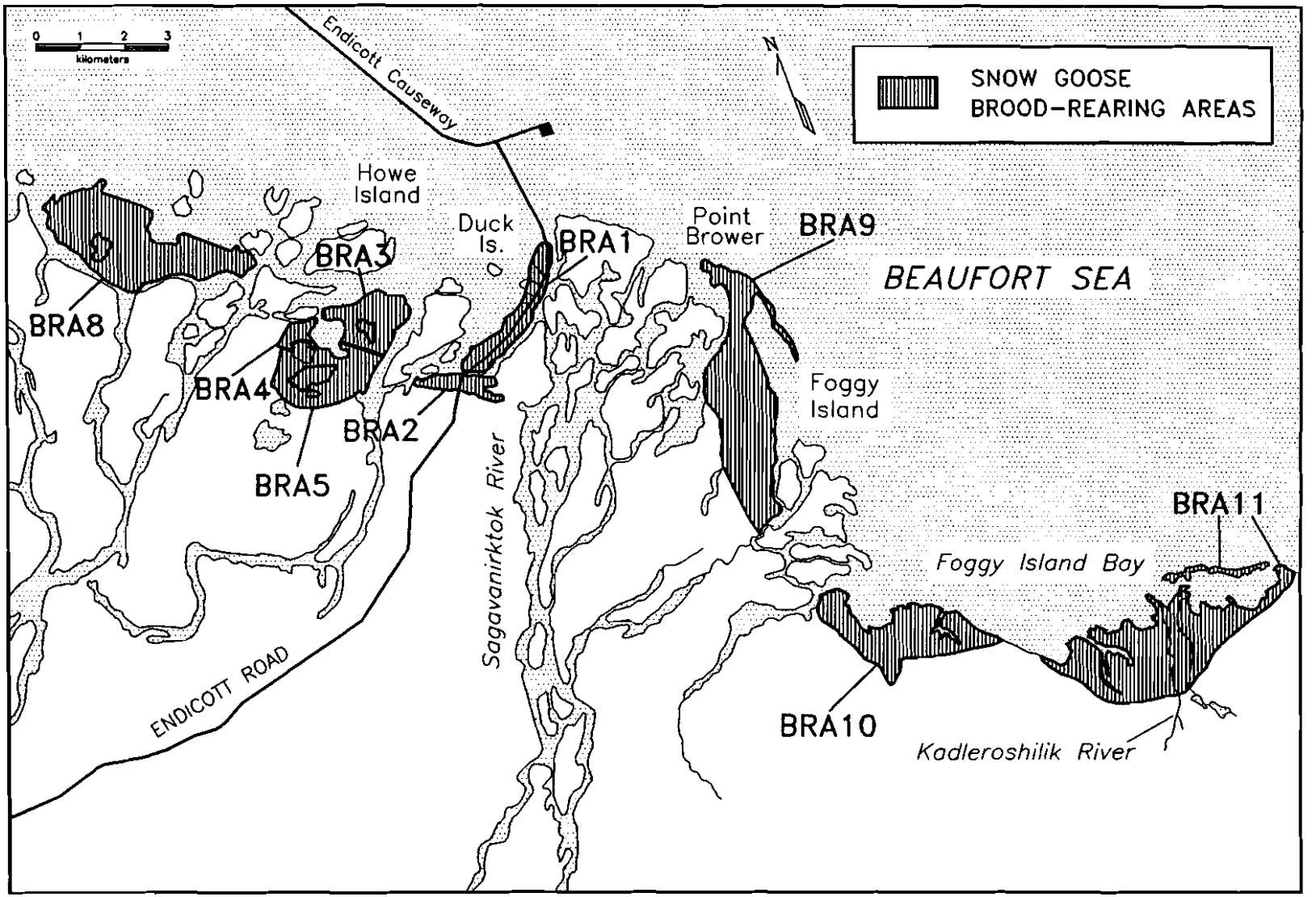


Figure 5. Locations of brood-rearing areas used by Brant on the Sagavanirktok River delta, Alaska, in 1989.

activity of a Brant group was concentrated for any period. The sites used extensively by Brant within each BRA were localized and extremely small, as was the case for Snow Geese (Burgess and Ritchie 1989). Use of the BRAs by Brant was divided into the following phenological periods: arrival, incubation, hatching, and brood-rearing. Dates for these periods were determined by observations of Brant on Howe Island.

Brant Productivity

Post-hatch ground censuses of nests were conducted on Howe Island in mid-July in 1985-1989, and on Duck Island in 1985-1987 and 1989. 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:1985-1989; Duck Island:1989) and nest contents were examined to estimate nesting success (Girard 1939). Because Brant nest contents are particularly vulnerable to destruction or removal by gulls and wind, estimates of Brant nest numbers and success derived by this method 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 the examination of nest contents was not possible for active eider nests due to the presence of large numbers of gulls which prey upon eggs in disturbed nests. Because eiders occasionally use nest bowls abandoned by other species, including Brant, some abandoned Brant nests that were occupied by eiders may have been missed in the counts.

Because Brant broods from the central Sagavanirktok River delta mix with broods hatched at other locations, estimation of gosling survival required data on the number of goslings hatched in the region between Pt. McIntyre and the Kadleroshilik River. The total number of goslings hatched on Howe Island was calculated by multiplying the mean observed size of broods dispersing from the island by the estimated number of successful nests. Nest success for

Howe was estimated as a range: the minimal value used only nests known to be successful and the maximal value included nests of unknown fate. An exact count of goslings produced on Duck Island was made as they arrived on the mainland; this count was probably affected by gosling and brood loss during dispersal. Productivity of Brant nesting in the LDA was estimated from examination of nest contents and from brood counts within seven days of hatching (Murphy et al. 1990). Productivity of Brant nesting in other locations (the Niakuk Islands, Foggy Island, inland areas of the Sagavanirktok River delta, and the upper Putuligayuk River) was estimated by multiplying the number of nests in these locations by the average nesting success (using both the minimal and maximal values for Howe Island) and estimated mean brood size for the Howe Island, Duck Island, and Surfcote colonies combined.

An index to gosling survival was provided by comparing the ratio of adults to goslings at hatching with the ratio of adults to goslings observed during an aerial survey of the region on 29 July. Actual survival rates of individual broods proved impossible to calculate due to brood mixing.

RESULTS

AERIAL SURVEYS

Nesting Brant

Abundance

Two hundred Brant nests (including 20 depredated nests) were identified during aerial surveys at 33 colonies (defined as locations including $\geq$2 nest sites) and 26 solitary nest sites between the Miluveach River and the Staines River (Brownlow Point) (Figure 6, Appendix F). In addition, at least 16 Brant nests were located in the LDA (Murphy et al. 1990) and 167 were located on the central Sagavanirktok River delta (165 in the Howe Island and Duck Island colonies and two isolated nest sites) (see SAGAVANIRKTOK DELTA BRANT SURVEYS), but were not counted during aerial surveys. The following narrative describes the results of aerial surveys only.

No new large Brant colonies were located in the study area. The mean number of nests per location was 3.4 (SD = 3.2). Nests were most often found singly (44%), but 26% of locations had $\geq$ 5 nests (Figure 7). During nesting surveys, 410 Brant were observed at 59 nesting locations and 468 Brant were observed at 31 other locations (Table 7, Appendix F). Groups of nonbreeders were recorded along the coast in areas later used by brood-rearing and staging Brant. Approximately 90% of the nonbreeders occurred in 13 large flocks, ranging in size from 14-80 birds ($\bar{x}$ = 32.5).

Distribution

With the exception of eight nests found on four offshore islands and gravel spits, Brant nests were located in wet tundra vegetation types including tundra ponds, lakes with islets, and flooded tundra in Basin-complexes (84% of nests), and in flooded, low-centered polygons associated with river deltas (12% of nests). Brant nesting locations (colonies and isolated nest sites) were between 0.1 km (islands in deltas) and approximately 23 km from the coast.

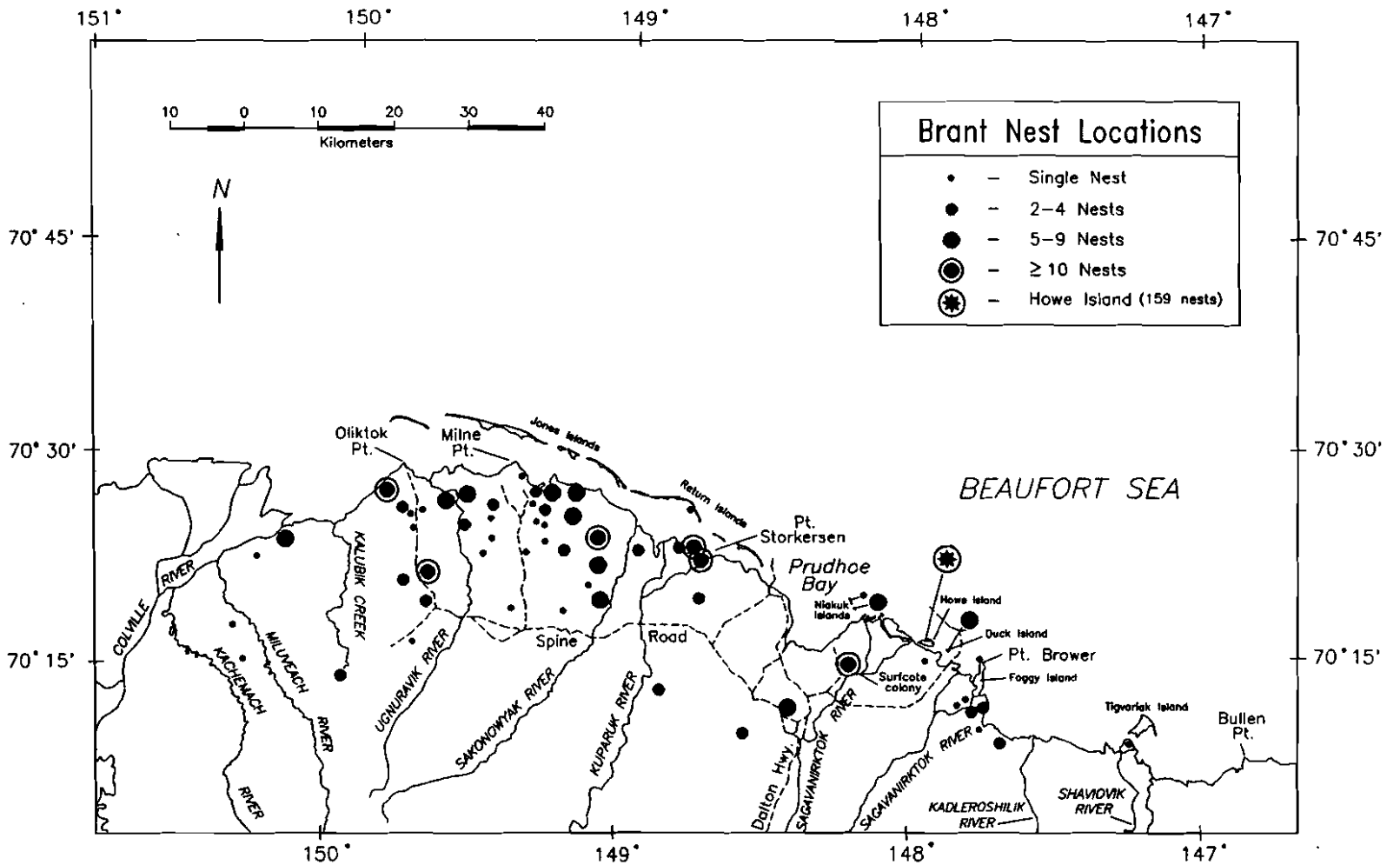


Figure 6. **Locations and sizes of Brant colonies and locations of solitary nests on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1989.**

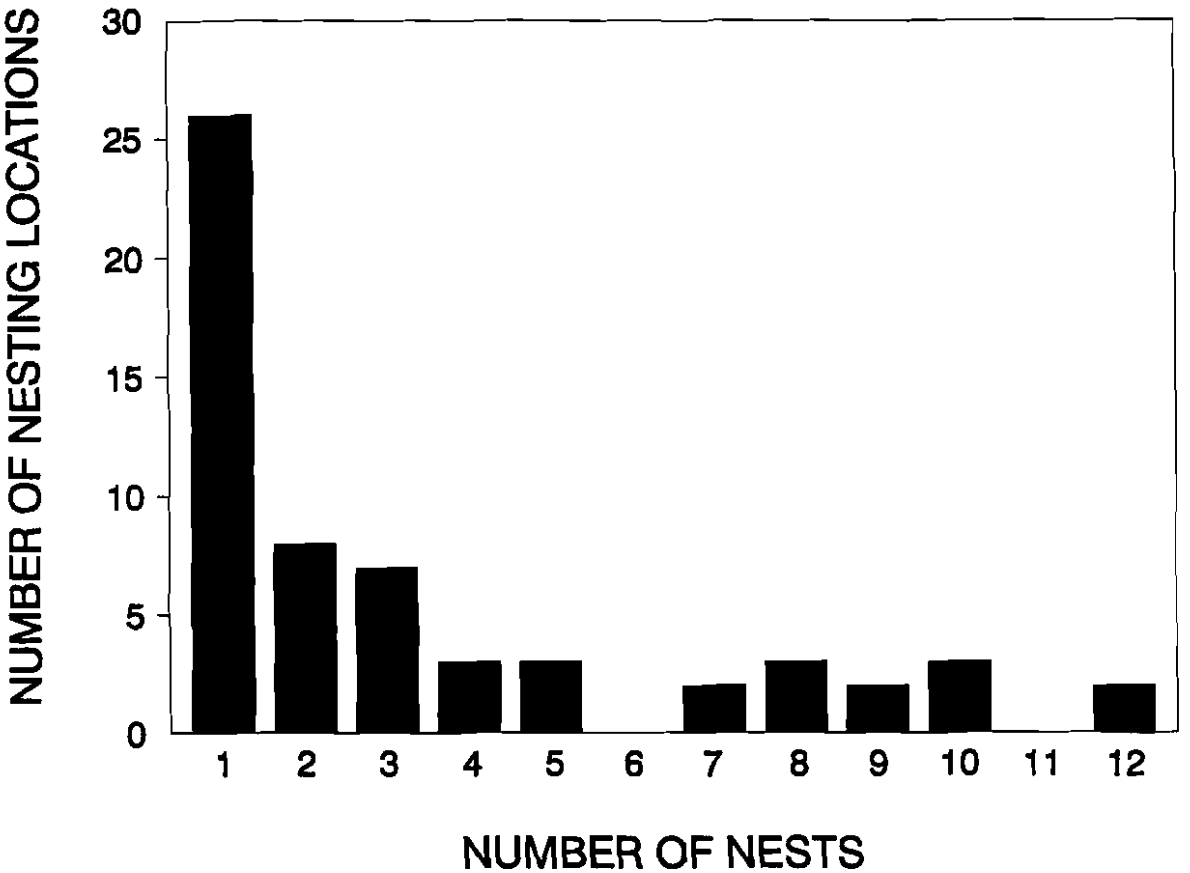


Figure 7. Frequency of occurrence of solitary nest sites and colonies of various numbers of Brant nests, as determined from aerial surveys between Brownlow Point and the Miluveach River, Alaska, June 1989.

Table 7. Distribution of adult Brant on sections of the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, June 1989. Sections are as delineated in Figure 1.

Section of Study Area	Breeding Adults		Non-breeding Adults				
	No.	(%)	No.	(%)	Mean Flock Size	n	SD
1: Brownlow Pt. to Sagavanirktok R.	47	(11.5)	101	(21.6)	14.4	7	14.3
2: Sagavanirktok R. Delta[1]	6	(1.5)	85	(18.2)	28.3	3	44.8
3: Heald Point to Kuparuk R[1]	45	(11.0)	73	(15.6)	12.2	6	10.9
4: Kuparuk R. to Kalubik Ck.	276	(67.3)	124	(26.4)	9.5	13	14.7
5: Kalubik Ck. to Miluveach R.	36	(8.9)	85	(18.2)	42.5	2	21.9
TOTAL	410	(100.0)	468	(100.0)	15.1	31	19.5

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

Sixty-one percent of nesting locations and 70% of nests occurred within 5 km of the coast (Figure 8). Mean distance to the coast for all nest locations was 5.5 km (SD = 5.3 km). Table 8 provides information on the abundance and distribution of Brant colonies and nests in each section of the Brant study area (as defined in STUDY AREA, and Figure 1). Colonies and nests were most numerous in the Kuparuk Oilfield (Kuparuk River to Oliktok Point) and least numerous on the Sagavanirktok River delta (Figure 9; Table 8).

Section 1: Staines River (Brownlow Point) to Sagavanirktok River. Eleven nests (5.5%) were found at five locations in this region; all nests were within 2 km of the coast (Figure 6, Table 8). No nests were recorded east of the Shaviovik River on Tigvariak Island or on Flaxman Island. Approximately 100 adults recorded in the Kadleroshilik and Shaviovik deltas were probably nonbreeding birds (Table 7).

Section 2: Sagavanirktok River Delta. At least four solitary Brant nests were located during aerial surveys: three on the central delta and one on a gravel island west of Point Brower (Figure 6, Table 8). Additionally, 165 Brant nests were located during ground censuses of Howe and Duck islands (see SAGAVANIRKTOK RIVER DELTA BRANT SURVEYS). No nests or Brant were observed on the large tundra-covered island west of Howe Island or on Foggy Island. Eighty-five nonbreeding Brant were recorded in three locations near Point Brower (23 June 1989) (Table 7).

Section 3: Heald Point to Kuparuk River. Twenty-one Brant nests (10.5%) were recorded at six locations during aerial surveys (Figure 6, Table 8). Nest locations included the Niakuk Islands and lakes associated with the upper Putuligayuk River. Twelve nests were located by ground crews at the Surfcote Colony in the LDA and an additional four isolated nests were located in the LDA (Murphy et al. 1990) (These areas were not searched during aerial surveys).

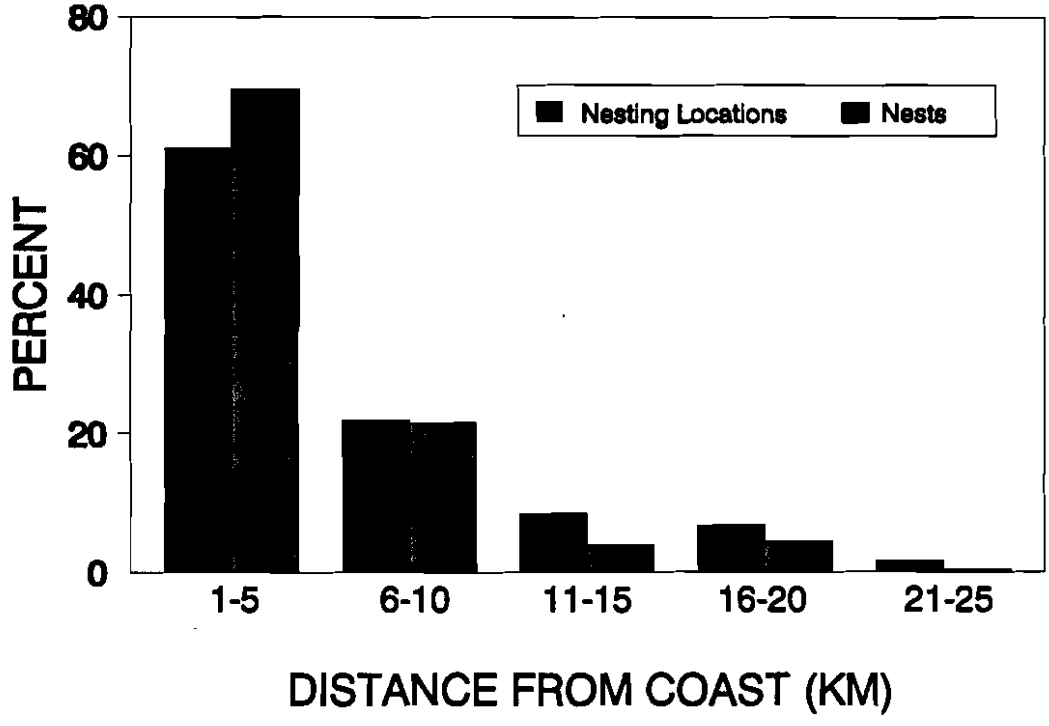


Figure 8. Distances of Brant nesting locations and nest sites from the coast between Brownlow Point and the Miluveach River, Alaska, in June 1989.

Table 8. 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 1989. Sections are as delineated in Figure 1.

Section of Study Area	Nesting Locations		Nests		Nests per Location		Distance from coast (km)	
	No.	(%)	No.	(%)	Mean	(SD)	Mean	(SD)
1: Brownlow Pt. to Sagavanirktok R.	5	(8)	11	(5.5)	2.2	(1.3)	1.2	(1.3)
2: Sagavanirktok R. Delta[1]	4	(7)	4	(2.0)	1.0	(0.0)	5.2	(4.7)
3: Heald Point to Kuparuk R.	6	(10)	21	(10.5)	3.5	(2.6)	7.4	(5.9)
4: Kuparuk R. to Kalubik Ck.	39	(66)	151	(75.5)	3.9	(3.6)	5.5	(5.3)
5: Kalubik Ck. to Miluveach R.	5	(8)	13	(6.5)	2.6	(3.0)	7.7	(6.9)
TOTAL	59	(100.0)	200	(100.0)	3.4	(3.2)	5.5	(5.3)

[1] Aerial survey results only; does not include large colonies on Howe and Duck islands or in the Lisburne Development Area.

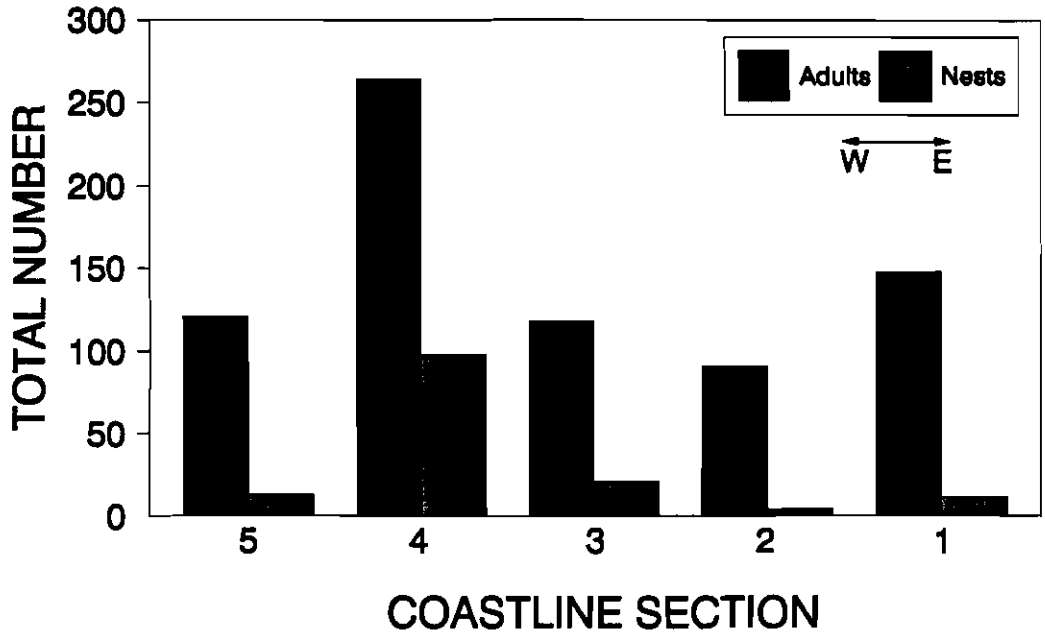


Figure 9. Numbers of adult Brant and Brant nests observed in each of five sections of the study area between Brownlow Point and the Miluveach River, Alaska, June 1989. (Sections are as follows: 1 = Brownlow Point to Sagavanirktok River, 2 = Sagavanirktok River delta, 3 = Heald Point to Kuparuk River, 4 = Kuparuk River to Kalubik Creek, 5 = Kalubik Creek to Miluveach River).

Sixty-seven nonbreeding Brant were recorded at four locations near Storkerson Point, and six nonbreeders were located at two inland locations (Figure 6, Table 7). No nests were located in the extensive wetlands south of Storkerson Point, on Stump Island, or on a wetland southwest of Lake Coleen that was used by nesting Brant in 1988 (R.J. Ritchie, unpubl. notes). This area was flooded in early June 1989 and all potential nesting islands were submerged until mid-June.

Section 4: Kuparuk River to Kalubik Creek. The majority of nesting locations (66%) and nest sites (76%) identified on aerial surveys were located in the region between the Kuparuk River and Kalubik Creek. The largest colony comprised 23 nests on three islands on the Kuparuk River delta. Most of the remaining nests were dispersed on islands in small lakes within 10 km of the coast (Figure 6, Table 8). One nest was located on the east end of Long Island, the easternmost island of the Return Islands group (Figure 6). No Brant nests were located on other barrier islands in this area; however, one group of 15 molting birds was observed on Bodfish Island (in the Jones Islands) on 6 July 1989. Ninety-eight nonbreeding birds were recorded at six locations on the coast and 26 Brant were recorded on inland lakes.

Section 5: Kalubik Creek to Miluveach River. Thirteen Brant nests were recorded at five widely scattered locations between Kalubik Creek and the Colville River (Figure 6, Table 8). (Islands in the Colville delta were not surveyed.) Most Brant (97%) west of Kalubik Creek were located in large groups; 70% of the Brant counted in this region were in two large flocks totaling at least 85 nonbreeding birds.

Ground-truthing

Ground counts of Brant nests were identical to aerial counts in five of seven colonies selected for comparison (Table 9). These five colonies were

Table 9. Comparison of counts of Brant nests made during aerial and ground surveys at selected locations in the Kuparuk and Prudhoe Bay oilfields, Alaska, 25-26 June 1989.

Colony Location	Nests		Waterbody Type[1]
	Aerial Count	Ground Count	
Coleen Lake S. (Prudhoe Bay) [2]	0	0	Deep-*Arctophila*
Coleen Lake N. (Prudhoe Bay)[2]	8	7-8	Deep-*Arctophila*
Milne Point	2	2	Deep-*Arctophila*
Milne Point	3	3	Shallow-Carex
CPF-1	0[3]	3	Basin-Complex
CPF-2	1	2	Basin-Complex
Thetis Mound	9	9	Deep-*Arctophila*
TOTALS	23	26-27	

[1] According to Bergman et al. 1977.

[2] These are wetlands directly west of Coleen Lake, on either side of the Spine Road.

[3] Adults were observed, but nesting was not verified from the aircraft.

located in lakes with small islets on which nests were easily identified from the air. No nests were recorded near CPF-1 during aerial surveys, and only one nest was observed at CPF-2. Ground counts recorded three and two nests, respectively, in these locations. These nests may have been missed for reasons unrelated to habitat (e.g., the incubating female may have been off nest at the time of the aerial survey). Nests at both locations, however, were dispersed on low ridges in flooded tundra, and were less conspicuous than nests on islands in lakes. The apparent difference in sightability of Brant nests between island nest sites and sites in flooded tundra may cause underestimation of the use of the latter habitat.

Brood-rearing/Molting Brant

Abundance and Distribution

Aerial surveys and photo censuses indicated that approximately 840-990 adult Brant with 590-610 goslings were located in coastal habitats between the Staines and Colville rivers in late July 1989 (2.8-3.3 adults and 2.0-2.1 goslings/km of coast) (Table 10). The total number of Brant in inland habitats in the study area was very small (approx. 33 adults, 22 goslings). Brood-rearing groups were composed of approximately 40% goslings. The adult to gosling ratios for all groups were 1.4 and 1.7 on 24-26 July and 29 July, respectively. Brant brood-rearing groups were observed at 21 sites (Figure 10), and groups without goslings were recorded at four locations in the Kuparuk Oilfield. All Brant locations are summarized on maps in Appendix F.

Brant within 0.8 km of the coast (>95% of adults and 97% of goslings) were located in tidal flats, lagoons, creek mouths, and river deltas in or near arctic salt-marsh vegetation (Burgess and Ritchie 1989; also see Murphy et al. 1989). The largest brood-rearing groups were located near the eastern channel of the Colville River; at creek mouths and embayments along Simpson Lagoon (especially near the mouth of the Ugnuravik River and Milne Point); near the mouth of the Kuparuk River; along the western coast of Prudhoe Bay (especially

Table 10. The distribution, size, and composition of Brant brood-rearing groups as determined by two aerial surveys on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, 24-26 July and 29 July 1989[1,2].

Location	Km of Coastline	24-26 July Survey			Linear Density		29 July Survey[3]			Linear Density	
		Adults	Goslings	AD:GOS[4]	Adults/ km	Gosling/ km	Adults	Goslings	AD:GOS	Adults/ km	Gosling/ km
Coastal Sections											
1: Brownlow Pt. to Sagavanirktok R.	97	126	40	3.2	1.3	0.4	100	25	4.0	1.0	0.3
2: Sagavanirktok R. Delta	32	60	70	0.9	1.9	2.2	48	75	0.6	1.5	2.3
3: Heald Point to Kuparuk R.	45	194	125	1.6	4.3	2.8	273	116	2.4	6.1	2.6
4: Kuparuk R. to Kalubik Ck.	80	356	295	1.2	4.5	3.7	455	292	1.6	5.7	3.7
5: Kalubik Ck. to Miluveach R.	48	108	90	1.2	2.3	1.9	110	83	1.3	2.3	1.7
Subtotal (coast)	302	844	620	1.4	2.8	2.1	986	591	1.7	3.3	2.0
Inland Regions											
Kuparuk (inland)	na[5]	21	12	1.8	na		na--------- not surveyed ----------				
Prudhoe Bay (inland)	na	12	10	1.2	na		na--------- not surveyed ----------				
Subtotal (inland)	na	33	22	1.5	na		na--------- not surveyed ----------				
TOTAL	302	877	642	1.4	2.8	2.1	986	591	1.7	3.3	2.0

[1] Numbers are counts from photos and aerial counts (if photos were not available).
[2] Coastal sections are as shown in Figure 1.
[3] Surveys on this date did not include the Shaviovik River delta (20 adults/15 goslings on 24 July) or inland areas (33 adults/22 goslings on 26 July)
[4] AD:GOS = Adult:Gosling ratio.
[5] na = Not applicable.

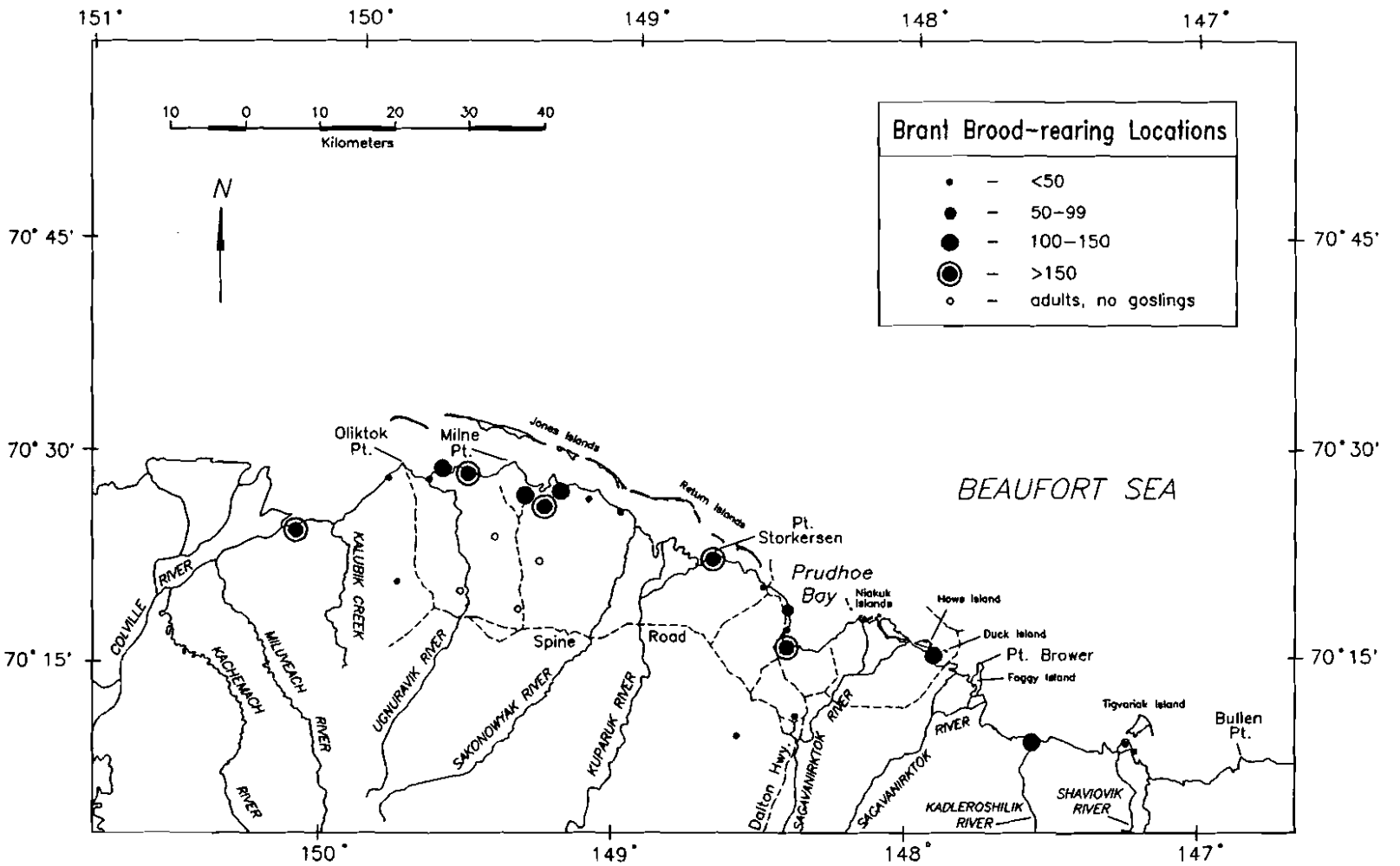


Figure 10. Locations and sizes of Brant brood-rearing groups on the Arctic Coastal Plain between Brownlow Point and the Miluveach River, Alaska, July 1989.

at the mouth of the Putuligayuk River); in the central Sagavanirktok River delta; and at the mouth of the Kadleroshilik River (Figure 10). Brood-rearing or molting Brant were rare east of the Kadleroshilik River.

Brant were rarely observed inland in late July (<5% of adults and 3% of goslings). Brood-rearing Brant were observed at one inland location in the Kuparuk Oilfield and at two locations south of Prudhoe Bay (Figure 10). In addition, four groups without goslings were located in inland areas of the Kuparuk Oilfield. Brant in inland areas were located in large, shallow lakes.

Numbers of Brant per linear kilometer of coast (excluding inland observations) were determined for the five coastline sections defined in Figure 1 (Figures 11, 12, Table 10). Distances used to compute linear densities were derived from measurements of the coastline following all major bays and intrusions. The highest densities of Brant (both adults and goslings) occurred in the Kuparuk Oilfield, followed closely by the Prudhoe Bay area (Figure 11). Low densities occurred in the Sagavanirktok River delta and east of Kalubik Cr. The lowest densities were observed east of the Sagavanirktok River delta.

The following text is organized geographically by coastal section and summarizes the abundance, distribution, and densities of Brant along the five coastline sections and in inland regions (see Figure 11). Information from other 1989 field programs (when available) has been provided to better define use of these areas (Burgess et al. 1990, Murphy et al. 1990).

Section 1: Staines River (Brownlow Point) to Sagavanirktok River. Four groups of Brant, totaling 126 adults and 40 goslings (14% of total adults and 6% of total goslings), were observed at two locations in this section of coast on 24 July 1989 (Table 10, Figure 11). Twelve percent of the adults and 58% of the goslings were located on tidal flats and wetlands associated with the Shaviovik River delta (Figure 10). The rest were in lagoons associated with the Kadleroshilik River delta. The Kadleroshilik delta was also occupied by a group of Brant on 29 July.

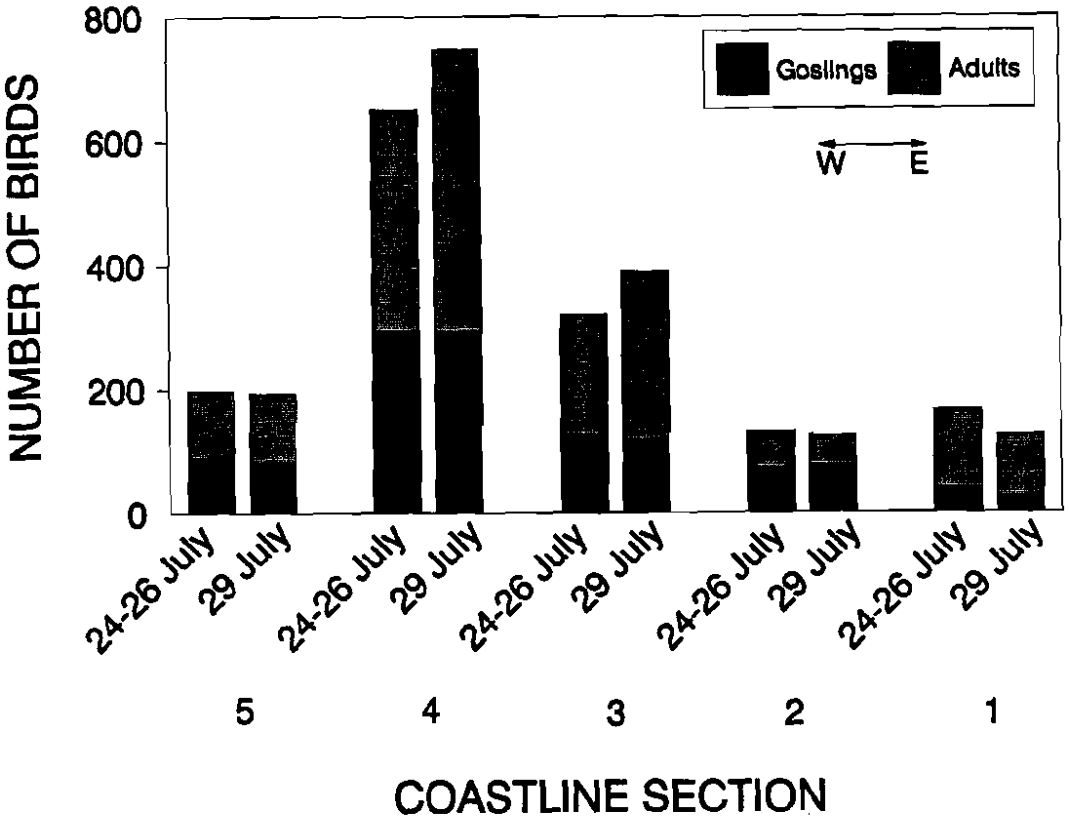


Figure 11. Numbers of adult Brant and goslings in each of five sections of the study area between Brownlow Point and Miluveach River, Alaska, July 1989. (Sections are as follows: 1 = Brownlow Point to Sagavanirktok River, 2 = Sagavanirktok River delta, 3 = Heald Point to Kuparuk River, 4 = Kuparuk River to Kalubik Creek, 5 = Kalubik Creek to Miluveach River).

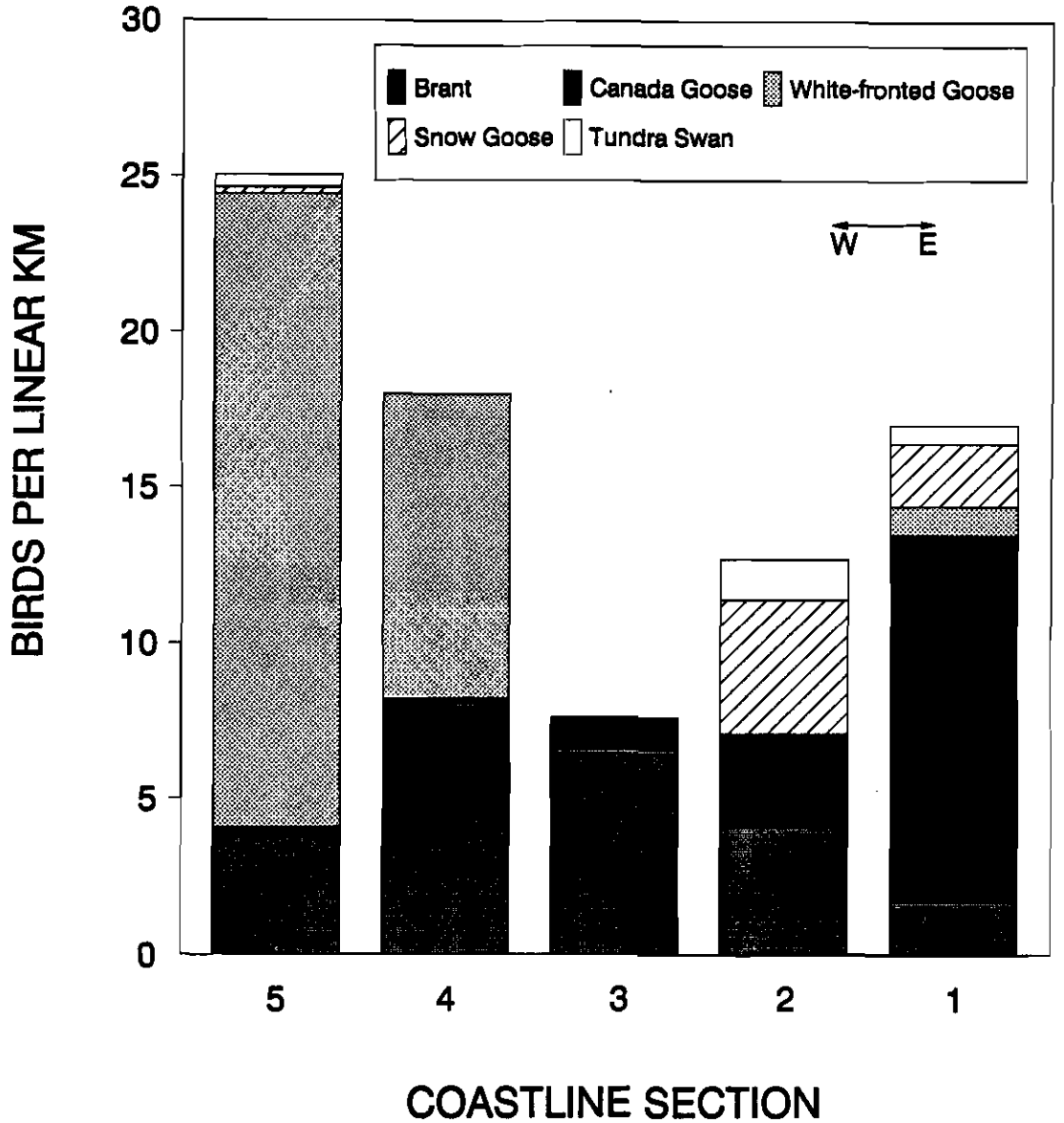


Figure 12. Linear densities of waterfowl species in each of five coastal sections of the study area between Brownlow Point and the Miluveach River, Alaska, 24-26 July 1989. (Sections are as follows: 1 = Brownlow Point to Sagavanirktok River, 2 = Sagavanirktok River delta, 3 = Heald Point to Kuparuk River, 4 = Kuparuk River to Kalubik Creek, 5 = Kalubik Creek to Miluveach River).

Most of this section of coastline was also searched earlier in July 1989 during aerial surveys for brood-rearing Snow Geese (Burgess et al. 1990). Brant goslings were first recorded in the area on 17 July; 25 adult Brant with ten goslings were observed 4 km west of the Kadleroshilik River delta. Brant groups without goslings also had been observed near the mouth of the Kadleroshilik River in late June and early July 1989. No Brant were observed on Tigvariak Island, Flaxman Island, coastal wetlands between the Staines and Kavik rivers, or in large lakes and basin complexes within approximately 8 km of the coast.

Section 2: Sagavanirktok River Delta. A group of at least 48 adults and 70-75 goslings (5-7% of total adults and about 12% of total goslings), was observed on the Sagavanirktok River delta on 25 and 29 July (Table 10, Figure 11). This group was located on tidal flats and salt-marsh vegetation adjacent to the Endicott Causeway/Road (BRA 1 and 2, Figure 5).

This area also was searched earlier in July 1989 during aerial surveys for brood-rearing Snow Geese (Burgess et al. 1990). Although Brant were not recorded in other portions of the Sagavanirktok River delta during aerial surveys in late July, brood-rearing groups had been common and widely dispersed until approximately mid-July. These broods probably had been produced in the colonies on Howe and Duck islands and were dispersing to the major brood-rearing areas when they were observed in early and mid-July. Seventeen adult Brant with 16 goslings were observed on tidal flats 3 km west of Howe Island on 6 July 1989. On the same date, eight Brant broods (16 adults) were recorded 1.5 km west of Howe Island and four broods (8 adults) were observed on tidal flats on the north side of Howe Island. Brant were not observed on Howe Island after this date. On 16 July, Brant were located on tidal flats 3 km west of Howe Island (40 adults with goslings) and in BRA 3 south of Howe Island (40 adults with goslings) (see Figure 5).

Although the Sagavanirktok River delta supports the largest Brant colony in the study area, Brant densities were relatively low in the area in late July (1.5-1.9 adults and 2.2-2.3 goslings/km). The adult/gosling ratio (0.6 - 0.9) was considerably lower in this section of coast than in the other four sections.

Section 3: Heald Point to Kuparuk River. One hundred ninety-four adult Brant (22%) and 125 goslings (20%) were located in this section of the coast on 25 July 1989. Brant in this area totalled 273 adults and 116 goslings on 29 July 1989. One large group at the mouth of the Putuligayuk River included 77% of the adults and 80% of the goslings in this section. One small brood-rearing group (10 adults, 17 goslings) was observed near Point McIntyre on 25 July, but Brant were not observed elsewhere in the extensive wetlands west of the West Dock Road. In addition to coastal locations, Brant (12 adults, 10 goslings) were observed at two inland locations, 6 and 9 km from the coast. Both locations were on the upper Putuligayuk River, adjacent to sites identified as Brant nesting areas in 1988 and 1989.

Brant also were observed in the coastal region of Prudhoe Bay earlier in July during aerial surveys for brood-rearing Snow Geese (Burgess et al. 1990). Brant (45 adults, no goslings) were first observed at the mouth of the Putuligayuk River on 11 July. By 16 July, 52 adults and an undetermined number of goslings were present and on 17 July, 125 adults and 70 goslings were observed. Additional adults and broods were located 3 km north of the Putuligayuk River on this date. By 29 July some of these birds may have combined with the group at the mouth of the Putuligayuk River; the number of adults present (215) exceeded all previous counts. Additional information on Brant use of the mouth of the Putuligayuk River is presented in Murphy et al. (1990).

The Heald Point to Kuparuk River section had the second highest densities of Brant of the five coastal sections surveyed (4.3-6.1 adults and 2.6-2.8 goslings/km). The adult:gosling ratio (1.6-2.4) ranked third among the five sections (Table 10).

Section 4: Kuparuk River Delta to Kalubik Creek. Approximately 356-455 of adult Brant (41-46%) and 292-295 goslings (45-49%) were observed in this section during aerial surveys in late July (Table 10, Figure 11). On 29 July, the number of adults had increased to 455, but the gosling count was about the same as that on 25 July.

Principal areas of use in this coastal section included large embayments immediately east of the Kuparuk River, near Milne Point, and adjacent to the mouth of the Ugnuravik River (Figure 10). With the exception of two groups located on exposed coast, all Brant near the coast were in salt-marsh vegetation fringing large tidal embayments and creek mouths. No Brant were observed on barrier islands in Simpson Lagoon.

Six groups (totaling 21 adults and 12 goslings) were located on 26 July at inland sites between 1.5 and 10.0 km from the coast (Appendix F). All inland groups were located on the shores of large shallow lakes, four of which had been identified as Brant nesting areas during June surveys.

Densities of both adult Brant and goslings were higher between the Kuparuk River and Kalubik Creek than in any of the other coastal sections (4.5 - 5.7 adults and 3.7 goslings/km). This section ranked second or third in adult:gosling ratio (1.2 - 1.6), the variation reflecting the large increase in number of adults on 29 July (Table 10).

Section 5: Kalubik Creek to Miluveach River. One large group (approximately 110 adults and 83 goslings [12.5% of total adults, 14.3% of total goslings] 29 July) was recorded on both late July aerial surveys, on a large tidal flat adjacent to the east channel of the Colville River.

SAGAVANIRKTOK DELTA BRANT SURVEYS

Phenology

The timing of Brant arrival on Howe Island was similar among the years 1987-1989 and was concentrated in the period between 1 and 10 June (Figure 13). In 1986, arrival occurred over a longer period, probably due to persistent

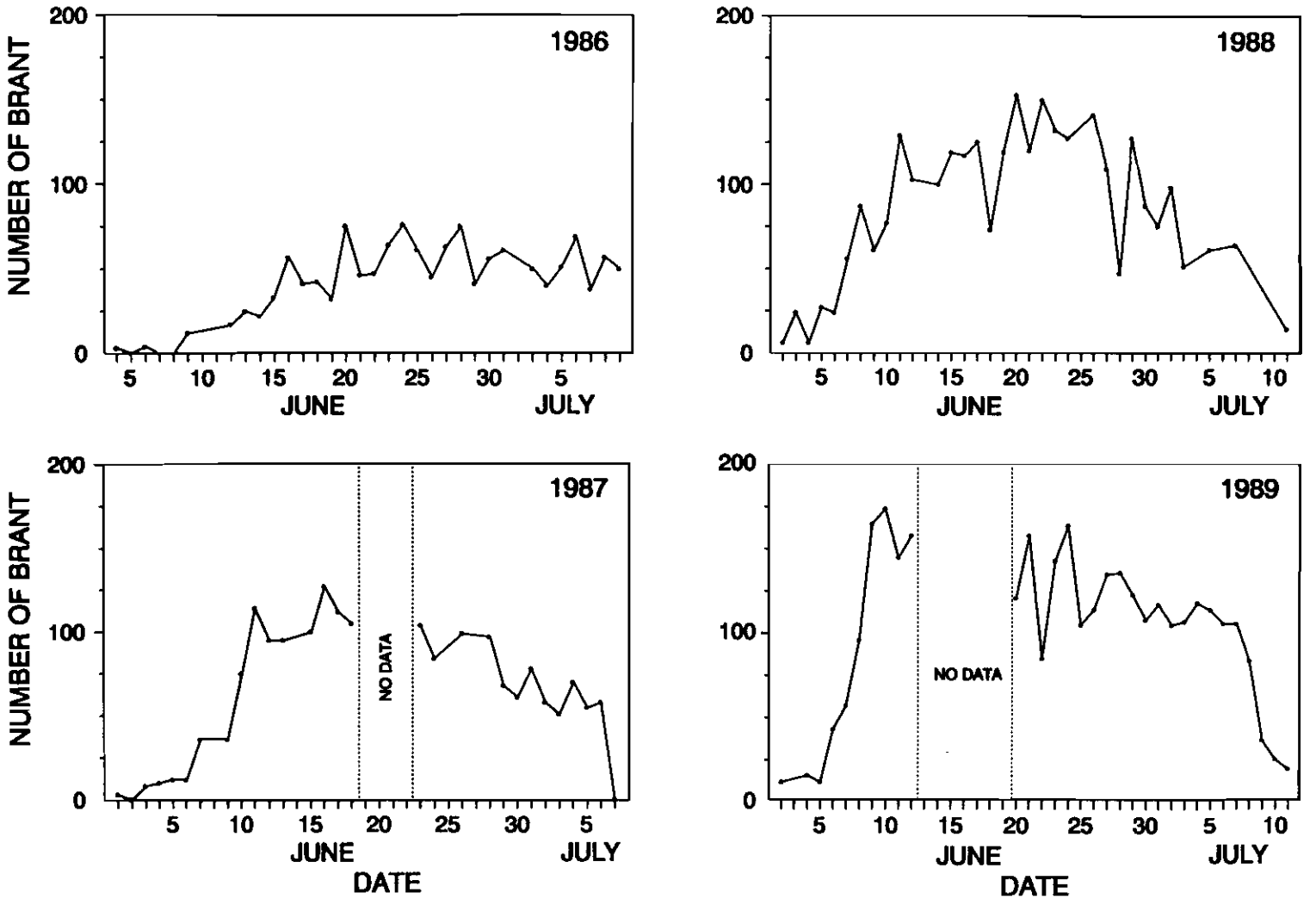


Figure 13. Numbers of Brant seen during daily scans of Howe Island, Alaska, 1986-1989.

snow cover on the island. In all years, numbers of Brant on Howe Island remained relatively constant during incubation, but in 1987-1989 they decreased rapidly once hatching began (no data for 1986).

In 1989, few Brant were present on Howe Island on 2 June. Numbers increased rapidly to a maximum of 173 birds on 10 June (Figure 13). Nest site selection was first observed on 6 June and the first incubating Brant were observed on 10 June. The estimated date of peak nest initiation was 7 June on Howe Island in 1989 (Figure 14). The first Brant goslings from both Howe and Duck islands were observed on 4 July. The hatching period for Brant on Howe Island was 3-15 July and the estimated date of peak hatching was 7 July (Figure 14). Most Brant dispersed from Howe Island by 11 July.

Productivity

Howe Island

The number of Brant nests on Howe Island increased from 33 in 1984 to 213 nests in 1988 (Figure 15). In 1989, there were 159 Brant nests on Howe Island, nine fewer than in 1987 and 54 fewer than in 1988. In all years for which there were data (1984-1989), Brant nests were primarily distributed on the western half of Howe Island (Figures 16a and 16b). As the total number of nests on Howe Island increased, the density of nests on the eastern half of the island increased somewhat, but remained less dense than the western half.

Nest success on Howe Island ranged from a low of 18% in 1985 to 89% in 1988, but was greater than 50% in each of the years 1986-1989 (Figure 15). The mean clutch size estimated from the nest contents of 120 successful nests in 1989 was 2.2 eggs (SD = 1.1, range = 1-5 eggs); this was low in comparison to the average brood size observed at dispersal (2.9 goslings/brood, SD = 1.2, n = 79 broods). Based on brood size, the estimated number of goslings produced on Howe Island in 1989 ranged from 366 (including only known successful nests) to 432 (if all nests of unknown fate were successful).

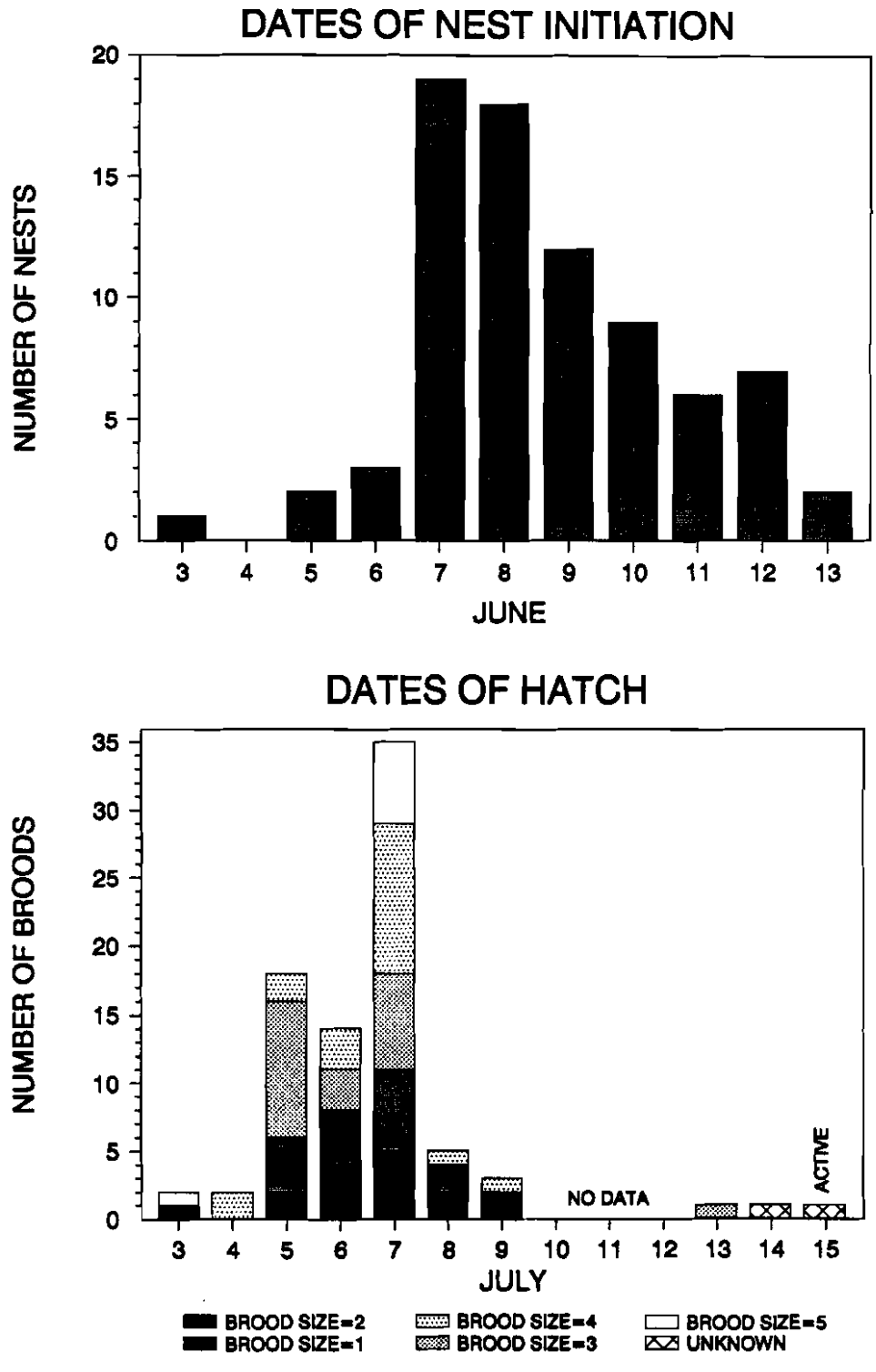


Figure 14. Dates of initiation and hatching for Brant nests on Howe Island, Alaska, 1989.

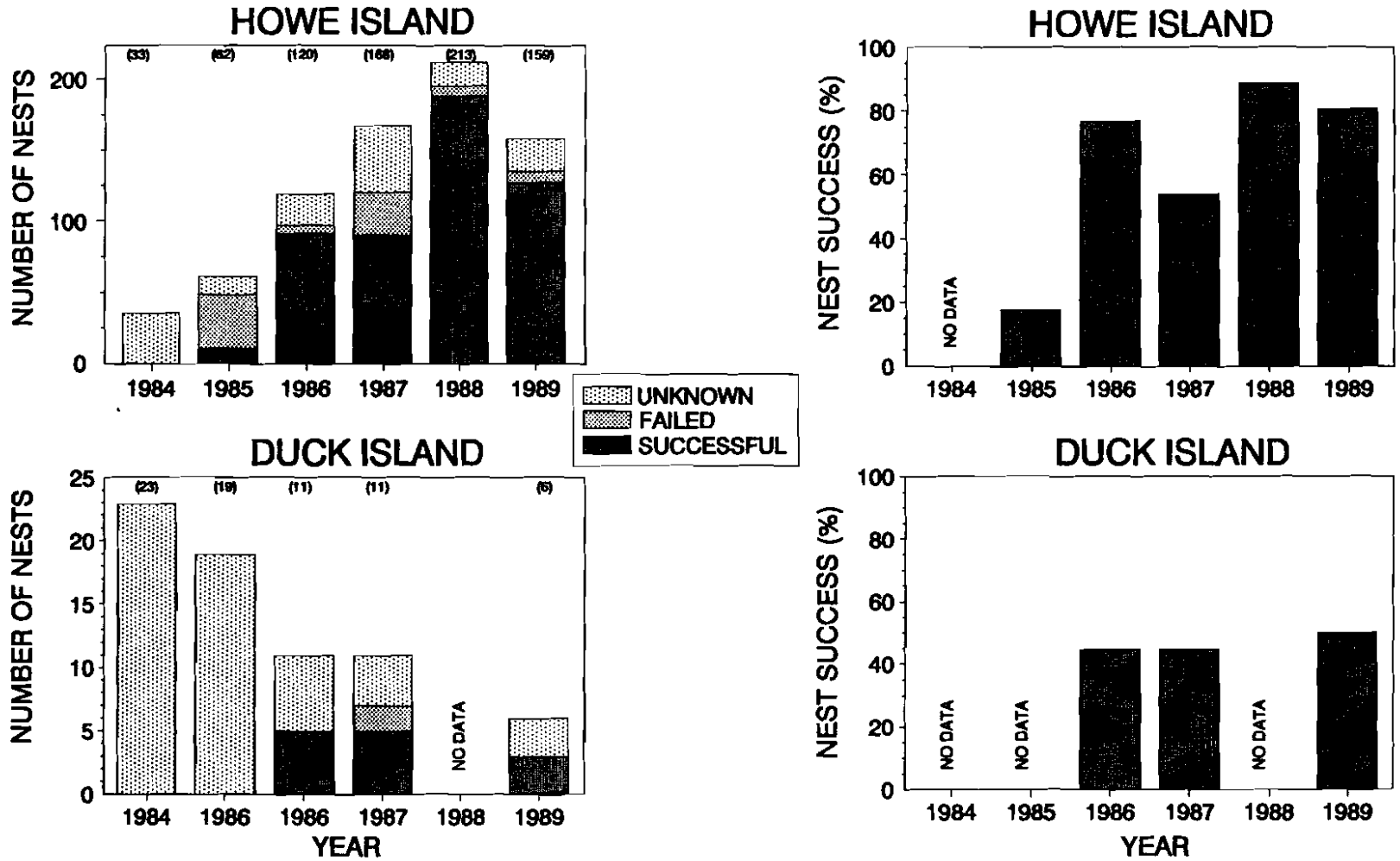


Figure 15. Numbers and fates of Brant nests on Howe and Duck islands, Alaska, 1984-1989. (Data for 1984 from Johnson et al. 1985).

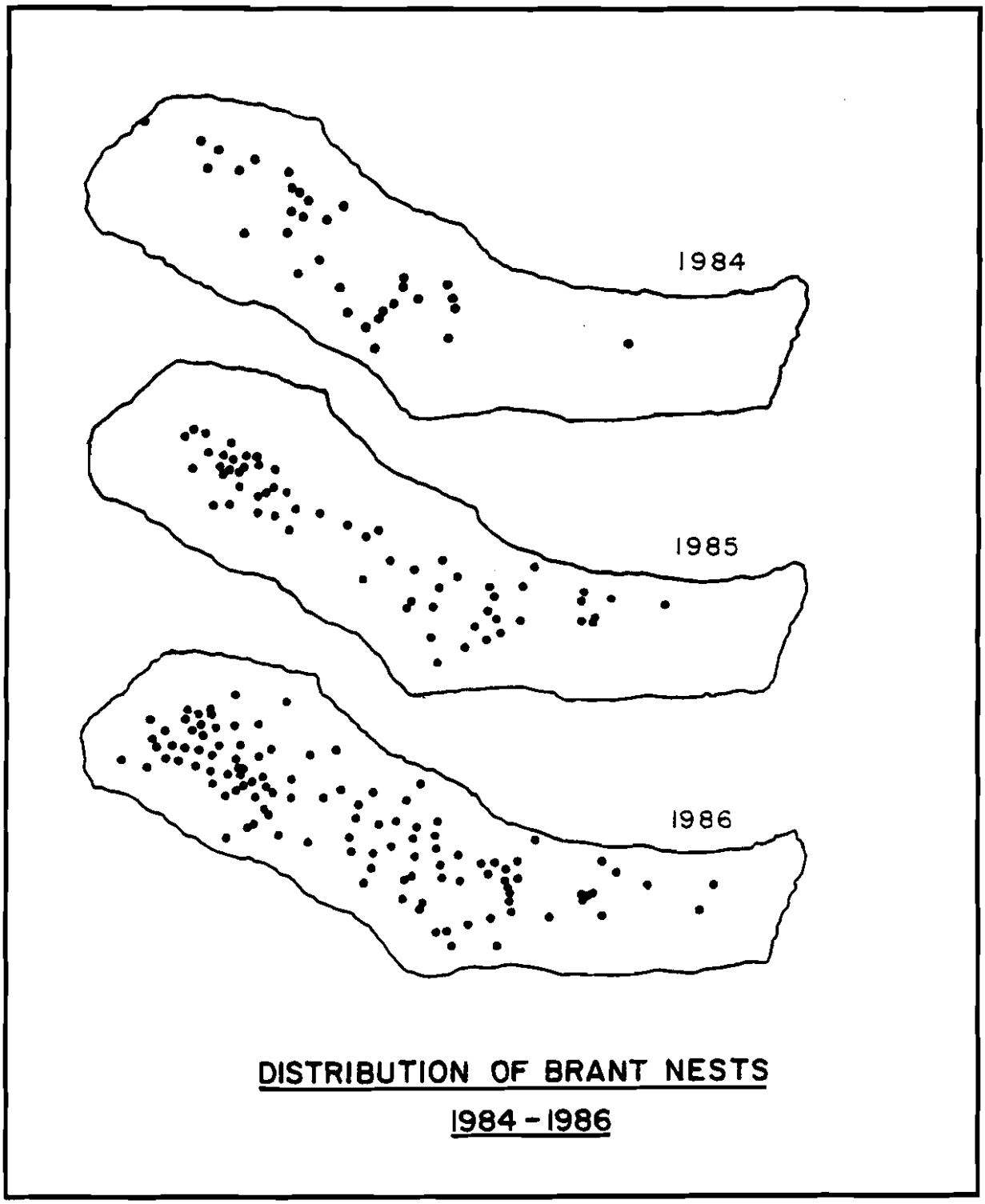


Figure 16a. Distribution of Brant nests on Howe Island, Alaska, 1984-1986. (1984 data from Johnson et al. 1985; other years from Burgess et al. 1990).

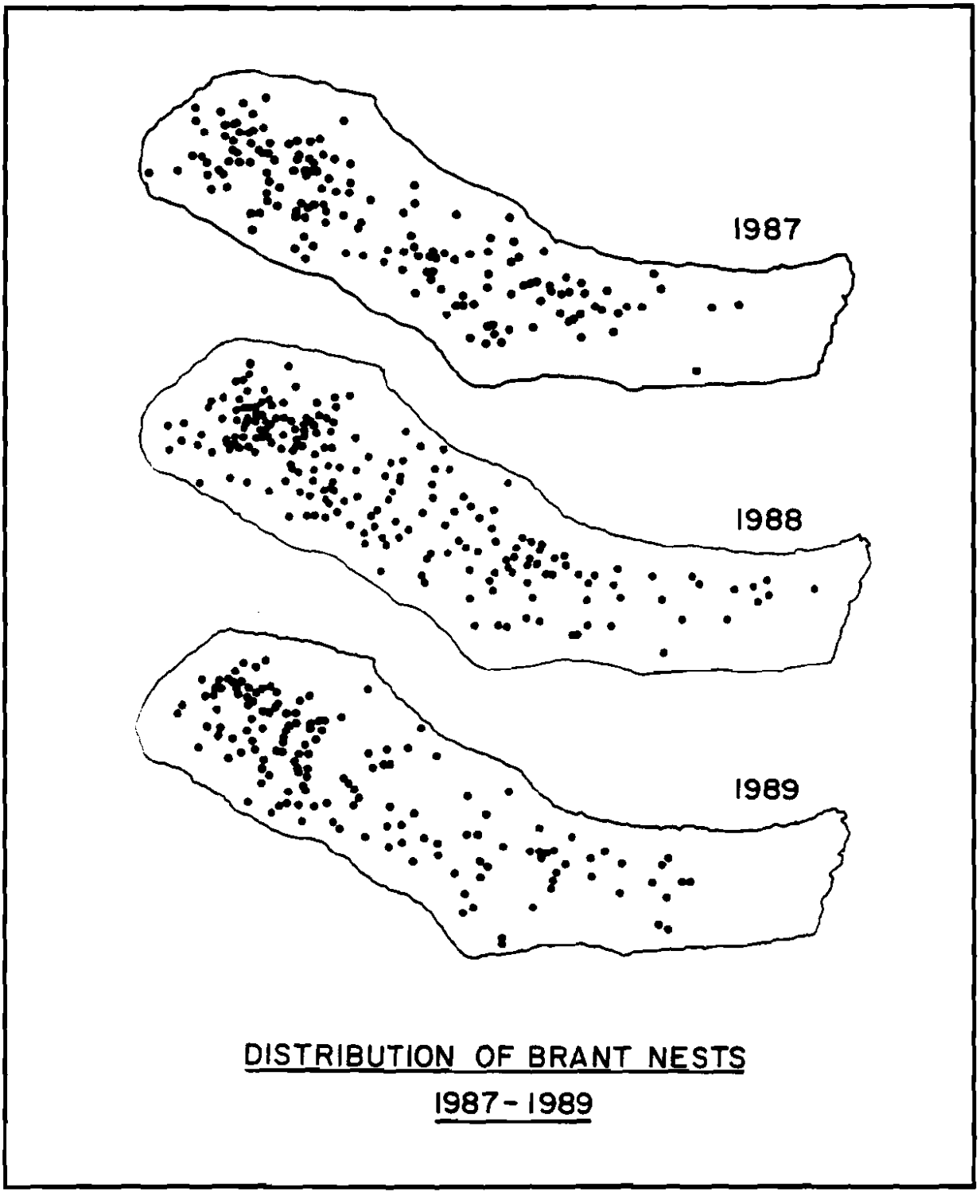


Figure 16b. Distribution of Brant nests on Howe Island, Alaska 1987-1989. (Data from Burgess et al. 1990).

Causes of nest failure could not be determined from examination of nest contents. Glaucous Gulls were active in the colony throughout incubation in all years and probably destroyed many nests. A brown bear (*Ursus arctos*) visited Howe Island sometime between 30 June and 5 July 1985 and was probably responsible for most of the nest failures that year. Also in 1985, a Snowy Owl was seen regularly on Howe Island and was observed killing an incubating Brant. In 1989, two Glaucous Gulls were observed feeding on a Brant carcass on 3 July, and on 8 July, a Peregrine Falcon (*Falco peregrinus*) was observed killing an incubating Brant. At least 1-4 Snowy Owls were present on Howe Island daily from 21 June through hatching in 1989.

Duck Island

On Duck Island, the number of Brant nests decreased from 23 in 1984 to six in 1989, a 68% reduction (Figure 15). The island was not visited in 1988, but during a scan on 5 July it appeared that 11 Brant were incubating. Brant nests on Duck Island appeared to be restricted entirely to the vegetated eastern half of the island. Some reuse of Brant nest bowls by Common Eiders was apparent in 1989.

Nesting success of Brant was lower on Duck Island than on Howe Island for all years for which there were data (Figure 15). In 1989, half the nests were successful. The groups arriving on the mainland in BRA 1 on 4 July included three broods of two goslings each and three pairs without goslings. Mean clutch size estimated from nest contents was 1.3 eggs (SD = 0.6, range = 1-2, n = 3). The lower productivity of Duck Island in all years was undoubtedly due to the presence of a large Glaucous Gull colony on the island (number of nests $\geq$35 in 1984-1987 and 1989; no data for 1988).

Other Brant Colonies and Solitary Nests

Brood-rearing surveys suggested that the Howe Island and Duck Island colonies were part of a discrete population of Brant located between Point

McIntyre and the Kadleroshilik River. In 1989, 47 additional Brant nests (excluding Howe and Duck islands) were located in this region by aerial or ground surveys (Figure 17). Nest success information was obtained for two areas and productivity data for one area.

In the LDA there were 16 Brant nests; 12 in the Surfcote colony and four solitary nests (Murphy et al. 1990). Seven (58%) of the nests in the colony were successful, and it was estimated that 13 goslings were produced. The four solitary nests in the LDA all failed. The Brant colonies on the upper Putuliguyak River (Figure 17) were first located in 1988 (R.J. Ritchie, unpubl. notes.). There were 12 nests in the northern colony and an unknown number in the southern colony in 1988 (R.J. Ritchie, pers. obs.), and nine and three nests, respectively, in 1989. Six Brant nests were located on the Niakuk Islands in 1989 (Figures 6, 17). No observations of nest success or brood size at hatching were possible for the Niakuk Islands. Thirteen Brant nests were located in eight locations in the Sagavanirktok River delta and just east of the delta. One of two isolated Brant nests on the mainland south of Howe Island was destroyed by a Parasitic Jaeger (*Stercorarius parasiticus*). The fate of the other could not be determined, but it was probably successful (first located during hatching).

Gosling Survival

Brant from Howe and Duck islands used brood-rearing areas between Point McIntyre and the Kadleroshilik River (see Movements and Habitat Use). Broods from these and other colonies and isolated nests in the region share brood-rearing areas. For this reason it was necessary that estimates of gosling survival be calculated for the regional population, rather than for separate colonies.

Calculation of gosling survival required three estimates: 1) total number of nests contributing to the gosling population in brood-rearing areas between Point McIntyre and the Kadleroshilik River, 2) mean brood size at hatching in

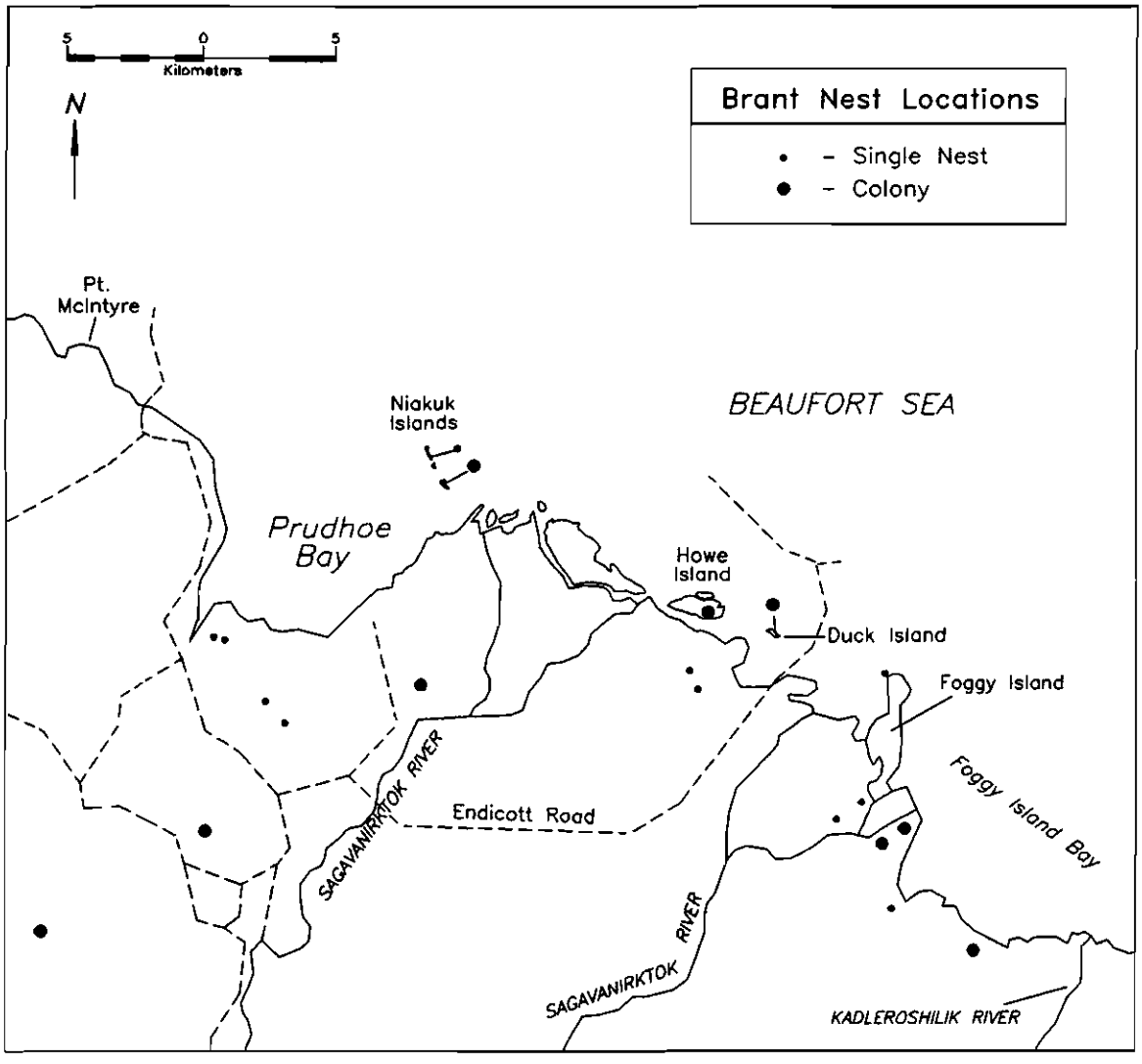


Figure 17. Locations of Brant colonies and solitary nests between Point McIntyre and Foggy Island Bay, Alaska, used to estimate gosling survival in 1989.

each colony or brood size at hatching of each isolated nest, and 3) number of goslings present in the region at some date after hatching. It was estimated that 212 nests were present in the region between Point McIntyre and the Kadleroshilik River in 1989, with the Howe Island, Duck Island, and Surfcote colonies accounting for 83% of the total. We estimated that 385-451 goslings hatched from these colonies (Table 11).

Nest success and brood size at hatching of the other 35 nests in the region were assumed to be similar to those for the Howe Island, Duck Island and Surfcote colonies combined. Nest success for the 3 colonies was 78-91% and brood size at hatching was 2.2 - 2.6 goslings. Using the lower values, the other 35 nests in the region were estimated to have produced 50 goslings.

This is probably a high estimate because nest success was higher in the Howe Island colony than elsewhere in the region, and its large size gave it a large influence on the combined values. This estimate of 50 goslings would give a ratio of 424 adults to 435 goslings at hatching. An aerial survey of brood-rearing groups of Brant made on 29 July for the same region (Table 11) yielded counts of 421 adults and 216 goslings, indicating approximately 50% survival of goslings to that date.

Movements and Habitat Use

From arrival of Brant on the delta to late brood-rearing, Brant were restricted to arctic salt-marsh vegetation types described by Burgess and Ritchie (1989). During the arrival period (2-10 June) Brant were observed only in low-lying areas in BRA 3 and on a sparsely vegetated channel island to the east (Table 12, Figures 5, 18). During incubation, groups of 2-57 nonbreeders were observed in BRAs 1-4 (Table 13, Figures 5,19).

Immediately after hatching, Brant from Howe and Duck islands dispersed to the brood-rearing areas in the vicinity of the colonies, (BRAs 1-3, and 8; Figures 5, 20). The numbers of Brant in these areas fluctuated substantially during the several days following peak hatching in the colonies. Group counts

Table 11. The 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.

	Hatching				Brood-rearing[3]	
Location	No. of Adults	No. of Goslings (Low estimate)[1]	No. of Goslings (High estimate)[2]	Location	No. of Adults	No. of Goslings
Howe Island	318	366	432	West Side Prudhoe Bay	58	47
Duck Island	12	6	6			
Surfcote Colony	24	13	13	Putuligayuk River Mouth	215	69
Lisburne Development Area - Additional Nests	8	0	0	Sagavanirktok River Delta	48	75
Upper Putuligayuk R.	18	~15	~21	Kadleroshilik River Delta	~100	25
	6	~5	~7			
Niakuk Is.	12	~10	~14			
Central Sagavanirktok River Delta	4	~2	~3			
East Channel Sagavanirktok R. Delta	22	~18	~25			
TOTAL	424	435	521		421	216

[1] Estimate includes only successful nests from Howe Island.
[2] Estimate includes both successful and unknown fate nests from Howe Island.
[3] Information from photographs and aerial survey made 29 July 1989.

Table 12. Use of areas on the outer Sagavanirktok River delta by Brant during arrival, 2-10 June 1989.

Map Location[1]	Number of Groups	Mean Group Size	SD	Range
A	3	34	18	16-52
B	4	10.3	12	2-28
C	1	33	-	-
D	1	63	-	-

[1] Map locations from Figure 18.

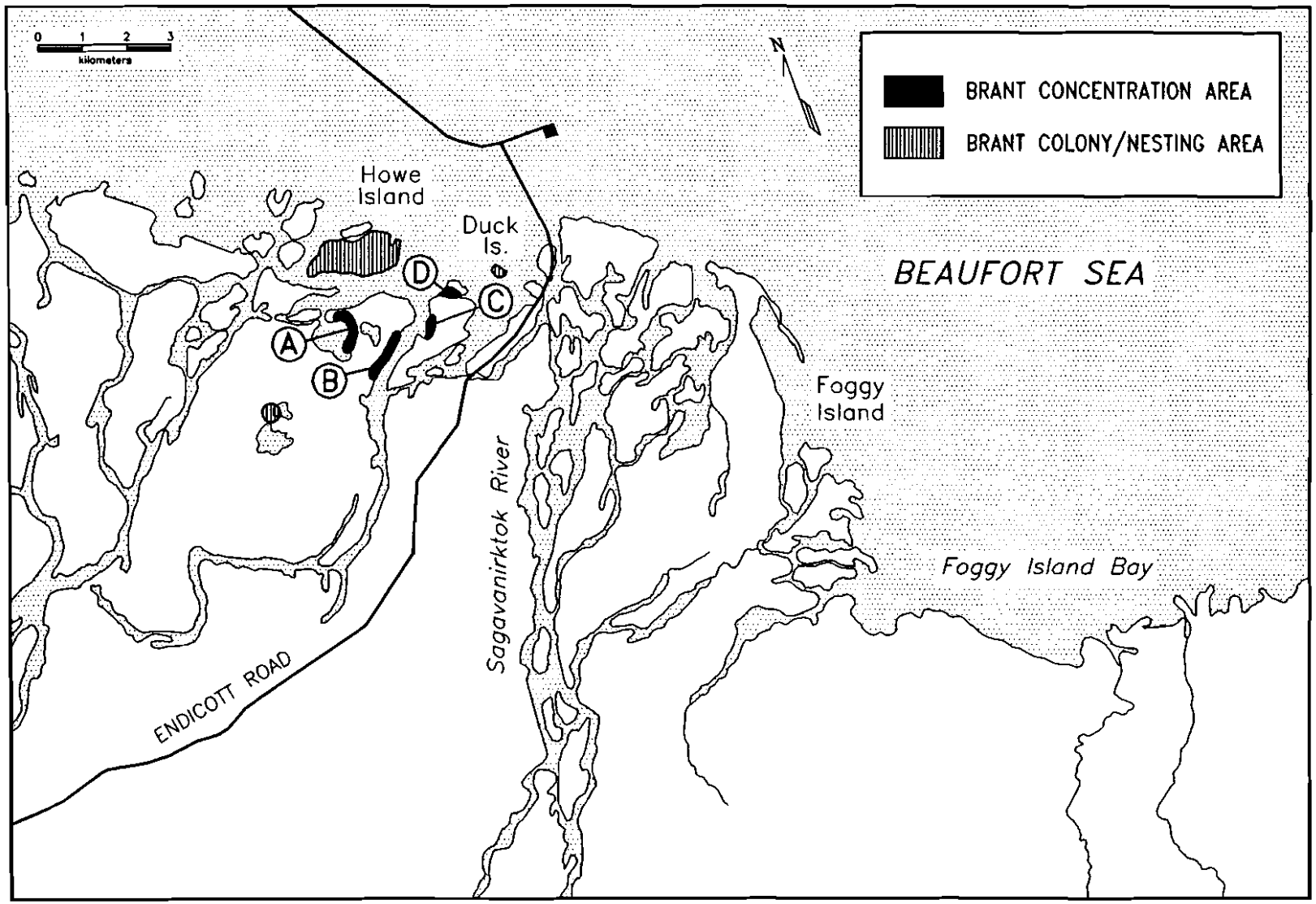


Figure 18. Use of the outer Sagavanirktok River delta by Brant during arrival, 2-10 June 1989. (Data are only for the areas immediately surrounding Howe Island).

Table 13. Use of areas on the outer Sagavanirktok River delta by Brant during incubation, 11 June - 3 July 1989. (No data available for 12 - 19 June 1989).

Snow Goose BRA[1]	Map Location[1]	Number of Groups	Mean Group Size	SD	Range
4	A	1	2.0	-	-
3	B	6	21.8	18.0	6-55
	C	8	37.1	13.1	24-57
	D	2	30.0	-	-
1	E	11	6.6	5.1	3-15
	F	5	10.8	6.1	4-18
2	G	2	13.0	-	7-19

[1] Brood-rearing areas presented in Figure 5.

[2] Map locations from Figure 19.

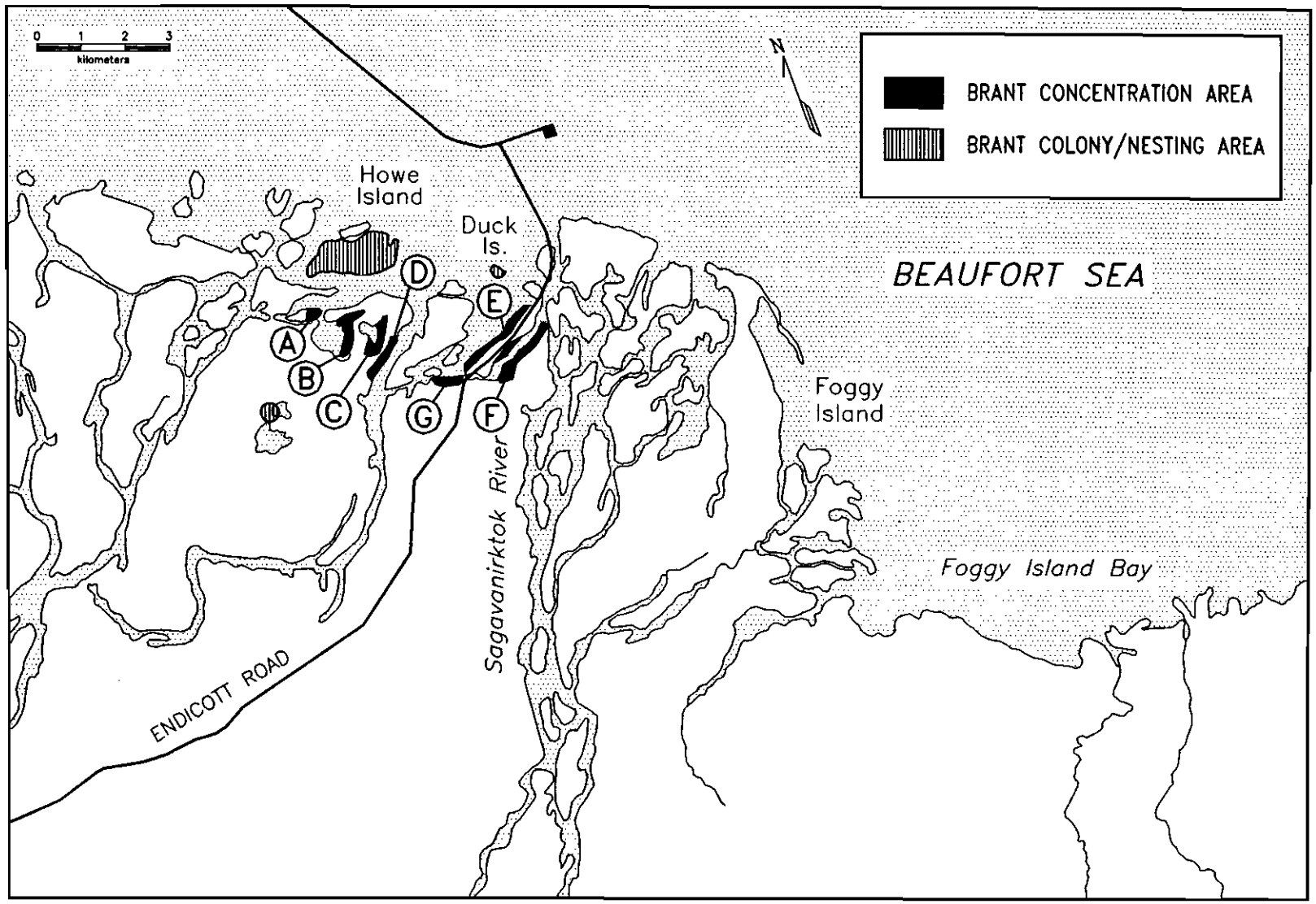


Figure 19. Use of the outer Sagavanirktok River delta by Brant during incubation, 11 June - 3 July 1989. (Data are only for the areas immediately surrounding Howe Island and the Endicott Road).

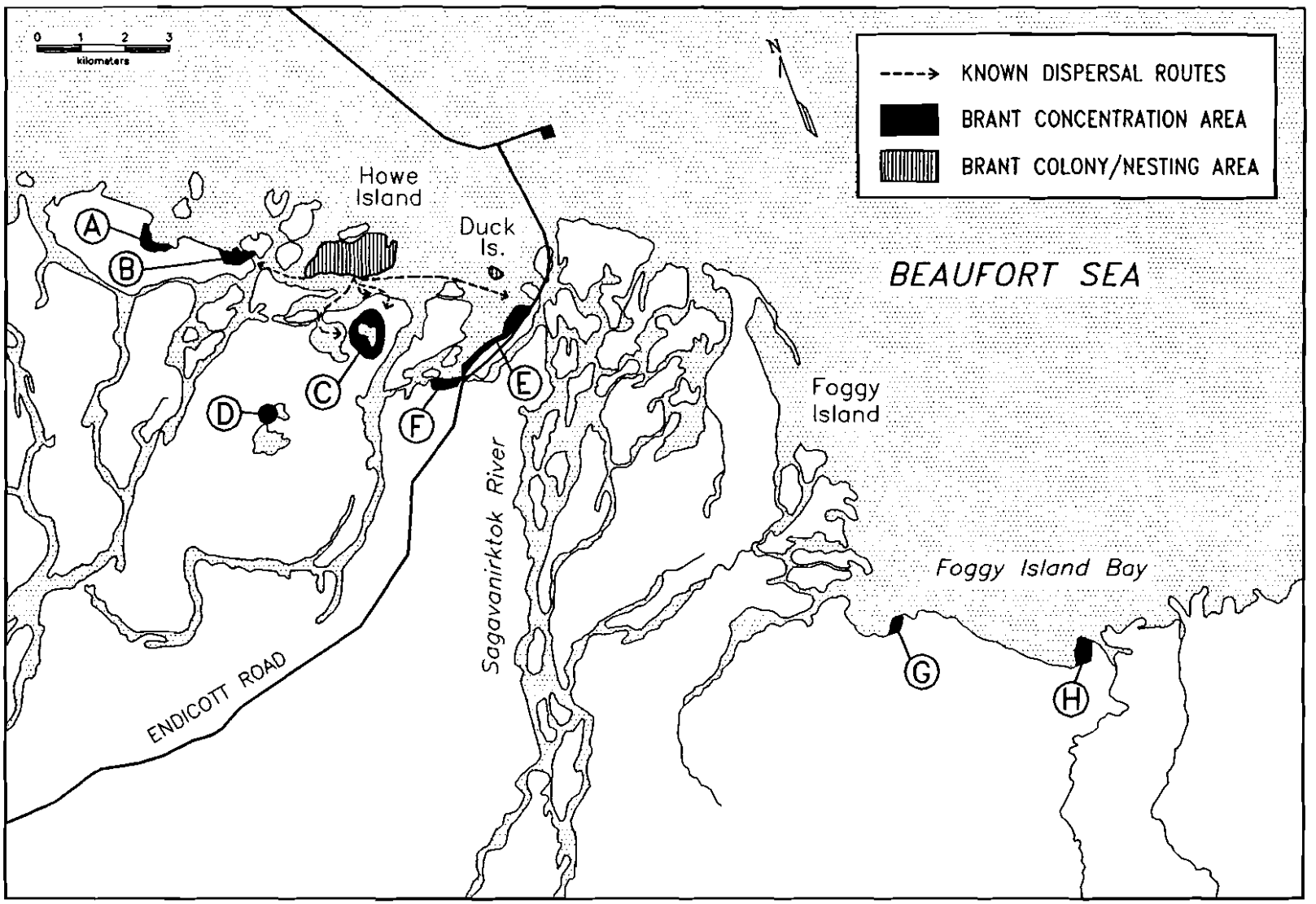


Figure 20. Use of the outer Sagavanirktok River delta by Brant during hatching, 4-11 July 1989. (Data are from ground observations and aerial surveys.

ranged from 8 to 85 adults in BRA 3 and 2 to 96 adults in BRA 1 (Table 14). Within 7-10 days of peak hatching (14-17 July), daily counts of adults in BRAs 1 and 2 began to stabilize, and more cohesive groups began to form. (No data are available from BRA 3 for this period.) About 40 adults with 48-63 goslings used BRA 1 between 13 and 22 July 1989.

Brant used three principal routes of dispersal from Howe Island after hatching. Some broods departed west from the mudflats off the west end of Howe Island to BRA 8. Most dispersed south from Howe Island to BRA 3. Others dispersed from the south or east shores of Howe Island directly to BRA 1 (Table 14, Figures 5,20). Nest census data and brood counts indicated that broods originating on Howe and Duck islands moved east as far as the Kadleroshilik River (Table 15, Figures 10, 21) and west at least as far as Prudhoe Bay.

Table 14. Use of areas on the outer Sagavanirktok River delta by Brant during hatching and dispersal from Howe Island, 4-11 July 1989.

Snow Goose BRA[1]	Map Location[2]	Number of Groups	Mean Group Size[3]	SD	Range	Status
8 [4]	A	2	6.5	-	6-7	failed breeders and brood-rearing group
	B	1	16.0	-	-	with broods
3 [5]	C	10	49.2	30.2	8-85	mostly brood-rearing groups
3 [4]	D	1	2.0	-	-	pair at nest site
1 [5]	E	41	24.3	24.8	2-96	mostly brood-rearing groups
2 [5]	F	4	26.5	19.0	10-52	with broods
10 [4]	G	1	11.0	-	-	no broods
11 [4]	H	1	20.0	-	-	no broods

[1] Brood-rearing areas presented in Figure 5.

[2] Map locations from Figure 20.

[3] Adults only.

[4] Data from aerial surveys.

[5] Data from ground surveys.

Table 15. Use of areas on the outer Sagavanirktok River delta by Brant during brood-rearing, 12-29 July 1989.

Snow Goose BRA[1]	Map Location[2]	Number of Groups	Mean Group Size	SD	Range
8 [3]	A	1	40.0	-	-
	B	1	26.0	-	-
3 [3]	C	1	40.0	-	-
1 [4]	D	11	33.5	13.0	10 - 48
2 [4]	E	4	37.0	23.1	10 - 60
10 [3]	F	1	25.0	-	-
11 [3]	G	2	105.0	-	100 - 110

[1] Brood-rearing areas presented in Figure 5.

[2] Map locations from Figure 21.

[3] Data available from aerial surveys.

[4] Data from ground surveys.

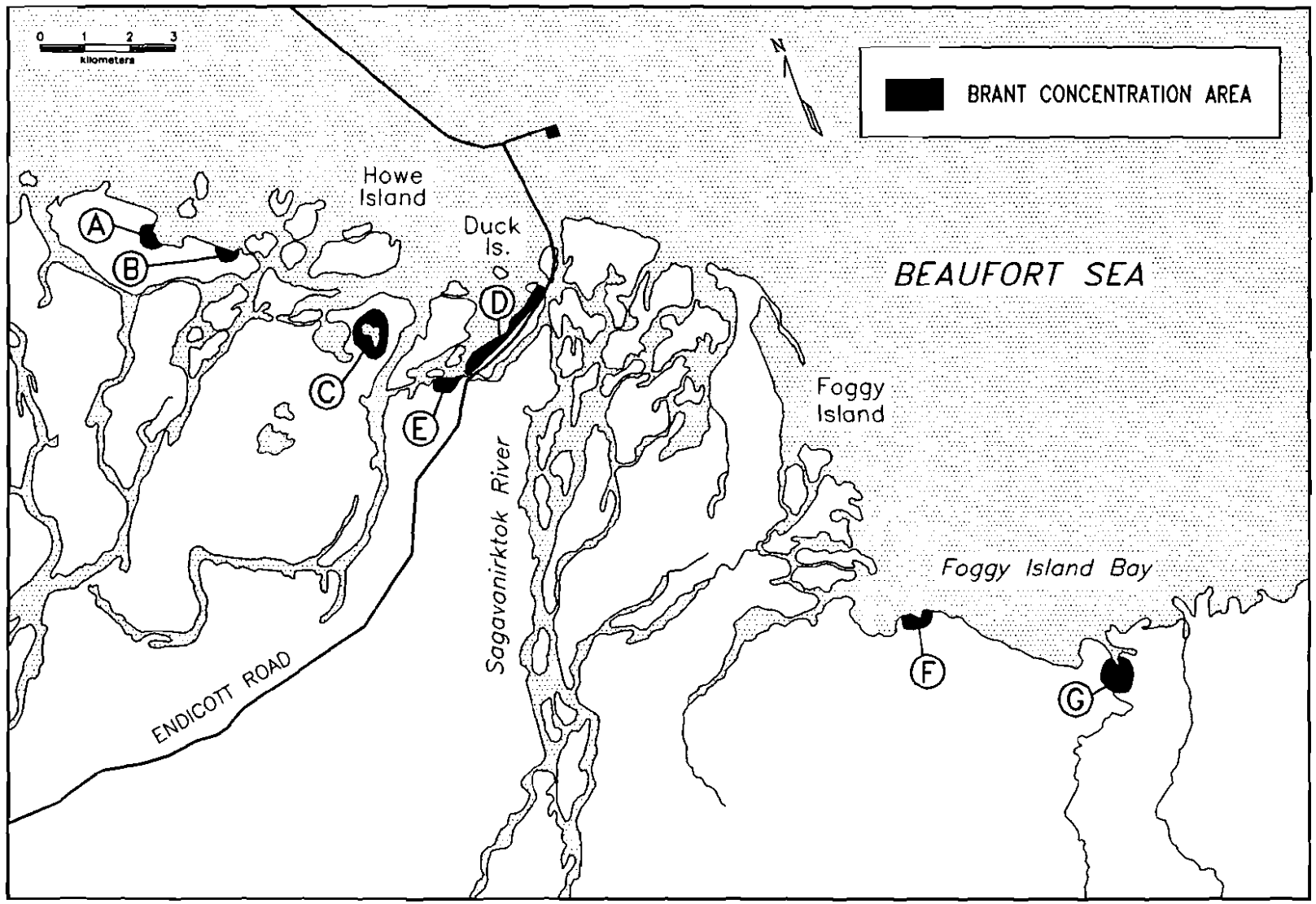


Figure 21. Use of the outer Sagavanirktok River delta by Brant during brood-rearing, 12-29 July 1989. (Data are from ground observations and aerial surveys).

DISCUSSION

AERIAL SURVEYS

Nesting Brant

Abundance

Bailey et al. (1933) reported that Brant were the most common nesting waterfowl near Barrow, and subsequent investigators also reported small colonies in that region (D. H. Fiscus, unpubl. field notes 1952-1953; Shepherd 1961). Gavin (1971b), however, was the first to estimate the population size of Brant summering in the study area. In early June 1970, Gavin flew a "complete survey" of the area within 16 km of the coast between the Colville and Canning rivers. Between 1971 and 1978, Gavin apparently selected areas within the region for exhaustive surveys in early June and implemented a sampling scheme (not described but referred to as "strip-transect surveys") for other regions (Gavin 1980). The counts and estimates computed by these techniques ranged between 715 and 1007 Brant ($\bar{x}$ = 881; between the Colville and Canning rivers) in early June 1970-1978 (Gavin 1980).

In June 1989, extensive aerial surveys and ground nest censuses of the Howe Island, Duck Island, and Surfcote colonies yielded a range of estimates of 1154-1242 Brant in an area comparable to Gavin's study area. This range was based on 878 Brant counted on aerial surveys, and an additional 276-364 Brant associated with 128-159 nests on Howe Island, 3-6 nests on Duck Island, and 7-16 nests in the LDA. (The range of nest numbers reflects successful and total numbers of nests.) Although there were some differences between Gavin's surveys and the 1989 surveys (e.g., differences in timing and phenology, or in the intensity of coverage of some areas), our counts of adult Brant are similar to those made in the 1970's.

Historical information from a small number of colonies in the region (Table 16) suggests that while regional Brant numbers may have shown some

Table 16. Records of Brant nesting from Brownlow Point to the Miluveach River, Alaska, (1969-present).

Region	Location	No. of Nests	Year; method; comments	References
East of Sagavanirktok River	Bullen Pt.-Brownlow Point	0	1981; extensive ground and aerial surveys	WCC and ABR 1983
	Shaviovik-Kavik	0	1986; intensive ground survey; Brant rarely observed in summer	USFWS 1987b
		1	1989; aerial surveys	This report
	Foggy Island	10	1989; aerial survey	This report
Sagavanirktok Delta	Spit west of Pt. Brower	+	1971; aerial surveys; 50 pairs on two "gravel" islands west of Foggy Island, may include Duck Island	Gavin 1971a
		~7	1976; ground visit	Divoky 1978
		1	1989; aerial survey	This report
	Duck Island	~35	1976; ground visit	Divoky 1978
		23	1984; ground survey	Johnson et al. 1985
		6-19	1985-1987, 1989; ground surveys	This report
	Howe Island	+	1977; aerial surveys; Brant returned to nest "as they have for a number of years"	Gavin 1977
		33	1984; ground survey	Johnson et al. 1985
		62-213	1985-1989; ground surveys	This report
	Central delta	$\geq$2	1989; aerial survey, ground visit	This report

Table 16. Continued.

Region	Location	No. of Nests	Year; method; comments	References
Prudhoe Bay Area	LDA "Surfcote"	30-40 pairs	1977; ground visit; foxes caused desertion	Gavin 1977
		20-28	1983 and 1984; intensive ground surveys	WCC 1983
		12-24	1985-1989; intensive ground surveys	Murphy et al. 1990
	Niakuk Islands	0	1976; ground visit; gull nests abundant	Divoky 1978
		3	1977; aerial survey of nests; "heavy use by geese"	Gavin 1977
		+	1982; aerial surveys; present	Herter et al. 1983
		0	1986; aerial surveys for gull nests	Murphy et al. 1987
		6	1989; aerial survey	This report
	Storkerson Pt.	12	1972; ground survey; most in *Arctophila* wetland	Bergman et al. 1977
		0	1989; aerial surveys	This report
	Deadhorse	16+	1988; ground visit; two colonies	R. J. Ritchie, pers. obs.
		12	1989; aerial surveys; three colonies	This report
Kuparuk River to Kalubik Creek[1]	Kuparuk Delta	+	n.d.; reference to Gavin	Seaman et al. 1981
		110	1974; ground survey; island in delta	D. V. Derksen, USFWS, pers. comm.
		23-30	1988-1989; aerial surveys	Ritchie et al. 1989, this study

Table 16. Continued.

Region	Location	No. of Nests	Year; method; comments	References
Kuparuk River to Kalubik Creek (Continued)	Beechey Mound	+	n.d.; Helmericks noted colonies here	Seaman et al. 1981
		"several colonies 5-10 nests"	1986; intensive ground survey; found in Class V lakes south Beechey Point	USFWS 1987b (see also Ritchie et al. 1989)
	Upper Sakonywyak	1	1986; ground survey; in shallow pond	USFWS 1987b
		1	1988; aerial survey	Ritchie et al. 1989
	Kuparuk Oilfield	15 "colonies" 1-15 nests	1988; aerial surveys; Kalubik to Kuparuk, includes Oliktok Road (see below)	Ritchie et al. 1989
		39 locations 1-12 nests each	1989; aerial surveys; includes locations at Milne Point, Oliktok; Beechey Mound	This report
	Milne Point Road	+	1988; ground visits; active in late 1980's	J. Dau, ADFG pers comm. Ritchie et al. 1990
		8	1988; aerial survey	Ritchie, et al. 1989
		4-12	1984-1988; ground survey	Hampton 1989
	Oliktok Road	+	n.d.; ground visits; colonies or adults with goslings reported at five locations (including CPF-3)	M. Joyce, ARCO, pers. comm.
		15-43	1985-1988; ground survey; CPF-3	Hampton et al. 1988; Hampton 1989 (see also Ritchie et al. 1989)
		7-21	1985-1988; ground surveys; 3N, 2C, 1C	Hampton 1989

Table 16. Continued.

Region	Location	No. of Nests	Year; method; comments	References
	Barrier Islands	4	1976; ground visit of Egg Island (1); Thetis Island (3)	Divoky 1978
		1	Egg Island	Schamel 1974
		0	Spy Island	Johnson and Richardson 1980
		1	1989; aerial surveys; Long Island	This study
Kalubik Creek to Miluveach River	Kalubik Creek	0	1978; staging use; no nest records	Kiera 1984
		10-13	1988-1989; aerial surveys; west of Kalubik Creek	Ritchie et al. 1989, this report

\+ Nesting, exact number or site unknown

[1] Includes reference to specific colonies at Milne Point Road, Oliktok Road, and Beechey Mound.

stability, substantial changes have occurred at specific colonies. For example, the number of Brant nests at the Surfcote Colony in the LDA ranged from 12-28 between 1983 and 1989 (WCC 1983, 1984; Murphy et al., 1990). Gavin (1977) stated that 30-40 pairs deserted this colony in 1977 due to harassment by arctic foxes (*Alopex lagopus*). Nest numbers on Duck Island fluctuated between 35 in 1976 (Divoky 1978) and 6 in 1989 (this study). Hampton (1989) recorded 15-43 Brant nests at a colony near CPF-3 in the Kuparuk Oilfield between 1984 and 1988. Data for other colonies show evidence of intermittent or occasional use. For instance, Gavin (1977) found three Brant nests on the Niakuk Islands in 1977. Divoky did not record any on a visit in 1976 (Divoky 1978), but he did mention that some Brant may have departed prior to his arrival. Six nests were identified (in 1989) during aerial surveys associated with this study. Spindler (1978) found a colony of 15 Brant nests on the Okpilak delta in 1978, but no nesting was recorded in 1982 (Spindler and Miller 1983).

A number of factors could account for this variability, including differences in survey timing and technique, levels of disturbance, conditions at the colony in spring, and predation. Although the scope of our program did not include monitoring of these other factors, casual observations of nest depredation at three colonies, foxes observed near two other colonies, and observations of spring high-water levels at a fourth colony suggested that some of these factors may influence the annual productivity of nesting Brant. In particular, it appears that foxes and flooding are capable of causing abandonment or complete failure of entire colonies.

Predators have been responsible for at least three failures of Brant colonies in the Prudhoe Bay area. Foxes were implicated in the complete desertion of the Surfcote colony in 1977 (Gavin 1977), and Glaucous Gulls apparently destroyed this same colony in 1985 (Murphy et al. 1986). Foxes and gulls have previously been described as effective predators on waterfowl nests (Ryder 1969, MacInnes and Misra 1972, Mickelson 1975, Stickney

1989). A brown bear was responsible for the near-complete failure of the Howe Island Brant colony in 1985 (Burgess and Ritchie 1987).

Barry (1962) reported that low productivity of Brant was associated with late thaw and/or flooding of nesting habitats early in the nesting season. Furthermore, he showed that extensive habitat was unused later during nesting even after water levels receded and nesting habitat was exposed. Flooding at a Prudhoe Bay colony (active in 1988) southwest of Lake Coleen probably prevented Brant from nesting there in 1989. Nest islands at that colony were submerged during the first half of June. Murphy et al. (1988) considered that the greatest potential impact of the Lisburne Development Project on the Surfcote Brant Colony was flooding due to inadequate drainage of the area in spring. The colony was not occupied in 1987, apparently because nesting islands were flooded. Gavin's (1980) reference to shifting colonies of Brant, "moving from known nest sites to new locations for a year or so" and then reoccupying original locations, may be largely the result of this phenomenon.

Distribution

The identification of a number of small, scattered Brant colonies and associated brood groups during aerial surveys in 1988 (Ritchie et al. 1989) added support to King's (1970) contention that "substantial Brant production comes from large areas of low-density nesting that have not been positively identified." More intensive surveys and the expansion of survey coverage in 1989 provided additional information on Brant distribution and numbers from areas in the region between the Colville and Staines rivers.

As was the case in 1988 (Ritchie et al. 1989), no previously unreported large Brant colonies were identified in 1989. In spite of acknowledged limitations of aerial surveys (especially in certain habitat types), it is unlikely that large active Brant colonies were overlooked in either year. Surveys in the region have identified large colonies on Howe and Duck islands (Gavin 1977, Johnson et al. 1985), the Surfcote Colony in LDA (Gavin 1977, WCC 1983,

Murphy et al. 1986), and a smaller colony near Storkerson Point (Bergman et al. 1977) (Table 16). Gavin's (n.d. [a]) statement that "considerable numbers of Brant nest in the Prudhoe Bay area" probably refers to these colonies.

Approximately 47% of Brant nests in the study area were in widely scattered, small colonies ($\leq$5 nests). The highest concentration of these small colonies occurred in the Kuparuk Oilfield area, within 10 km of the coast between Kalubik Creek and the Kuparuk River. Most (>70%) Brant nesting was on islands in Deep-*Arctophila* (Class IV) and in Basin-complexes (Class VI) wetlands (habitat classifications follow Bergman et al. 1977). The remainder were located in flooded, polygonal tundra, shallow-*Carex* ponds (Class II) and gravel islands in the Beaufort Sea. The five Kuparuk Oilfield colonies monitored by Hampton (1989) were located in lakes and Basin-complexes that provided numerous islands and complex shorelines for nesting.

Small colonies have been reported previously in this area of the Kuparuk Oilfield (Seaman et al. 1981, USFWS 1987b, Hampton et al. 1988). Brant nests were recorded in 1989 at 15 of the 16 nest locations identified in 1988 (Ritchie et al. 1989) (see Brood-Rearing/Molting Brant). Additional small colonies and dispersed single nests undoubtedly were undetected in this area in both 1988 and 1989.

In some areas, low densities of nesting Brant may be due to the lack of preferred nesting habitat. West of Kalubik Creek and south of the Spine Road, the Coastal Plain shows greater relief and may provide fewer wetlands suitable for nesting. Lakes with small islets, a preferred nesting habitat in the area between the Kalubik Creek and Kuparuk River, are more limited in number west of Kalubik Creek. The lack of these habitat types, as well as the distance from the coast, may account for limited Brant nesting south of Prudhoe Bay.

In other surveyed areas, it appeared that preferred habitats were not always used by Brant. This was true especially in the area east of the Sagavanirktok River delta. The few nests found in that region were associated with the Shaviovik River delta or in close proximity to the Sagavanirktok River

delta. Historical records tend to support this observation. Bartonek (1969) observed only 20 Brant with young on an aerial survey between the Sagavanirktok River delta and Demarcation Bay in 1969. Intensive ground censuses near the Kavik River delta in 1986 (USFWS 1987b) and Point Thompson in 1981 (WCC 1983 and ABR 1983) did not locate any Brant nests. Gavin (n.d.[c]) recorded the greatest densities of Brant on his transects in the Colville-Ugnuravik, Kuparuk, and Sagavanirktok deltas and lower densities in the remaining area, including the area from the Sagavanirktok River to the Canning River. Brant nests also have not been recorded on Flaxman Island (Gavin 1977, Divoky 1978) or Tigvariak Island (Gavin 1977); these islands appear similar in physiography and vegetation to Howe Island and Duck Island. The low levels of nesting in these locations may be related to some other factor limiting the Brant population such as proximity to salt-marsh vegetation used for brood-rearing.

Although the number (approximately 380 in 1989) and density of nests in the study area are low in comparison with those in western Alaska and northern Canada (Pacific Waterfowl Flyway Council 1981; Bellrose 1978), they represent a major component of the known North Slope breeding population of Brant. Few breeding records of Brant occur east of the study area (15 nests on the Okpilak River delta [Spindler 1978]; broods near the Canning [Martin and Moiteret 1981]; and broods near Demarcation Bay in ANWR [Divoky 1978]). On the North Slope west of the study area, Brant nests probably do not number more than 700, including colonies in the Colville delta (~300 nests, [Simpson et al. 1982, Meehan and Jennings 1988]), near Teshekpuk Lake (100+ nests, Derksen et al. 1979a), the Meade River (~10 nests, Derksen et al. 1979a), Pitt Point (<20 nests, D. H. Fiscus, 1952-1953, unpub. field notes), and on islands and mainland near Kasegaluk Lagoon (~50 nests, [Divoky 1978]). Although Brant may nest in scattered locations as they do in the area between the Kalubik River and Kadleroshilik River, no recent surveys have indicated Brant are regular breeders in other areas of the North Slope.

Survey Efficiency

Aerial surveys provide one of the most efficient means of surveying large areas of appropriate nesting habitat. Fixed-wing aircraft surveys to locate Brant nests appeared to be effective in locating small Brant colonies, but often provided low estimates of the actual size of those colonies. Factors that contribute to bias in aerial surveys include: failure to identify unsuccessful nests, variation in the visibility of nest sites among habitats, and reduced probability of sighting peripheral nests in dispersed colonies.

The magnitude of bias in counts by fixed-wing aircraft can be determined by conducting multiple surveys (either ground or aerial surveys). Ground census of two nest colonies after counts were made from the air located additional nests. Examination of the results of Brant investigations in the Kuparuk Oilfield suggests that much of the difference between ground and aerial counts may have been due to nest failures prior to the aerial survey. In 1988, a ground census of nests (prior to 15 June) at the Milne Point Brant colony located 12 nests (Hampton 1989), while eight nests were observed during an aerial survey on 24 June (Ritchie et al. 1989). Predation on Brant nests in the region was high in 1988, as evidenced by the destruction of 26% of nests at the CPF-3 colony between 15 June and 6 July (Hampton 1989); a fox was observed raiding nests in the Milne Point colony in 1989.

It is difficult to assess the exact effect of nest dispersion and vegetation type on the efficiency of surveys by fixed-wing aircraft. Ground counts conducted in this investigation could not distinguish between bias due to nest dispersion and that due to vegetation type. Because the cruising speed of fixed-wing aircraft cannot be reduced to a level where dispersed or well-hidden nests will be detected, bias due to either effect could only be reduced by making multiple passes over a site after nesting geese were observed, which would increase disturbance. Helicopters might provide a less biased estimate of nest numbers in such situations (see Kaminski 1979, Shandrake and McCormick 1989), but here again increased disturbance would be an important consideration.

Brood-Rearing/Molting Brant

Abundance

There are few previous survey data with which to compare our results. King (1970) counted 1308 goslings on a flight in July between Point Lay and Barter Island. He also estimated that 5000 goslings could have been produced in 1966 on Alaska's Arctic Coastal Plain. Although no attempt was made to differentiate adults and goslings in all groups, approximately 1130 Brant were observed in the study area in 1988. This estimate was derived from a number of sources. In early August 1988, 352 Brant were observed in the Kuparuk River area and 65 Brant were observed at the mouth of Kalubik Creek (Ritchie et al. 1989). On 6 August, approximately 325-350 Brant were in the LDA (Murphy et al. 1989; R.J. Ritchie, pers. obs.), 60 Brant were in the Sagavanirktok River delta, and 300 Brant were in the Kadleroshilik River delta (R.J. Ritchie, pers obs.).

Brant are highly visible along the coast because they typically move toward water at the approach of the survey aircraft. Although counts can vary depending on habitat, how densely the flock is grouped and the age of goslings, photo censuses and results from ground-based studies in the Lisburne and Endicott Development areas (see SAGAVANIRKTOK DELTA BRANT SURVEYS) support our contention that our brood-rearing surveys were accurate. Furthermore, estimating productivity from our nest counts may also provide an indication of survey effectiveness and an estimate of abundance. That is, if we assume that approximately 320 nests is a conservative estimate of successful nests in the study area and use an average brood size of 2.0-2.5 (King 1970), we would estimate 640-800 goslings using the study area in late July. Our counts on 24-26 July totaled 642 goslings.

Distribution

Although we know of no similarly-timed surveys along this section of the Arctic Coastal Plain, available information suggests that brood-rearing Brant

have traditionally preferred specific salt marshes within the study area. These include the mouths of Kalubik Creek and the Ugnuravik River, Milne Point, the Kuparuk River delta, the mouth of the Putuligayuk River, the Sagavanirktok River delta, and Foggy Island Bay.

Few brood-rearing Brant have been recorded at inland sites in the study area. Hampton (1989) described regular use near colonies along the Oliktok Road 8 km from the coast. Shepherd (1961) found Brant as far as 60 km inland west of the Colville River. King (1970) thought it noteworthy that many Brant near Teshekpuk Lake used inland freshwater lakes for brood-rearing and molting, and he encountered Brant up to 32 km inland. Use of inland habitats by Brant is common on the Yukon-Kuskokwim delta, but these birds also tend to move toward the coast late in the brood-rearing period (Derksen et al. 1979b). A 17% increase in numbers of adults recorded on the coast between surveys during this study probably reflects some additional movement to the coast. However, since gosling numbers did not change markedly, and some non-breeders might have regained flight by late July (Derksen et al. 1979b), increases may have been due to immigration of flocks from outside the study area.

Section 1: Staines River to Sagavanirktok River. The use of the region east of the Sagavanirktok River by brood-rearing Brant is limited primarily to the extensive salt marsh at the mouth of the Kadleroshilik River, and to a lesser degree, the Shaviovik River delta. Results of other surveys also indicate limited brood-rearing use of this area. Bartonek (1969) saw only 20 Brant with young on a flight from the Sagavanirktok River to Demarcation Bay, between 31 July and 3 August 1969. A few Brant were recorded at two locations between Bullen Point and the Staines River in late July 1983 (WCC and ABR 1983). Aerial surveys conducted for the Endicott Snow Goose Program have regularly recorded Brant with broods in Foggy Island Bay (60 Brant, 7 August 1987; 43 Brant with broods 12 July 1987; and a mixed flock of 300 Brant, 13 August 1988), but not east of the Kadleroshilik River delta (R.J. Ritchie, pers. obs.).

Section 2: Sagavanirktok River Delta. Although the Sagavanirktok River delta supports the largest Brant colony in the region, Brant densities were low in the delta in late July 1989. The ratio of adults to goslings indicated that most of the brood-rearing population had left the delta. Survey data and ground observations indicated that brood-rearing Brant from the Sagavanirktok River delta colonies dispersed east as far as the Kadleroshilik River and west as far as the western shore of Prudhoe Bay (see SAGAVANIRKTOK DELTA BRANT SURVEYS). Most of the goslings located in the region between Point McIntyre and the Kadleroshilik River in 1989 were probably hatched in the Howe Island, Duck Island, and LDA colonies.

Section 3: Heald Point to Kuparuk River. Dense groups of Brant with broods have consistently used the salt marshes on the south and west shores of Prudhoe Bay, especially near the mouth of the Putuligayuk River (WCC 1983, 1985; Murphy et al. 1989). WCC (1983) reported 91 adult Brant with 95 goslings using the LDA, including the mouth of the Putuligayuk River. Murphy et al. (1990) have observed Brant in this region, as well as along the southeast shoreline of Prudhoe Bay, during the past five years (1985-1989). Peak numbers in July have ranged from approximately 100 Brant (including goslings) in 1985 to 350+ in 1988 (Murphy et al. 1989). Kiera (1982) noted staging Brant in this area on 18 August 1978. Little historical information is available on Brant use of areas inland from Prudhoe Bay, on the Niakuk Islands, and west of the West Dock Road.

Section 4: Kuparuk River to Kalubik Creek. Brood-rearing Brant were more abundant along this section of coast than along other coastal sections during surveys in 1989. Brood-rearing groups were observed in many locations previously reported to be used by brood-rearing and staging Brant. Gavin (in Bartonek 1969) was the first to report substantial numbers of Brant using the Kuparuk River delta; 500 adults and goslings were reported in 1969. Kiera

(1982) also reported 200 Brant along the coast, between the Kuparuk River delta and the Canning River, on an aerial survey on 27 July 1978. WCC (1981) found 300-500 staging Brant between Milne Point and Kavearak in the fall of 1981, and smaller numbers near the Sakonowyak and Kuparuk river deltas and near Point Storkersen. These areas were used by large brood-rearing groups during both of our surveys in 1989 and by a few Brant in 1988 (Ritchie et al. 1989). Brant broods (90-114 adults; 50-75 goslings; 19-24 July 1984; B.E. Lawhead, pers. obs.) and staging Brant have been recorded in the Oliktok Point area (WCC 1981; Ritchie et al. 1989).

Brant were observed infrequently in inland areas of the Kuparuk Oilfield in 1988 and 1989. Other investigators have reported Brant broods at inland locations near nesting Brant colonies in the Kuparuk Oilfield, including CPF-3 (Hampton et al. 1988, Hampton 1989), DS-3C (R. Johnson, ABR, pers. comm.) and near the Milne Point Road (J. Dau, ADFG, pers. comm.). Although Brant were regularly observed during Tundra Swan surveys along the coast in the Kuparuk Oilfield in 1988 and 1989, only one sighting was made (in 1988) of Brant at an inland location (Ritchie et al. 1989).

Section 5: Kalubik Creek to Miluveach River. Brant have been observed using salt marshes near the mouth of Kalubik Creek in 1978 (Kiera 1982), 1988 (Ritchie et al. 1989), and during swan brood-rearing surveys in 1989.

SAGAVANIRKTOK DELTA BRANT SURVEYS

Phenology

The dates of the arrival and hatching of Brant were similar among years 1987-1989. Arrival was delayed about ten days in 1986 because snow cover was unusually deep on Howe Island. Areas of bare ground did not appear until after most geese had arrived at the nesting colony and some parts of the island were snow covered throughout the incubation period (Burgess et al. 1990) Despite persistent snow cover during nest initiation on many parts of the island in 1987 and 1989, nesting was not delayed in either year.

Three observations in 1989 suggested that non-breeders and failed breeders remained on Howe Island throughout the nesting period, rather than undergoing a molt migration (Palmer 1976). First, the numbers of adults present did not decrease substantially during the nesting period. Second, the number of Brant counted during scans of the colony increased from 1988 to 1989, although the number of nests in the colony decreased. Third, the number of birds counted during scans was higher than could be accounted for by the number of nests and remained relatively constant throughout the incubation period. These observations are in marked contrast to the molt migration of both nonbreeders and failed breeders from the Snow Goose colony that occurs over a 1-3 day period in mid to late incubation (Burgess et al. 1990)

Population Size

Regional surveys of brood-rearing Brant suggest that a relatively discrete population can be identified (for the purposes of examining productivity) between Point McIntyre and the Kadleroshilik River (Figure 17). This population comprises the Howe Island, Surfcote, Duck Island, Niakuk Islands and upper Putuliguyak River Brant colonies, and solitary Brant nests in the LDA and in the Sagavanirktok River delta.

This population appeared to be distinct, in that Brant from this area (most of which originated on Howe Island) shared brood-rearing habitats, with what appeared to be an apparent lack of mixing with Brant that nested outside that area. In 1989, the breeding population in June was estimated to have been 212 nests and 424 breeding adults. The most complete survey of brood-rearing habitats was on 29 July; on that date it was estimated that 421 brood-rearing/molting adults were present.

There are few historical records pertaining to the population size of brood-rearing Brant between Point McIntyre and Foggy Island Bay. However, data are available for the major nest colonies: Howe Island, Duck Island, and Surfcote.

Howe Island

The numbers of Brant counted during daily scans of the Howe Island colony have increased every year between 1986 and 1989; the mean number counted has more than doubled since 1986. Although more Brant were observed in 1989 compared to 1988, the number of nests declined from 213 to 159. A similar decrease in nest numbers was observed for the Snow Goose colony (Burgess et al. 1990). Reasons for the decrease are unknown. Persistent snow cover on Howe Island did not delay nest initiation in 1989, and no nests were conspicuously later than was observed in previous years (1985-1988). However, snow cover was particularly deep across most of the North Slope in spring 1989, and critical staging areas for Brant may have been unavailable. If so, adult females may not have acquired or retained adequate nutrient reserves to allow breeding in 1989.

Duck Island

The Duck Island Brant colony has shown a steady decrease in size between 1984 and 1989. Historical records suggest that the Brant colony existed at 1984 levels or higher during at least some years between 1970 and 1984 (Divoky 1978). Possible reasons for the decline include: chronic low productivity due to the abundance of Glaucous Gulls in the colony, and extremely high levels of disturbance associated with construction of the Endicott Road and Causeway in 1985.

Observations in 1989 suggested that the presence of a large Glaucous Gull colony on the island did result in lower productivity of Brant nests there compared to the Howe Island colony. This low productivity was due to both nest predation and gosling mortality during dispersal from the colony. However, the available historical information suggests that Glaucous Gulls, Brant, and Common Eiders have co-existed for some time on delta islands in the Sagavanirktok River delta, and that Brant are capable of reasonably good productivity in such mixed colonies (Gavin n.d.[b]; Gavin, unpubl. field notes).

The effect of disturbance on the size and productivity of the Duck Island Brant colony cannot be determined. The construction of the Endicott Development Project brought a dramatic increase in development-related disturbance to the central Sagavanirktok River delta, particularly in the vicinity of Duck Island, in 1985. However, no direct cause-and-effect relationship can be shown between the decline in the size of the Duck Island Brant colony and the initiation of these activities on the delta. Observations of Brant activity in 1985 (during monitoring nesting Snow Geese on the island) identified no conspicuous behavioral reactions of Brant to construction activities (R.M. Burgess, pers. obs.).

There do not appear to be any data from other small island colonies in the Sagavanirktok River delta against which to compare the steady decrease in use of Duck Island by Brant. With the exception of the Surfcote Colony (Murphy et al.,1990), there have been no long-term investigations of the consistency of use or productivity of other Brant colonies in the region. Brant have shown considerable fidelity to the Surfcote colony, although that colony also has shown a steady decrease in size since 1984 (Murphy et al. 1990). Historical records suggest that some smaller mainland colonies have exhibited conspicuous fluctuations in size (Table 16). However, all of these mainland colonies experience annual fluctuations in the abundance of terrestrial predators (chiefly arctic foxes), and in water levels, which may influence the observed annual changes in use. Neither has been observed to affect Brant on Duck Island.

Other Colonies and Isolated Nests

Reasons for the decreases in size of the Surfcote Colony are also unknown. In recent years, two factors appeared to have influenced the size and productivity of the colony: predation, and flooding of nesting habitat by high water during breakup (Murphy et al. 1990). There are no good records of disturbance levels at the Surfcote colony between the construction of the

Surfcote storage pad (prior to 1970) and the mid-1980s. However, five years of disturbance monitoring between 1985 and 1989 suggested that disturbance was not an important influence on the colony after 1985. The long-term impact of these factors on use of the colony is unknown.

Aside from the number of nests located in June 1988 or 1989, little is known of the upper Putuligayuk or Niakuk islands colonies, or of solitary Brant nests in the region. There is no reliable historical information on the use of these locations by Brant.

Productivity

Howe Island

The Howe Island colony was by far the largest Brant colony in the region and had the highest nesting success. Because of its location, it was relatively protected from terrestrial predators, but did prove vulnerable to a brown bear in 1985. Glaucous Gulls are abundant around the colony, but only a single gull nest site was active on the island, far from nesting Brant, each year between 1986 and 1988. One additional nest, in the middle of the Brant colony, was present in 1989. The waterfowl colonies on the Sagavanirktok River delta do appear to attract various raptors to the area, and Brant appear to be particularly vulnerable to Snowy Owls and Golden Eagles (*Aquila chryseatos*). However, no comparison of the actual risk of predation to an individual Brant can be made between Howe Island and other nest locations.

Mean nesting success of Brant on Howe Island in the years 1986 to 1989 was 75%. This is considerably higher than the average of 40% reported by Mickelson (1975) on the Yukon-Kuskokwim delta for 1969-1972, but similar to success reported for the Anderson River between 1958 and 1965 (Barry 1966), and slightly less than values reported for the Colville River delta in 1987 and 1988 (Conant 1987, 1988). The mean brood size at hatching of 2.9 goslings (in 1989) did not differ from that found in Mickelson's (1973) study.

Duck Island

Nest success was between 45% and 50% in the Duck Island colony in the years 1986, 1987, and 1989 (no data for 1984, 1985, or 1988). In every year, estimated nest success on Duck Island was less than that observed on Howe Island. Casual observations in 1989 suggested that the lower productivity of Duck Island was attributable to the large colony of Glaucous Gulls also nesting on the island.

Other Colonies and Solitary Nests

Nest success was 58% in the Surfcote colony in 1989 (Murphy et al. 1990). Between 1984 and 1989, the productivity of the Surfcote Brant Colony was apparently controlled by two factors: flooding, and predation by gulls and foxes. The importance of both factors was confirmed by casual observations of Brant and foxes during field work and by examination in 1989 of the sites of colonies known active in 1988.

Few of the solitary nests or small colonies could be examined to determine productivity. Of six solitary nests (four in the LDA and two in the Central Sagavanirktok River delta), only one was successful (17%). For the years 1984 through 1989, individual productivity appeared to be lower in mainland nesting areas than it was in the delta islands colonies.

Mortality of Brant goslings in brood-rearing habitats between Point McIntyre and the Kadleroshilik River was estimated at about 50% between hatching and 29 July in 1989. Actual mortality may have been somewhat higher because of consistent negative bias in estimates used to calculate gosling numbers at hatching. The calculations involve total number of nests, nest success, and brood sizes at hatching, all of which are probably slightly underestimated. Therefore, 50% was probably a conservative estimate of gosling mortality in 1989.

Few comparative data are available on mortality of Brant goslings in other regions. Brood counts showed a 30% decrease between hatching and fledging

in the Yukon-Kuskokwim Delta (Mickelson 1973). However, brood counts provide inaccurate data on gosling survival for two reasons. First, they cannot adequately account for total brood loss. Second, brood counts of Brant in the Sagavanirktok River delta were clearly affected by frequent mixing of broods, particularly in areas subjected to high levels of disturbance. In brood-rearing areas adjacent to the Endicott Road, brood mixing was apparent because observed brood size actually increased, although the number of "broods" decreased.

Similar observations of brood-mixing in Brant have been made in the Yukon-Kuskokwim Delta (J.S. Sedinger, UAF, pers. comm.). This phenomenon has been referred to as gang-brooding in Giant Canada Geese (*B.c. maxima*) (Warhurst and Bookout 1983). High densities of groups, disturbance, variable fidelity of parents to goslings, and vocalizations by (other) females were thought to contribute to formation of gang broods.

Movements and Habitat Use

Immediately after hatch, Brant from Howe and Duck islands dispersed to brood-rearing areas near the colonies, but most used these areas only briefly before moving to more distant locations. About a week after hatch, numbers in these near brood-rearing areas stabilized and more cohesive groups formed. Observations of brood-rearing Brant in Prudhoe Bay (Murphy et al. 1989), and in Snow Goose brood-rearing areas (R.J. Ritchie, pers. obs.) also suggest that cohesive groups form in brood-rearing areas and that long-distance movements are not common for such groups after the initial period of dispersal.

Judging by numbers alone, Brant from the Howe Island and Duck Island colonies apparently dispersed as far east as the Kadleroshilik River and west to the western side of Prudhoe Bay. There apparently was little mixing with Brant from the Storkerson Point or other western areas, and only small numbers of Brant were observed in the region east of the Kadleroshilik River.

Brant associated with colonies in the Sagavanirktok River delta frequented arctic salt marshes to the apparent exclusion of other vegetation types during all periods from arrival through brood-rearing in 1989. Although Brant used wet-sedge tundra vegetation during the nesting season in the LDA (Murphy et al. 1990), brood-rearing Brant throughout the region used salt-marsh vegetation almost exclusively.

Habitat use on the outer Sagavanirktok River delta appeared to change slightly between the nesting and brood-rearing periods. Brood-rearing groups avoided some salt marshes that had been used regularly before hatching. In particular, brood-rearing Brant appeared to avoid salt marshes from which long-distance visibility was obstructed. Other factors that may have influenced selection of salt marshes include forage quality and distance to open water.

Brant and Snow Geese often were found in the same general areas in BRAs 1-3 in 1989 (and in other years), but the two species had somewhat different habitat-use patterns. Brant appeared to prefer lower and wetter areas of salt marsh, while Snow Geese ranged throughout salt marshes making some use of higher elevation areas. This separation of use could result partly from the apparently greater reluctance of Brant to remain in areas without long-distance visibility. In BRA 3, Brant appeared to prefer wet peninsulas jutting into the larger lakes while Snow Geese used the entire perimeter of lakes, including more elevated areas of salt marsh closer to the high dunes. In BRA 1 and 2, both Brant and Snow Geese used strips of salt-marsh vegetation between 1 and 15 m from the shore of the river channel and on the gently sloping shores of small lakes within 50 m of the channel. Only Snow Geese used the higher terrain on the southern half of BRA 1 and the steep shores of the large lake there.

SUMMARY AND CONCLUSIONS

TUNDRA SWANS

Four hundred eighty-three Tundra Swans and 79 nests were observed at 289 locations in the Kuparuk Oilfield and OGL 54 between 19 and 24 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 the 150°40'W in OGL 54. Tundra Swan nests were within 4 km of nine new or proposed drill-site locations. In June 1989, the densities of Tundra Swans were estimated at 0.02 nests/km^2 and 0.11 swans/km^2. These densities were similar to those found in 1988 and were within the normal range for the Coastal Plain. Six hundred seventy Tundra Swans and 142 cygnets in 64 broods were recorded between 19 and 22 August in the Kuparuk Oilfield and OGL 54. The mean brood size was 2.2 cygnets, similar to the mean observed in 1988. Densities of swans during August were 0.02 broods/km^2 and 0.16 swans/km^2, similar to the estimates made in 1988. Numbers of adults and nesting pairs appear to have increased since 1986.

BRANT

In addition to the large colony on Howe Island, Brant were distributed in small colonies and solitary nest sites across the Arctic Coastal Plain, especially between the Kadleroshilik River and the Miluveach River. The highest concentration of these small colonies occurred between the Kuparuk River and Kalubik Creek within 5-10 km of the coast. Few Brant nests were observed farther inland or east of Foggy Island Bay. Brood-rearing surveys verified this assessment of the distribution of productive nesting areas in the region. The adult Brant population was estimated to number over 1100 in June. Historical data for the region are limited and fixed-wing surveys during nesting probably underestimate nest numbers. As far as could be determined, the overall abundance of nesting Brant was similar to that recorded in the 1970s.

Historical data document traditional use of most of the intensively used brood-rearing areas located in 1989. Records were available for the Kalubik Creek area, the mouth of the Ugnuravik River, Kuparuk River delta, the Putuligayuk River, and the Sagavanirktok and Kadleroshilik river deltas. Brood-rearing also occurs inland but broods leave many of these areas by late July. Little brood-rearing occurs east of the Kadleroshilik River. Data are not available to estimate the numbers of Brant using the entire study area during brood-rearing in previous years. In 1989, a minimum of 1464 Brant, including 620 goslings, used coastal wetlands in the study area, supporting the contention that this low-density nesting habitat adds substantially to the productivity of the North Slope regional Brant population.

The timing of arrival, nest initiation, and hatching of Brant on Howe Island in 1989 was similar to that observed 1987 and 1988. The numbers of Brant seen in daily scans of the island indicated that the size of the colony increased from 1986-1989 but nest numbers decreased in 1989. The reasons for this latter decline are unknown. Brant in the Howe Island colony had at least 81% nesting success in 1989 and the average brood size during dispersal was 2.9 goslings.

Duck Island had only six known Brant nests in 1989, a 68% decline since 1986. Three of the six nests were successful and the average brood size during dispersal was 2.0 goslings. The lower productivity compared to Howe Island was largely attributable to the large number of Glaucous Gulls nesting on Duck island.

Broods from Howe Island and Duck Island colonies shared brood-rearing areas with Brant from other colonies and isolated nests in the area between Point McIntyre and the Kadleroshilik River in 1989. There was no apparent mixing of broods produced in this region with broods produced elsewhere. There were 212 Brant nests located in this area in 1989, and an estimated 435 goslings at hatching. By the end of July, an aerial survey counted 216 goslings in the same region.

Habitat use by Brant on the Sagavanirktok River delta during nesting and in the region between Point McIntyre and the Kadleroshilik River during brood-rearing was entirely restricted to arctic salt-marsh vegetation types. The avoidance by brood-rearing groups of some salt marshes that had been used during nesting indicated that different selection criteria were used during brood-rearing.

LITERATURE CITED

Bailey, A.M., C.D. Brower, and L.B. Bishop. 1933. Birds of the region of Point Barrow, Alaska. Program of Activities, Chicago Academy of Sciences 4:13-40.

Barry, T.W. 1956. Observations of a nesting colony of American Brant. Auk 73:193-202.

Barry, T.W. 1962. Effect of late seasons on Atlantic Brant reproduction. J. Wildl. Manage. 26:19-26.

Barry, T.W. 1966. The geese of the Anderson River Delta, Northwest Territories. Ph.D. Thesis, Univ. of Alberta, Edmonton. 181 pp.

Bartels, R.F., and T.J. Doyle. 1984. Distribution, abundance, and productivity of Tundra Swans in the coastal wetlands of the Arctic National Wildlife Refuge, Alaska, 1983. Pages 202-209 *in* G. W. Garner and P.E. Reynolds, eds. 1983 Update Report Baseline Study of Fish, Wildlife, and their Habitats. ANWR Prog. Rep. No. FY 84-8, U.S. Fish and Wildl. Serv., Fairbanks, AK.

Bartonek, J.C. 1969. Arctic Slope and Trans-Alaska Pipeline Task Force report: The bird resources of Alaska's Arctic Slope and petroleum development. U.S. Fish and Wildl. Serv., Anchorage, AK. 39 pp.

Bellrose, F.C. 1978. Ducks, geese, and swans of Northern America. 2nd ed. Stackpole, Harrisburg, PA. 540 pp.

Bergman, R.D., R.L. Howard, K.F. Abraham, and M.W. Weller. 1977. Waterbirds and their wetland resources in relation to oil development at Storkersen Point, Alaska. U.S. Fish and Wildl. Serv.. Resour. Publ. 129. 38 pp.

Brackney, A.W., J.M. Morton, J.M. Noll, and M.A. Masteller. 1985. Tundra Swan (*Cygnus columbianus*) surveys. Pages 11-12 *in* G.W. Garner and P.E. Reynolds, eds. 1984 Update Report; Baseline Study of the Fish, Wildlife, and their Habitats. U.S. Fish and Wildl. Serv., Anchorage, AK. 777 pp.

Burgess, R.M., and R.J. Ritchie. 1987. Snow Goose Monitoring Program, Endicott Development Project Environmental Program, 1985. Prepared by Envirosphere Co., for USACE, Anchorage, AK. 97 pp.

Burgess, R.M. and R.J. Ritchie. 1989. Draft report. Snow Goose Monitoring Program, 1988 Endicott Development Project. Report prepared for the Army Corps Eng., by SAIC, Anchorage, AK.

Burgess, R.M., A.A. Stickney, J.R. Rose, and R.J. Ritchie. 1990. Draft report. Snow Goose monitoring program, 1989 Endicott Development Project. Report prepared for the Army Corps Eng., by SAIC, Anchorage, AK. 272 pp.

Campbell, B.H., D.H. Rosenberg, and T.C. Rothe. 1990. Annual Report of Survey-Inventory Activities, Vol. XVIII, Part XIII: Waterfowl. Fed. Aid Wild. Restor. Proj. W-22-6, Job 11.0, Alaska Dep. Fish and Game, Juneau.

Campbell, B.H., and T.C. Rothe. 1990 Annual Report of Survey Inventory Activities, Vol. XIX, Part XIII: Waterfowl. Fed. Aid Wild. Restor. Proj. W-23-2, Job 11.0, Alaska Dep. Fish and Game, Juneau.

Carson, C.E., and K.M. Hussey. 1962. The oriented lakes of arctic Alaska. J. Geol. 70:74-81.

Conant, B. 1988. Alaska: Productivity of geese, swans, and brant, 1988. U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, AK. 28 pp.

Conant, B., and S.L. Cain. 1987. Alaska Tundra Swan status report 1987. Off. Migr. Bird Manage., U.S. Fish and Wildl. Serv., Juneau. 17 pp.

Derksen, D.V., W.D. Eldridge, and T.C. Rothe. 1979a. Waterbird and wetland habitat studies. Pages 229-311 *in* NPR-A Work Group 3. Studies of selected wildlife and fish and their use of habitats on and adjacent to the NPR-A 1977-1978, Vol. 2. U.S. Fish and Wildl. Serv., Anchorage.

Derksen, D.V., M.W. Weller, and W.D. Eldridge. 1979b. Distributional ecology of geese molting near Teshekpuk Lake, National Petroleum Reserve-Alaska. Pages 189-207 *in* R.L. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific Flyway geese. OSU Bookstores, Corvallis, Oregon. 346 pp.

Derksen, D.V., T.C. Rothe, and W.D. Eldridge. 1981. Use of wetland habitats by birds in the National Petroleum Reserve-Alaska. U.S. Dep. Inter., Fish and Wildl. Serv. Resource Publ. 141. Washington, D.C. 27 pp.

Divoky, G.J. 1978. Identification, documentation, and delineation of coastal migratory bird habitat in Alaska, Vol. 1: Breeding bird use of barrier islands in the northern Chukchi and Beaufort seas. Pages 482-548 *in* Environ. Assessment of the Alaskan Continental Shelf, Annu. Rep. Principal Invest., Vol. 1, OCSEAP BLM/NOAA, Boulder, Colo.

Einarsen, A.S. 1965. Black Brant, sea goose of the Pacific Coast. Univ. Washington Press, Seattle, WA. 142 pp.

Gabrielson, I.N., and F.C. Lincoln. 1959. The birds of Alaska. Wildl. Manage. Inst. 922 pp.

Gallaway, B.J., and R.P. Britch, eds. 1983. Environmental Summer Studies (1982) for the Endicott Development. Vol. IV: Terrestrial Ecology. Unpubl. Rep. for Sohio Alaska Petroleum Company, Inc. Anchorage, Alaska by LGL Alaska Research Associates, Inc., Anchorage, Alaska. 15 pp.

Gavin, A. n.d. (a) Birds of Prudhoe Bay Area, North Slope Alaska.

Gavin, A. n.d. (b) The offshore region, Prudhoe Bay. Unpubl. rep. (1970-1975). 40 pp.

Gavin, A. n.d. (c) Some notes on waterfowl and other birds, Prudhoe Bay area, North Slope, Alaska. Unpubl. rep. (1969-1970). 18 pp.

Gavin, A. 1971a. Offshore island survey, Colville River to Canning River. Unpubl. rep. (June 4-23, 1971). 6 pp.

Gavin, A. 1971b. General wildlife report: Prudhoe Bay Area, 1971. Unpubl. rep. 24 pp.

Gavin, A. 1972. 1972 wildlife survey Prudhoe Bay area of Alaska. Fin. rep., prep. by ARCO, Alaska, Inc., Anchorage. 20 pp.

Gavin, A. 1974. Wildlife of the North Slope. The sixth year of study. Fin. rep. prep. by ARCO, Alaska, Inc. 16 pp.

Gavin, A. 1976. North Slope wildlife studies 1976. Unpubl. rep. prep. for ARCO, Alaska, Inc. 11 pp.

Gavin, A. 1977. Ecological and environmental report: Prudhoe Bay region, North Slope of Alaska 1977. Unpubl. rep. prep. for ARCO, Alaska, Inc. 17 pp.

Gavin A. 1980. An arctic coastal environment, Prudhoe Bay, Alaska. Paper presented to Second Symposium on Management, Conservation and Utilization of the Coastal Zone, 17-20 November 1980. 20 pp.

Girard, G.L. 1939. Notes on the life history of the Shoveller. Tran. N. Amer. Wild. Conf. 4:364-371.

Hampton, P. 1989. A study of Brant brood-rearing area fidelity and noise characteristics of CPF-3k, Kuparuk River Field. Unpubl. draft rep. prep. for ARCO, Alaska, Inc. prep. by Hunter/ESE, Anchorage, AK. 45 pp.

Hampton, P.D., L.C. Orr, and L. Byrne. 1988. An evaluation of the effects of noise on waterfowl in the vicinity of CPF-3, Kuparuk Field, Alaska. Rep. by ESE to ARCO Alaska, Inc., Anchorage.

Hansen, H.A. 1957. Annual waterfowl report, Alaska. Unpubl. rep., Bur. Sport Fish. and Wildl., U.S. Fish and Wildl. Serv., Fairbanks. 7 pp.

Hawkins, L. 1983. Tundra Swan study, 1983 progress report. Unpubl. rep. U.S. Fish and Wildl. Serv., Anchorage. 6 pp.

Herter, D.R., D.M. Troy, and R.M. Burgess. 1983. Environmental Summer Studies (1982) for the Endicott Development. Vol. IV: Terrestrial Ecology. Part 3 - Waterbirds. LGL Alaska Research Assoc., Inc. Rep., prep. for SOHIO Alaska Petroleum Co.

Johnson, S.R., and D.R. Herter. 1989. The birds of the Beaufort Sea. BP Exploration (Alaska) Inc. Anchorage, AK. 372 pp.

Johnson, S.R. and W.J. Richardson. 1980. Beaufort Sea barrier island-Lagoon ecological process studies: Fin. Rep., Simpson Lagoon. Part 3. Birds, LGL Limited, Edmonton, Alberta, Canada.

Johnson, S.R., D.M. Troy, and J.G. Cole. 1985. The status of Snow Geese in the Endicott Development Unit, Sagavanirktok River delta, Alaska: A 5-year summary. pp. 1-53. In: Gallaway, B.J. and S.R. Johnson (eds.), Environmental Monitoring Studies (Summer 1984) for the Endicott Development. Unpubl. Rep. for Sohio Alaska Petroleum Company, Inc. Anchorage, Alaska by LGL Alaska Research Associates, Inc., Anchorage, Alaska. 205 pp.

Kaminski, R.M. 1979. Locating nesting waterfowl by helicopter. Wildl. Soc. Bull. 7:194-197.

Kessel, B., and T. Cade. 1958. Birds of the Colville River, northern Alaska. Biol. Papers Univ. Alaska 2:1-83.

Kiera, E. 1984. Feeding ecology of Black Brant on the north slope of Alaska. Pages 40-48. *in* Proc. Pac. Seabird Group Symposium.

King, J.G. 1970. The swans and geese of Alaska's Arctic Slope. Wildfowl 21:11-17.

King, J.G. 1973. The use of small airplanes to gather swan data in Alaska. Wildfowl 24:15-20.

King, R. 1979. Results of aerial surveys of migrating birds on NPR-A in 1977 and 1978. Pages 183-226 *in* NPR-A Work Group 3. Studies of selected wildlife and fish and their use of habitats on and adjacent to the NPR-A, 1977-1978, Vol. 1, U.S. Fish and Wildl. Serv., Anchorage.

King, R. 1989. Unpubl. rep., Migratory Bird Management, U.S. Fish and Wildl. Serv., Fairbanks. 1 pp.

King, J.G., and D.V. Derksen. 1986. Alaska goose populations: past, present, future. Trans. North Am. Wildl. and Nat. Resour. Conf. 51:464-479.

Lensink, C.J. 1973. Population structure and productivity of Whistling Swans on the Yukon Delta, Alaska. Wildfowl 24:21-25.

MacInnes, C.D., and R.K. Misra. 1974. Predation on Canada Goose nests at McConnell River, Northwest Territories. J. Wildl. Manage. 36:414-422.

Martin, P.D., and C.S. Moitoret. 1981. Bird populations and habitat use, Canning River Delta, Alaska. Unpubl. rep. to Arctic National Wildlife Refuge, U.S. Fish and Wildl. Serv.

Meehan, R., and T.W. Jennings. 1988. Characterization and value ranking of waterbird habitat on the Colville River delta, Alaska. Unpubl. report prep. by USFWS, Alaska Investigations, Anchorage, AK. Prep. for U.S. Environmental Protection Agency. 105 pp.

Mickelson, P.G. 1973. Breeding biology of Cackling Canada Geese (*Branta canadensis minima*) and associated species on the Yukon-Kuskokwim Delta, Alaska. Ph.D. Thesis, Univ. of Michigan, Ann Arbor. 246 pp.

Mickelson, P.G. 1975. Breeding biology of Cackling Geese and associated species on the Yukon-Kuskokwim Delta, Wildl. Mono. 45:1-33.

Murphy, S.M., B.A. Anderson, C.L. Cranor, and C.B. Johnson. 1986. Lisburne Terrestrial Monitoring Program 1985: The effects of the Lisburne Development Project on geese and swans. First Ann. Rep. prep. for ARCO Alaska, Inc., Anchorage, Alaska, by Alaska Biological Research, Inc., Fairbanks, AK. 152 pp.

Murphy, S.M., B.A. Anderson, C.L. Cranor, and C.B. Johnson. 1988. Lisburne Terrestrial Monitoring Program 1987: The effects of the Lisburne Development Project on geese and swans. Third Ann. Rep. prep. for ARCO Alaska, Inc., Anchorage, Alaska, by Alaska Biological Research, Inc., Fairbanks, AK. 205 pp.

Murphy, S.M., B.A. Anderson, C.L. Cranor, and M.T. Jorgenson. 1989. Lisburne Terrestrial Monitoring Program 1988: The Effects of the Lisburne Development Project on geese and swans. Fourth Ann. Rep. Prepared for ARCO Alaska, Inc., Anchorage, Alaska, by Alaska Biological Research, Inc., Fairbanks, Alaska. 255 pp.

Murphy, S.M., B.A. Anderson, C.L. Cranor, M.T. Jorgenson, and B.K. Lance. 1990. Lisburne Terrestrial Monitoring Program 1989: The Effects of the Lisburne Development Project on geese and swans. Draft Ann. Rep. Prepared for ARCO Alaska, Inc., Anchorage, Alaska, by Alaska Biological Research, Inc., Fairbanks, Alaska. 275 pp.

Pacific Waterfowl Flyway Council. 1981. Management plan, Pacific coast Brant. Unpubl. report. Technical Committee. 75 pp.

Palmer, R.S. 1976. Handbook of North American birds. Vol. 2, part 1. Yale University Press, New Haven, CT. 521 pp.

Pitelka, F.A. 1974. An avifaunal review for the Barrow region and North Slope of Arctic Alaska. Arctic and Alpine Research 6:161-184.

Platte, R.M., and A.W. Brackney 1987. Tundra Swan surveys. Pages 16-17 *in* G.W. Garner and P.E. Reynolds, eds. 1985 update report; baseline study of the fish, wildlife, and their habitats. U.S. Fish and Wildl. Serv., Anchorage, AK. 481 pp.

Ritchie, R.J., J.G. King, and P.W. Banyas. 1989. Aerial waterfowl surveys in the Kuparuk River Unit and Oil and Gas Lease Sale 54. Unpubl. fin. rep. prep. for ARCO, Alaska, Inc., Anchorage, by Alaska Biological Research, Inc. Fairbanks, AK 26 pp.

Ryder, J.P. 1969. Nesting colonies of Ross' Goose. Auk 86:282-292.

Salter, R.E., M.A. Gollop, S.R. Johnson, W.R. Koski, and C.E. Tull. 1980. Distribution and abundance of birds on the arctic coastal plain of northern Yukon and adjacent Northwest Territories, 1971-1976. Can. Field-Nat. 94:219-238.

Schamel, D.L. 1974. The breeding biology of the pacific eider on a barrier island in the Beaufort Sea, Alaska. M.S. Thesis Univ. Alaska, Fairbanks, AK. 95 pp.

Seaman, G.A., G.F. Tarde, D.L. Clausen, and L.A. Trasky. 1981. Mid-Beaufort coastal evaluation study: Colville River to Kuparuk River. Alaska Dep. Fish and Game, Anchorage, AK.

Shandruk, L.J., and K.J. McCormic. 1989. The relative effectiveness of fixed-wing aircraft and helicopters for surveying Trumpeter Swans. Canadian Wildlife Service. Progress Notes No. 1982. 3 pp.

Shepherd, P.E.K. 1961. Distribution and abundance of the Black Brant in Alaska. Pages 58-60 *in* Alaska Dep. Fish and Game. 1960-61 Pittman-Robertson Proj. Rep. 2. Div. Game, Juneau, AK.

Simpson, G., J. Barzen, L. Hawkins, and T. Pogson. 1982. Waterbird studies on the Colville River Delta, Alaska. Unpubl. 1982 Summary rep., U.S. Fish and Wildl. Serv., Anchorage, AK. 24 pp.

Sladen, W.J. 1973. A continental study of Whistling Swans using neck collars. Wildfowl 24:8-14.

Spindler, M.A. 1978. Bird populations and habitat use on the Okpilak River Delta area, Arctic National Wildlife Range, 1978. Unpubl. rep. U.S. Fish and Wildl. Serv., Fairbanks, AK. 83 pp.

Spindler, M.A., and P.A. Miller. 1983. Terrestrial bird populations and habitat use on coastal plain tundra of the Arctic National Wildlife Refuge, Alaska. Pages 107-200 *in* G.W. Garner and P.E. Reynolds, ed. 1982 Update Report Baseline Study of the Fish, Wildlife, and their Habitats. U.S. Fish and Wildl. Serv. Anchorage, AK. 379 pp.

Stewart, D.B., and L.M.J. Bernier. 1989. Distribution, habitat, and productivity of Tundra Swans on Victoria Island, King William Island and southwestern Boothia Peninsula, NWT. Arctic 42:333-338.

Stickney, A.A. 1989. The foraging behavior, habitat use and diet of arctic foxes (*Alopex lagopus*) in a goose nesting area near Kokechik Bay, Alaska. M.S. Thesis, Univ. of Alaska, Fairbanks, AK. 81 pp.

Troy, D.M. 1985. Birds of Prudhoe Bay and vicinity. Sohio Alaska Petroleum Company, Anchorage, AK. 36 pp.

U.S. Fish and Wildlife Service. (USFWS) 1987a. Trumpeter and Tundra swan survey protocol update. Memorandum, Migr. Bird Manage., USFWS, Juneau, AK. 8 pp.

U.S. Fish and Wildlife Service. (USFWS) 1987b. Bird-habitat associations on the North Slope, Alaska. Progress Report (1986). Prep. by USFWS, Alaska Investigations, Anchorage, AK. 96 pp. + appendices.

Wahrhaftig, C. 1965. Physiographic divisions of Alaska. U.S. Geol. Surv. Prof. Pap. 482. 52 pp.

Walker, D.A., K. R. Everett, P.J. Webber, and J. Brown. 1980. Geobotanical atlas of the Prudhoe Bay region, Alaska. Cold Reg. Res. and Eng. Lab. (CRREL) Rep. 80-14, U.S. Army Corps of Eng., Hanover, N.H. 69 pp.

Warhurst, R.A. and T. A. Bookhout. 1983. Effect of gang-brooding on survival of Canada Goose goslings. J. Wildl. Manage. 47:1119-1124.

Wilk, R.J. 1988. Distribution, abundance, population structure and productivity of Tundra Swans in Bristol Bay, Alaska. Arctic 41:288-292.

Woodward-Clyde Consultants. (WCC) 1981. Oliktok environmental studies. Second interim rep. to ARCO Alaska, Inc., Anchorage, AK.

Woodward-Clyde Consultants. 1983. Lisburne Development Area: 1983 Environmental Studies. Fin. rep. prep. for ARCO, Alaska, Inc., Anchorage, AK.

Woodward-Clyde Consultants (WCC) 1985. Lisburne development environmental studies, 1984. Vol. 2-caribou, birds and oceanography. Rep. prep. for ARCO Alaska, Inc., Anchorage, AK.

Woodward-Clyde and Alaska Biological Research. 1983. Terrestrial environmental study for Point Thomson development project. Fin. rep. prep. for Exxon Co., U.S.A., Thousand Oaks, CA.

Appendix Table A1. Aerial survey coverage of USGS quadrangles in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 1989.

Location (USGS quadrangle)		Transect Length	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 coverage of the total area in the quadrangle within the boundaries of the study area.

Appendix Table B1. 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, 19-23 June 1989.

Location (USGS quadrangle)		Quarter Quad	Breeding Adults	Nests			Non-breeding Adults					
				With Pairs	With Single Adult	Total Nests	Pairs	Singles	No. Flocks	Flocked Swans	Total Non-breeders	Total Swans
Beechey Point	A-4	*NE	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-
		*SW	0	0	0	0	2	0	0	0	4	4
		NW	9	4	1	5	4	3	0	0	11	20
		Total	9	4	1	5	6	3	0	0	15	24
	A-5	*NE	2	1	0	1	0	1	0	0	1	3
		*SE	0	0	0	0	0	0	0	0	0	0
		*SW	0	0	0	0	0	1	0	0	1	1
		*NW	0	0	0	0	0	0	0	0	0	0
		Total	2	1	0	1	0	2	0	0	2	4
	B-4	NE	1	0	1	1	2	4	0	0	8	9
		*SE	2	1	0	1	3	0	0	0	6	8
		SW	4	1	2	3	3	9	0	0	15	19
		NW	11	3	5	8	4	2	0	0	10	21
		Total	18	5	8	13	12	15	0	0	39	57
	B-5	NE	8	4	0	4	8	2	0	0	18	26
		SE	3	1	1	2	3	3	0	0	9	12
		SW	6	3	0	3	5	4	1	4	18	24
		NW	7	2	3	5	3	5	0	0	11	18
		Total	24	10	4	14	19	14	1	4	56	80

Appendix Table B1. Continued.

Location (USGS quadrangle)		Quarter Quad	Breeding Adults	Nests			Non-breeding Adults					
				With Pairs	With Single Adult	Total Nests	Pairs	Singles	No. Flocks	Flocked Swans	Total Non-breeders	Total Swans
Beechy Point	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
	C-5	NE	-	-	-	-	-	-	-	-	-	-
		SE	1	0	1	1	0	1	0	0	1	2
		SW	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-
		Total	1	0	1	1	0	1	0	0	1	2
Harrison Bay	A-1	NE	0	0	0	0	3	2	0	0	8	8
		*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	3	1	0	0	7	9
		Total	2	1	0	1	6	3	0	0	15	17
	A-2	*NE	2	0	2	2	2	4	0	0	8	10
		SE	0	0	0	0	5	5	0	0	15	15
		*SW	2	1	0	1	7	2	0	0	16	18
		*NW	0	0	0	0	0	0	0	0	0	0
		Total	4	1	2	3	14	11	0	0	39	43
	A-3	NE	-	-	-	-	-	-	-	-	-	-
		SE	2	1	0	1	2	3	0	0	7	9
		SW	0	0	0	0	1	1	0	0	3	3
		NW	-	-	-	-	-	-	-	-	-	-
		Total	2	1	0	1	3	4	0	0	10	12

Appendix Table B1. Continued.

Location (USGS quadrangle)		Quarter Quad	Breeding Adults	Nests			Non-breeding Adults					
				With Pairs	With Single Adult	Total Nests	Pairs	Singles	No. Flocks	Flocked Swans	Total Non-breeders	Total Swans
Harrison Bay	B-1	NE	0	0	0	0	0	3	1	3	6	6
		SE	7	3	1	4	5	4	1	3	17	24
		SW	2	0	2	2	9	2	0	0	20	22
		*NW	2	1	0	1	2	0	0	0	4	6
		Total	11	4	3	7	16	9	2	6	47	58
	B-2	NE	-	-	-	-	-	-	-	-	-	-
		*SE	3	1	1	2	5	1	0	0	11	14
		SW	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-
		Total	3	1	1	2	5	1	0	0	11	14
Umiat	C-1	NE	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-
		NW	0	0	0	0	0	0	0	0	0	0
		Total	0	0	0	0	0	0	0	0	0	0
	C-2	*NE	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-
		NW	13	3	7	10	4	9	0	0	17	30
		Total	13	3	7	10	4	9	0	0	17	30
	C-3	NE	2	0	2	2	5	6	0	0	16	18
		*SE	0	0	0	0	0	0	0	0	0	0
		SW	-	-	-	-	-	-	-	-	-	-
		*NW	0	0	0	0	0	0	0	0	0	0
		Total	2	0	2	2	5	6	0	0	16	18

Appendix Table B1. Continued.

Location (USGS quadrangle)		Quarter Quad	Breeding Adults	Nests			Non-breeding Adults					
				With Pairs	With Single Adult	Total Nests	Pairs	Singles	No. Flocks	Flocked Swans	Total Non-breeders	Total Swans
Umiat	D-1	NE	0	0	0	0	1	0	0	0	2	2
		SE	-	-	-	-	-	-	-	-	-	-
		SW	0	0	0	0	2	0	0	0	4	4
		NW	0	0	0	0	0	1	0	0	1	1
		Total	0	0	0	0	3	1	0	0	7	7
	D-2	NE	0	0	0	0	2	0	0	0	4	4
		SE	2	1	0	1	1	0	0	0	2	4
		SW	3	1	1	2	4	2	1	3	13	16
		NW	12	5	2	7	8	6	1	4	26	38
		Total	17	7	3	10	15	8	2	7	45	62
	D-3	NE	3	1	1	2	4	3	0	0	11	14
		SE	12	6	0	6	2	5	1	16	25	37
		*SW	0	0	0	0	0	0	0	0	0	0
		*NW	0	0	0	0	0	0	0	0	0	0
		Total	15	7	1	8	6	8	1	16	36	51
Grand Total			123	45	33	78	114	95	6	33	356	479

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

Appendix Table C1. Distances of new and proposed drill sites from Tundra Swan pairs, nests, and broods located during aerial surveys in June and August 1989.

Drill Site	June		August	
	Distance to Nearest Nest (km)	Distance to Nearest Pair (km)	Distance to Nearest Brood (km)	Distance Nearest Pair (km)
West SAK*	0.9	1.5	2.0	2.4
UGNU*	1.0	4.0	6.2	3.4
COL 1	3.6	3.6	3.6	3.4
COL 2	3.0	4.4	2.7	0.6
1 J	1.0	1.6	5.2	3.0
1 M	3.4	2.4	2.4	3.5
2 L	3.4	1.2	2.4	1.4
2 N	4.4	3.0	4.3	2.2
3 L	1.2	5.6	1.4	1.0
3 T	3.0	7.0	3.6	5.0
Mean	2.5	3.4	3.4	2.6
S.D.	±1.3	±1.9	±1.5	±1.3

* New drill sites as of 1989.

Appendix Table D1. Numbers of Tundra Swans and Tundra Swan broods recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-22 August 1989.

				Broods				Non-breeding Adults						
(USGS quadrangle		Quarter Quad	Breeding Adults	With Pair	With Single Adult	Total Broods	Young	Pairs	Singles	Flocks	Flocked Swans	Total Non-breeders	Total Adults	Total Swans
Beechey Point	A-4	*NE	0	0	0	0	0	2	0	0	0	4	4	4
		SE	-	-	-	-	-	-	-	-	-	-	-	-
		*SW	0	0	0	0	0	1	1	0	0	3	3	3
		NW	9	4	1	5	9	9	4	1	3	25	34	43
		Total	9	4	1	5	9	12	5	1	3	32	41	50
	A-5	NE	2	1	0	1	1	1	1	1	4	7	9	10
		SE	0	0	0	0	0	2	0	0	0	4	4	4
		SW	-	-	-	-	-	-	-	-	-	-	-	-
		NW	0	0	0	0	0	2	0	0	0	4	4	4
		Total	2	1	0	1	1	5	1	1	4	15	17	18
	B-4	NE	3	1	1	2	6	2	3	3	11	18	21	27
		SE	4	2	0	2	5	3	0	0	0	6	10	15
		SW	9	4	1	5	13	9	2	0	0	20	29	42
		NW	9	4	1	5	14	11	4	3	10	36	45	59
		Total	25	11	3	14	38	25	9	6	21	80	105	143
	B-5	NE	13	6	1	7	15	10	0	1	4	24	37	52
		SE	8	4	0	4	9	5	1	0	0	11	19	28
		SW	6	3	0	3	7	8	1	0	0	17	23	30
		NW	7	3	1	4	5	8	1	0	0	17	24	29
		Total	34	16	2	18	36	31	3	1	4	69	103	139
	C-4	NE	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
		SW	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
		Total	0	0	0	0	0	0	0	0	0	0	0	0

Appendix Table D1. Continued.

(USGS quadrangle		Quarter Quad	Breeding Adults	Broods: With Pair	Broods: With Single Adult	Broods: Total Broods	Broods: Young	Non-breeding Adults: Pairs	Non-breeding Adults: Singles	Non-breeding Adults: Flocks	Non-breeding Adults: Flocked Swans	Non-breeding Adults: Total Non-breeders	Total Adults	Total Swans
Beechey Point	C-5	NE	-	-	-	-	-	-	-	-	-	-	-	-
		SE	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
		NW	-	-	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	0	0	0	0	0	0	0
Harrison Bay	A-1	NE	2	1	0	1	2	3	1	1	3	10	12	14
		SE	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
		NW	0	0	0	0	0	3	0	1	3	9	9	9
		Total	2	1	0	1	2	6	1	2	6	19	21	23
	A-2	NE	0	0	0	0	0	8	0	1	3	19	19	19
		SE	2	1	0	1	2	5	2	1	3	16	17	20
		*SW	0	2	0	2	4	5	1	0	0	11	15	19
		*NW	4	0	0	0	0	0	0	0	0	0	0	0
		Total	6	3	0	3	6	18	3	2	6	45	51	57
	A-3	NE	-	-	-	-	-	-	-	-	-	-	-	-
		SE	4	2	0	2	4	0	1	2	7	8	12	16
		SW	0	0	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-	-
		Total	4	2	0	2	4	0	1	2	7	8	12	16
Harrison Bay	B-1	NE	2	1	0	1	3	2	0	1	3	7	9	12
		SE	6	3	0	3	10	11	3	1	3	28	34	44
		SW	2	1	0	1	3	11	3	3	15	40	42	45
		*NW	2	1	0	1	1	2	0	1	3	7	9	10
		Total	12	6	0	6	17	26	6	6	24	82	94	111

Appendix Table D1. Continued.

(USGS quadrangle		Quarter Quad	Breeding Adults	Broods: With Pair	Broods: With Single Adult	Broods: Total Broods	Broods: Young	Non-breeding Adults: Pairs	Non-breeding Adults: Singles	Non-breeding Adults: Flocks	Non-breeding Adults: Flocked Swans	Non-breeding Adults: Total Non-breeders	Total Adults	Total Swans
Harrison Bay	B-2	NE	-	-	-	-	-	-	-	-	-	-	-	-
		*SE	0	0	0	0	0	5	1	0	0	11	11	11
		SW	-	-	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	5	1	0	0	11	11	11
Umiat	C-1	NE	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
		Total	0	0	0	0	0	0	0	0	0	0	0	0
	C-2	NE	0	0	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-	-	-
		NW	10	5	0	5	10	6	0	1	4	16	26	36
		Total	10	5	0	5	10	6	0	1	4	16	26	36
	C-3	NE	4	2	0	2	4	7	5	2	6	25	29	33
		*SE	0	0	0	0	0	0	0	0	0	0	0	0
		SW	-	-	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-	-	-
		Total	4	2	0	2	4	7	5	2	6	25	29	33
	D-1	NE	-	-	-	-	-	1	0	0	0	2	2	2
		SE	-	-	-	-	-	-	-	-	-	-	-	-
		SW	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
		Total	0	0	0	0	0	1	0	0	0	2	2	2

Appendix Table D1. Continued.

(USGS quadrangle		Quarter Quad	Breeding Adults	Broods: With Pair	Broods: With Single Adult	Broods: Total Broods	Broods: Young	Non-breeding Adults: Pairs	Non-breeding Adults: Singles	Non-breeding Adults: Flocks	Non-breeding Adults: Flocked Swans	Non-breeding Adults: Total Non-breeders	Total Adults	Total Swans
Umiat	D-2	NE	0	0	0	0	0	4	0	0	0	8	8	8
		SE	2	1	0	1	1	2	0	0	0	4	6	7
		SW	2	1	0	1	2	10	0	2	13	33	35	37
		NW	4	2	0	2	4	15	7	2	6	43	47	51
		Total	8	4	0	4	7	31	7	4	19	88	96	103
	D-3	NE	0	0	0	0	0	6	3	2	8	23	23	23
		SE	6	3	0	3	8	11	4	1	5	31	37	45
		*SW	0	0	0	0	0	0	0	0	0	0	0	0
		*NW	0	0	0	0	0	1	0	0	0	2	2	2
		Total	6	3	0	3	8	18	7	3	13	56	62	70
Grand Total			122	58	6	64	142	191	49	31	117	548	670	812

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

Appendix E. The distribution of other birds observed during Tundra Swan surveys, 1989.

Distribution During June. Nests of geese were not observed during our aerial surveys in June. However, flocks of Greater White-fronted Geese (*Anser albifrons frontalis*) and other unidentified goose species totalling 2582 geese were counted, and their locations were mapped on USGS quadrangles (Appendix Table E-1). White-fronted geese accounted for 99% (2562) of these birds. The remaining 1% (20) were unidentified geese, which may have included Canada Geese (*Branta canadensis*), White-fronted Geese, and Brant.

Flocks of White-fronted Geese were dispersed throughout the study area, wherever large lakes and drained-lake basins occurred. The largest numbers of geese were found from Milne Point Road west to the Miluveach River (Beechey Point B-5 and Harrison Bay B-1 quadrangles), and in the Iktilik River area (Umiat D-2 quadrangle).

Observations of other birds, especially Glaucous Gulls at nests, Snowy Owls and their nests, Pacific Loons (*Gavia pacifica*), and Yellow-billed Loons (*Gavia adamsii*) were also recorded on USGS maps. Because the sightability of these species was different from that of swans (i.e., they are less easily recognized near the far edge of a 0.8 km wide transect), these results are not accurate estimates of distribution and abundance.

Appendix Table E-1. Numbers of selected avian and mammalian species and avian nests recorded (by quarter quads) during aerial surveys in the Kuparuk Oilfield and the Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-24 June 1989.

Location (USGS quadrangle)		Quarter Quad	White-fronted Goose	Brant	Unidentified Geese	Glaucous Gull Nests	Pacific Loon	Pacific Loon Nests	Yellow-billed Loon	Snowy Owl	Snowy Owl Nests	Black Scoters	Muskox
Beechy Point	A-4	*NE	7	0	0	2	0	0	0	1	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-
		*SW	48	0	0	0	0	0	0	0	0	0	0
		NW	37	0	0	2	1	0	0	4	1	0	0
		Total	92	0	0	4	1	0	0	5	1	0	0
	A-5	*NE	42	0	0	2	3	0	0	1	0	0	0
		*SE	16	0	0	1	0	0	0	0	0	0	0
		*SW	8	0	9	0	0	0	0	0	0	0	0
		*NW	11	0	0	1	0	0	0	0	0	0	0
		Total	77	0	9	4	3	0	0	1	0	0	0
	B-4	NE	66	20	0	0	1	1	0	5	0	0	0
		*SE	3	0	0	0	0	0	0	2	0	0	0
		SW	94	0	0	3	1	0	0	4	0	0	0
		NW	136	10	0	3	6	0	0	2	0	0	0
		Total	299	30	0	6	8	1	0	13	0	0	0
	B-5	NE	81	70	0	0	4	0	0	5	0	0	0
		SE	74	0	0	2	1	0	0	0	0	0	0
		SW	122	0	0	8	2	0	0	1	0	0	0
		NW	58	0	0	6	3	0	0	1	0	0	-
		Total	335	70	0	16	10	0	0	7	0	0	0
	C-5	NE	-	-	-	-	-	-	-	-	-	-	-
		SE	0	0	0	0	0	0	0	1	0	0	0
		SW	0	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	0	0	1	0	0	0

Appendix Table E-1. Continued.

Location (USGS quadrangle)		Quarter Quad	White-fronted Goose	Brant	Unidentified Geese	Glaucous Gull Nests	Pacific Loon	Pacific Loon Nests	Yellow-billed Loon	Snowy Owl	Snowy Owl Nests	Black Scoters	Muskox
Harrison Bay	A-1	NE	3	0	0	3	2	0	0	0	0	0	0
		*SE	0	0	0	0	0	0	0	0	0	0	0
		*SW	0	0	0	0	0	0	0	0	0	0	0
		NW	8	0	0	0	5	0	0	3	0	0	0
		Total	11	0	0	3	7	0	0	3	0	0	0
	A-2	*NE	27	0	4	7	4	0	0	0	0	150	0
		SE	60	0	0	4	4	0	0	0	0	0	0
		*SW	109	0	0	8	4	0	0	0	0	0	0
		*NW	3	0	0	0	0	0	0	0	0	0	0
		Total	199	0	4	19	12	0	0	0	0	150	0
	A-3	NE	-	-	-	-	-	-	-	-	-	-	-
		SE	96	0	0	3	1	0	0	0	0	0	0
		SW	14	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-
		Total	110	0	0	3	1	0	0	0	0	0	0
Harrison Bay	B-1	NE	65	40	0	1	1	0	0	1	0	0	0
		SE	149	0	0	1	1	0	0	1	0	0	0
		SW	115	12	0	1	1	0	0	4	0	0	0
		*NW	20	10	0	1	1	0	0	0	0	0	0
		Total	349	62	0	4	4	0	0	6	0	0	0
	B-2	NE	-	-	-	-	-	-	-	-	-	-	-
		*SE	69	8	0	2	0	0	0	1	0	0	0
		SW	-	-	-	-	-	-	-	-	-	-	-
		NW	-	-	-	-	-	-	-	-	-	-	-
		Total	69	8	0	2	0	0	0	1	0	0	0

Appendix Table E-1. Continued.

Location (USGS quadrangle)		Quarter Quad	White-fronted Goose	Brant	Uniden-tified Geese	Glaucous Gull Nests	Pacific Loon	Pacific Loon Nests	Yellow-billed Loon	Snowy Owl	Snowy Owl Nests	Black Scoters	Muskox
Umiat	C-1	NE	7	0	0	0	2	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-	-
		NW	8	0	0	0	0	0	0	0	0	0	0
		Total	15	-	0	0	2	0	0	0	0	0	0
	C-2	*NE	39	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-
		SW	-	-	-	-	-	-	-	-	-	-	-
		NW	176	0	0	4	0	0	0	0	0	0	0
		Total	215	0	0	4	0	0	0	0	0	0	0
	C-3	NE	69	-	-	8	7	-	-	-	-	-	-
		*SE	0	0	0	0	0	0	0	0	0	0	0
		SW	-	-	-	-	-	-	-	-	-	-	-
		*NW	0	0	0	0	0	0	0	0	0	0	0
		Total	69	0	0	8	7	0	0	0	0	0	0
	D-1	NE	0	0	1	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-
		SW	7	0	0	0	0	0	0	0	0	0	0
		NW	6	0	0	0	1	0	0	0	0	0	0
		Total	13	0	0	1	1	0	0	0	0	0	0
	D-2	NE	185	0	0	3	3	0	0	0	0	0	0
		SE	33	0	0	0	1	0	2	0	0	0	13
		*SW	108	0	7	3	3	0	2	0	0	0	0
		NW	153	0	0	6	3	0	3	0	0	0	0
		Total	479	0	7	12	10	0	5	0	0	0	13

Appendix E-1. Continued.

Location (USGS quadrangle)	Quarter Quad	White-fronted Goose	Brant	Unidentified Geese	Glaucous Gull Nests	Pacific Loon	Pacific Loon Nests	Yellow-billed Loon	Snowy Owl	Snowy Owl Nests	Black Scoters	Muskox
D-3	NE	119	2	0	8	10	0	1	0	0	0	0
	SE	106	0	0	7	2	0	0	0	0	0	0
	*SW	0	0	0	0	0	0	0	0	0	0	0
	*NW	2	0	0	1	1	0	0	0	0	0	0
	Total	227	2	0	16	13	0	1	0	0	0	0
Grand Total		2559	175	20	102	79	1	6	37	1	150	13

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

A total of 102 Glaucous Gull nests was recorded on surveys in June (Appendix Table E-1). Nests were widely dispersed across the Coastal Plain; most were located on large lakes with islands.

During aerial surveys in June, 37 Snowy Owls and one Snowy Owl nest were observed in the Kuparuk Oilfield section of the study area. The northeast portion of the study area from the Kuparuk River west to Kalubik Creek (Beechey Point B-4 and B-5 quadrangles) contained 54% of all Snowy Owls (Appendix Table E-1). The Snowy Owl nest was located near the Sakonowyak River (northwest quarter of the Beechey Point A-4 quadrangle). Snowy Owls appeared to be most common in wet, lowland areas in the northern one-third of the study area and near the Kuparuk River delta. No Snowy Owls were observed in the OGL 54 area.

Seventy-eight Pacific Loons and six Yellow-billed Loons were observed in the study area during aerial surveys in June (Appendix Table E-1). Pacific Loons were found throughout the study area wherever sizeable lakes occurred. Yellow-billed loons were found only in the Umiat D-2 and D-3 quadrangles of the OGL 54 section of the study area and were restricted to the largest lakes. Information on these and additional species is presented in Appendix Table E-1.

Distribution During August. A total of 6060 geese, excluding Brant, were counted on August aerial surveys (Appendix Table E-2). Of these, 6050 were White-fronted Geese and the remaining 10 were Canada Geese.

Appendix Table E-2. Numbers of selected species recorded (by quarter quad) during aerial surveys in the Kuparuk Oilfield and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 19-22 August 1989.

Location (USGS quadrangle)	Quarter Quad	White-fronted Goose	Brant	Canada Goose	Pacific Loon	Pacific Loon Young	Yellow-billed Loon	Red-throated Loon	Unidentified Loon	Snowy Owl	Short-eared Owl	Sandhill Crane Adults	Sandhill Crane Young
Beechy Point													
A-4	*NE	110	0	10	0	0	0	0	0	0	0	0	0
	SE	-	-	-	-	0	-	-	-	-	-	-	-
	*SW	260	0	0	5	0	0	0	0	0	0	0	0
	NW	616	0	0	22	2	0	0	2	4	0	0	0
	Total	986	0	10	27	2	0	0	2	4	0	0	0
A-5	NE	181	0	0	7	1	0	0	4	2	0	0	0
	SE	48	0	0	2	0	0	0	0	0	0	0	0
	SW	273	0	0	1	0	0	0	3	3	0	0	0
	NW	3	0	0	5	0	0	0	0	1	0	0	0
	Total	505	0	0	15	1	0	0	7	6	0	0	0
B-4	*NE	47	10	0	3	0	0	0	5	0	0	0	0
	*SE	105	0	0	6	0	0	0	2	1	0	0	0
	SW	278	0	0	38	4	0	0	0	1	0	0	0
	NW	350	0	0	7	0	0	0	0	1	0	0	0
	Total	780	10	0	54	4	0	0	7	3	0	0	0
B-5	NE	185	0	0	24	2	0	0	0	0	0	0	0
	SE	395	0	0	12	0	0	0	1	5	0	0	0
	SW	158	6	0	16	0	0	0	3	5	0	0	0
	NW	77	0	0	42	1	0	0	1	2	0	0	0
	Total	815	6	0	94	3	0	0	5	12	0	0	0

Appendix E-2. Continued.

Location (USGS quadrangle)	Quarter Quad	White-fronted Goose	Brant	Canada Goose	Pacific Loon	Pacific Loon Young	Yellow-billed Loon	Red-throated Loon	Unidentified Loon	Snowy Owl	Short-eared Owl	Sandhill Crane Adults	Sandhill Crane Young
C-4	NE	-	-	-	-	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-	-	-	-	-
	*SW	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
C-5	*NE	0	0	0	0	0	0	0	0	0	0	0	0
	*SE	75	0	0	2	1	0	0	0	0	0	0	0
	SW	-	-	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-	-	-
	Total	75	0	0	2	1	0	0	0	0	0	0	0
Harrison Bay													
A-1	NE	90	0	0	13	0	0	0	1	3	0	0	0
	SE	24	0	0	1	0	0	0	0	0	0	0	0
	SW	30	0	0	4	0	0	0	0	0	0	0	0
	NW	77	0	0	6	0	0	0	2	1	0	0	0
	Total	221	0	0	24	0	0	0	3	4	0	0	0
A-2	*NE	10	0	0	18	2	2	0	4	0	0	0	0
	SE	54	0	0	12	1	0	0	1	0	0	0	0
	*SW	157	0	0	0	0	0	2	3	1	0	0	0
	*NW	0	0	0	0	0	0	0	0	0	0	0	0
	Total	221	0	0	30	3	2	2	8	1	0	0	0

Appendix E-2. Continued.

Location (USGS quadrangle)	Quarter Quad	White-fronted Goose	Brant	Canada Goose	Pacific Loon	Pacific Loon Young	Yellow-billed Loon	Red-throated Loon	Unidentified Loon	Snowy Owl	Short-eared Owl	Sandhill Crane Adults	Sandhill Crane Young
	A-3 NE	-	-	-	-	-	-	-	-	-	-	-	-
	*SE	0	0	0	2	0	3	0	0	1	0	0	0
	*SW	0	0	0	2	0	0	0	0	0	0	0	0
	NW	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0	0	0	4	0	3	0	0	1	0	0	0
	B-1 NE	64	100	0	2	0	0	0	0	3	0	0	0
	SE	1028	0	0	27	3	0	2	1	1	0	0	0
	SW	25	0	0	13	0	2	0	0	7	0	0	0
	*NW	0	0	0	2	0	0	0	0	0	0	0	0
	Total	1117	100	0	44	3	2	2	1	11	0	0	0
	B-2 NE	-	-	-	-	-	-	-	-	-	-	-	-
	SE	52	0	0	6	0	0	0	1	0	0	0	0
	SW	-	-	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-	-	-
	Total	52	0	0	6	0	0	0	1	0	0	0	0
Umiat													
	C-1 NE	258	0	0	6	0	0	0	0	0	0	0	0
	SE	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-
	NW	0	0	0	0	0	0	0	0	0	0	0	0
	Total	258	0	0	6	0	0	0	0	0	0	0	0

Appendix E-2. Continued.

Location (USGS quadrangle)	Quarter Quad	White-fronted Goose	Brant	Canada Goose	Pacific Loon	Pacific Loon Young	Yellow-billed Loon	Red-throated Loon	Unidentified Loon	Snowy Owl	Short-eared Owl	Sandhill Crane Adults	Sandhill Crane Young
C-2	*NE	40	0	0	3	0	0	0	2	0	0	0	0
	SE	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-
	NW	330	-	-	4	0	0	0	0	0	0	0	0
	Total	370	0	0	7	0	0	0	2	0	0	0	0
C-3	NE	60	0	0	4	0	3	0	0	0	0	2	0
	SE	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
	Total	60	0	0	4	0	3	0	0	0	0	2	0
D-1	NE	90	0	0	4	0	0	0	0	0	0	0	0
	SE	-	-	-	-	-	-	-	-	-	-	-	-
	SW	60	0	0	1	0	0	0	0	0	0	0	0
	NW	0	0	0	1	0	0	0	0	0	0	0	0
	Total	60	0	0	6	0	0	0	0	0	0	0	0
D-2	*NE	10	0	0	2	0	0	0	0	0	1	0	0
	*SE	20	0	0	0	0	0	0	0	0	0	0	0
	SW	45	0	0	3	0	0	0	2	0	0	0	0
	NW	100	0	0	4	0	0	0	0	1	0	0	0
	Total	175	0	0	9	0	0	0	2	1	1	0	0
D-3	NE	35	0	0	12	0	0	0	0	0	0	1	1
	SE	70	0	0	6	0	0	0	0	1	0	0	0
	SW	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
	Total	105	0	0	18	0	0	0	0	1	0	1	1
Grand Total		6060	116	10	353	17	10	4	38	44	1	3	1

Flocks of White-fronted Geese were found throughout the study area. However, large flocks (>50 birds) were located primarily on large inland lakes, at least 16 km from the coast. White-fronted Geese were most numerous in the Kuparuk Oilfield section of the study area with 75% (4551) of those observed occurring there (Appendix Table E-2). The Kalubik Creek and Miluveach River area (Harrison Bay B-1 quadrangle) held the greatest number of White-fronted Geese, containing 18.5% (1117) of the entire population. Ten Canada Geese were located at the extreme eastern end of the study area in the Kuparuk River approximately 24 km from the coast.

No assessment of Glaucous Gull or Snowy Owl nesting success or productivity was possible from our aerial surveys. Snowy Owls, however, were still present in small numbers on August surveys; 44 Snowy Owls and one Short-eared Owl (*Asio flammeus*) were observed (Appendix Table E-2). Highest concentrations of Snowy Owls during August surveys were found near the mouth of the Colville River (Harrison Bay B-1 quadrangle) and in the southern Kuparuk oilfield (southern half of Beechey Point B-5 quadrangle).

Three hundred fifty-three adult and 17 young Pacific Loons were observed during August surveys (Appendix Table E-2). Eighty-two percent (14) of the young loons were located in the Kuparuk Oilfield section of the study area. Ten Yellow-billed Loons, four Red-throated Loons (*Gavia stellata*), and 38 unidentified loons were recorded in the study area in August (Appendix Table E-2). Young were not detected in association with these birds.

Three adult Sandhill Cranes (*Grus grus*) and one young were recorded in the OGL 54 section of the study area during surveys in August (Appendix Table E-2).

APPENDIX F

Map locations of Brant nests and brood-rearing/staging groups between Brownlow Pt. and Miluveach River, Alaska, as determined from aerial surveys in June and July, 1989.

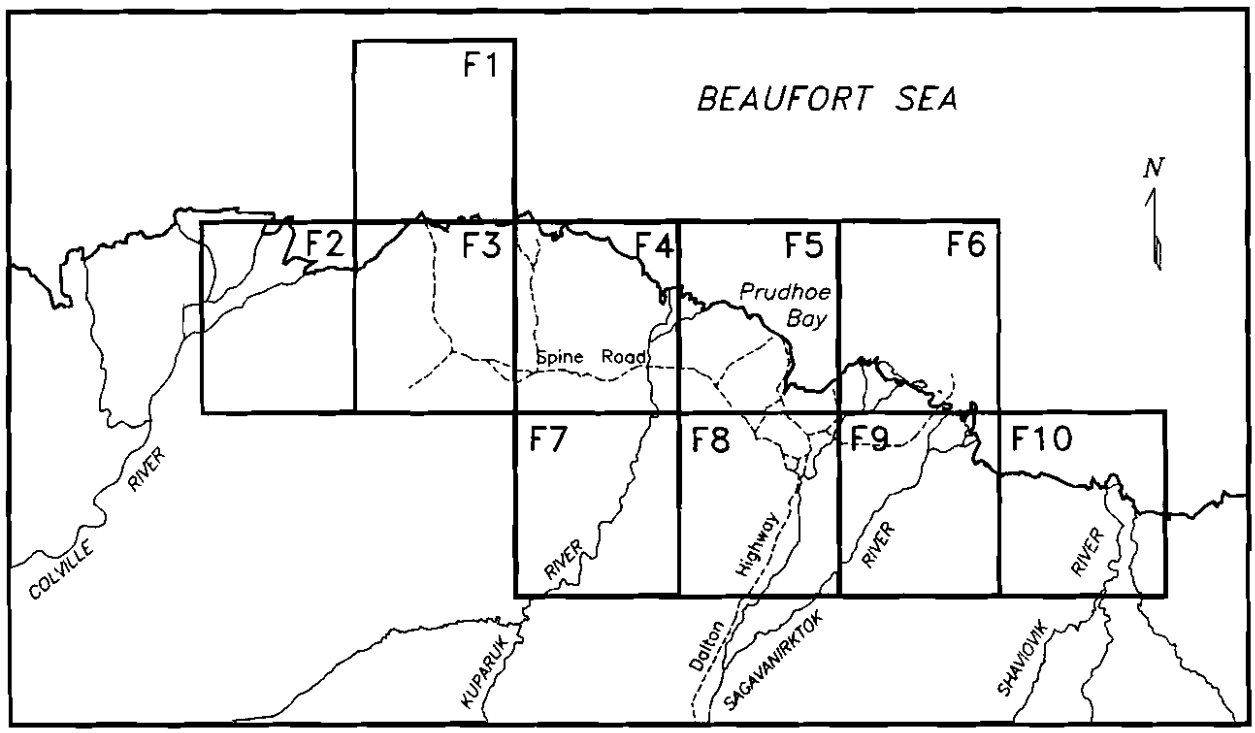
KEY

BROOD-REARING/STAGING AREAS

# / #	number of adults / number of goslings	24-26 July 1989 aerial survey
# / #	number of adults / number of goslings	29 July 1989 aerial survey

NEST LOCATIONS

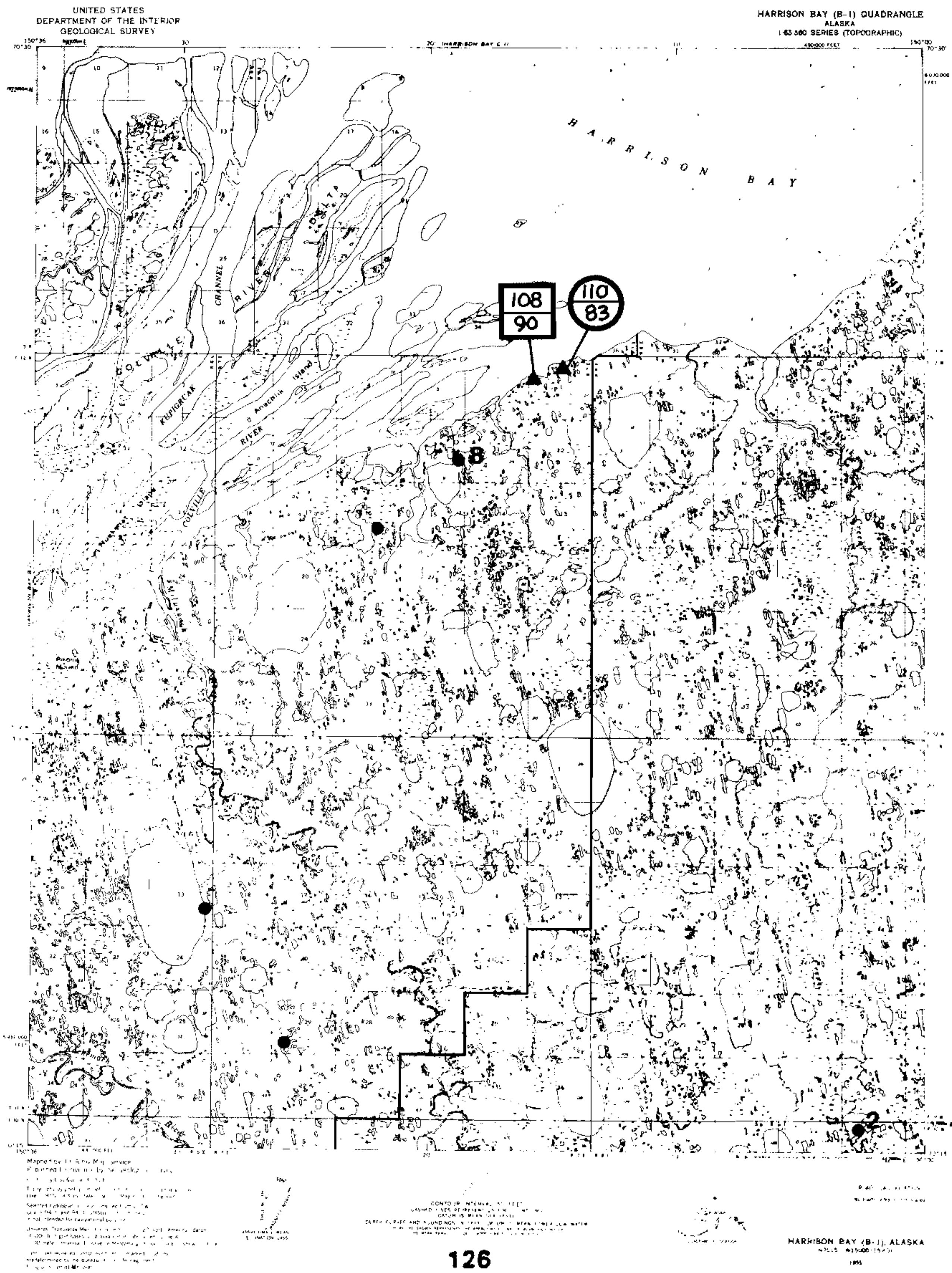
- ● = Single nest
- ●# = Location with >1 nest (e.g., ● 4 = 4 nests)



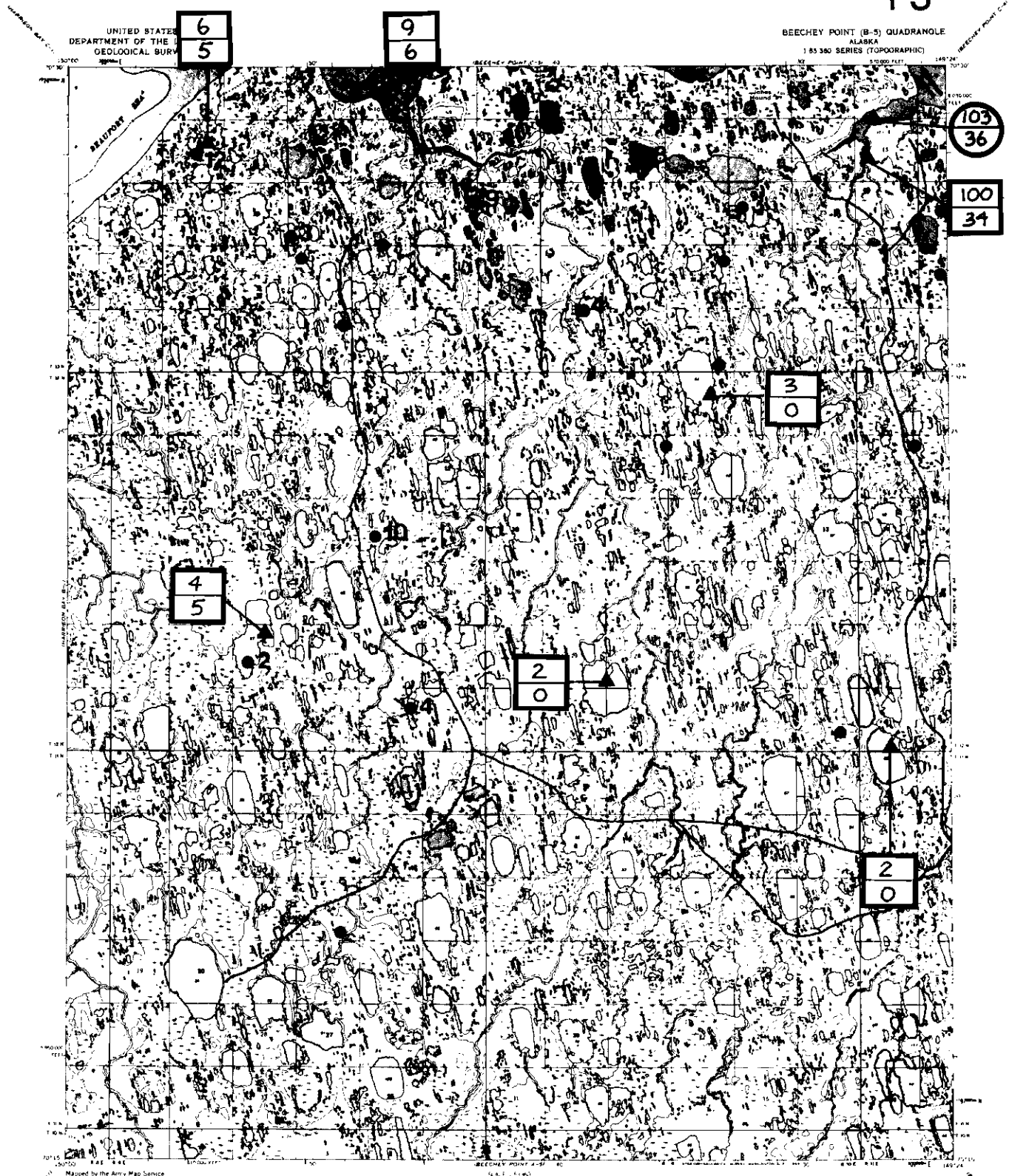
UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

BEECHEY POINT (C-5) QUADRANGLE
ALASKA-NORTH SLOPE BOROUGH
PHOTOREVISED FROM 1955 AERIAL PHOTOGRAPHS

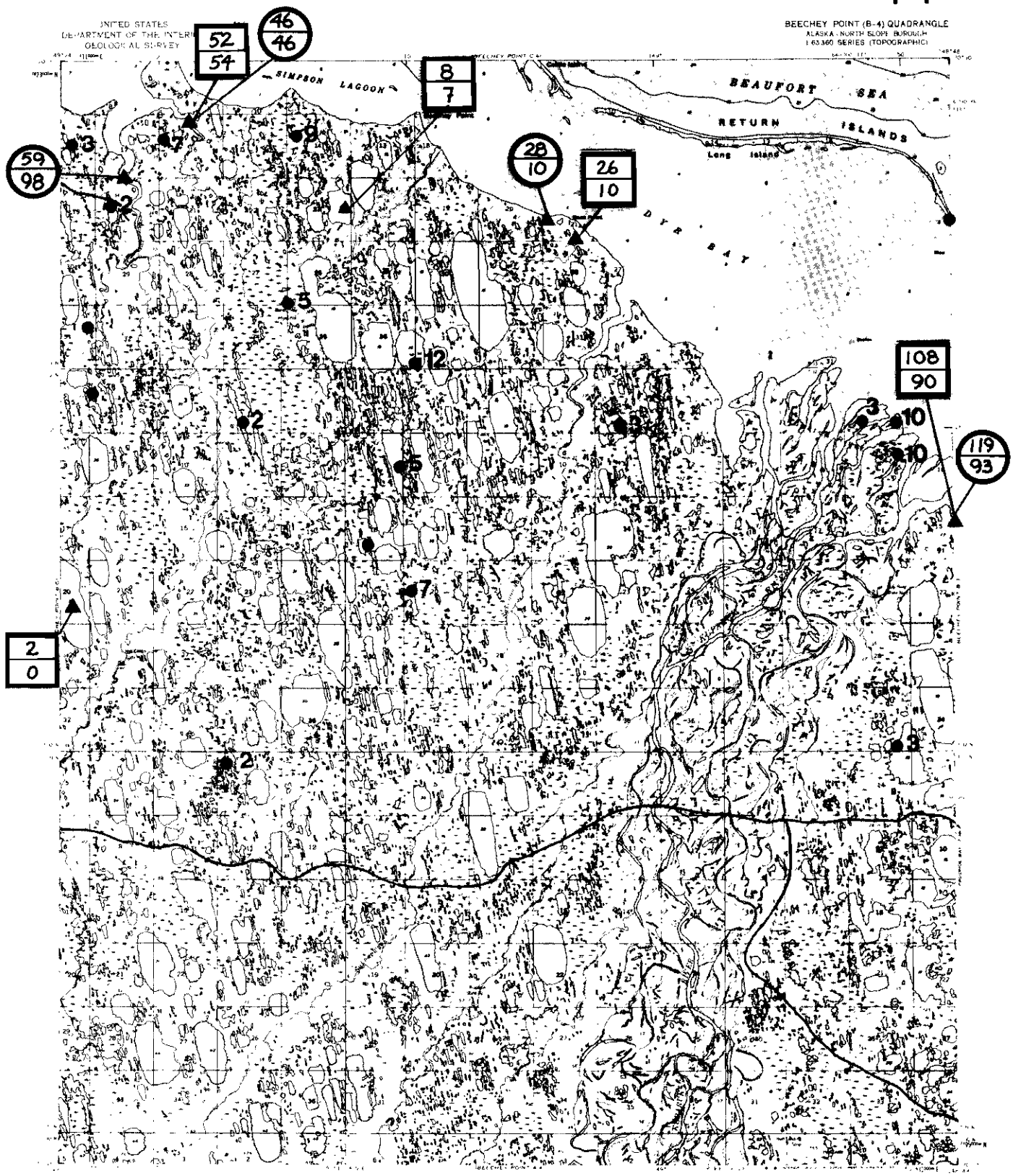
BEECHEY POINT (C-5), ALASKA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
HARRISON BAY (B-1) QUADRANGLE
ALASKA
1:63 360 SERIES (TOPOGRAPHIC)
HARRISON BAY
COLVILLE
CHANNEL
RIVER
108
90
110
83
8
2
HARRISON BAY (B-1), ALASKA

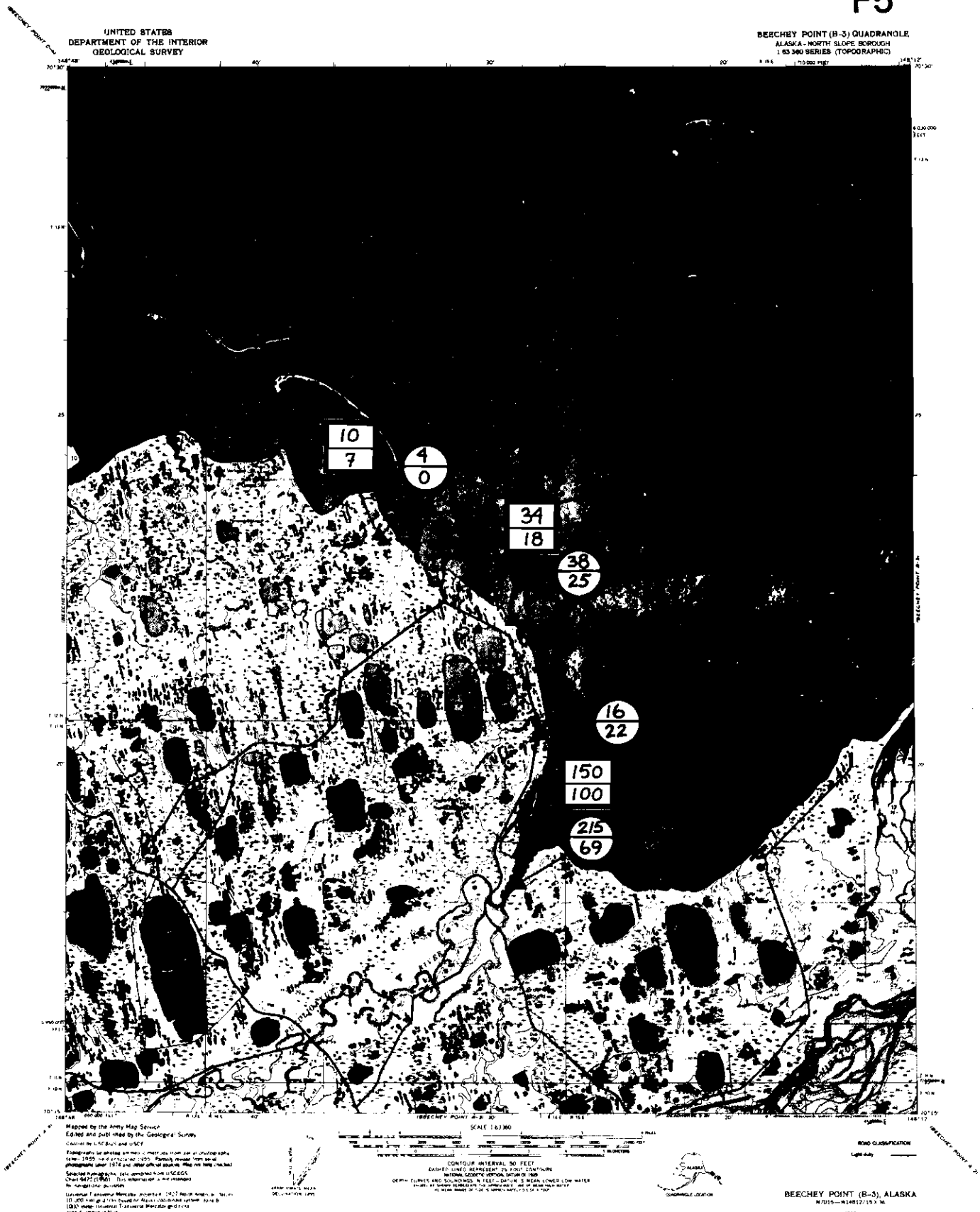
F3


UNITED STATES
DEPARTMENT OF THE I
GEOLOGICAL SURV
BEECHEY POINT (B-5) QUADRANGLE
ALASKA
1 63 360 SERIES (TOPOGRAPHIC)
6
5
9
6
103
36
100
34
3
0
4
5
2
0
2
0
Mapped by the Army Map Service
Edited and published by the Geological Survey
Control by USC&GS and USGS
CONTOUR INTERVAL 50 FEET
DATUM IS MEAN SEA LEVEL
ROAD CLASSIFICATION
BEECHEY POINT (B-5), ALASKA

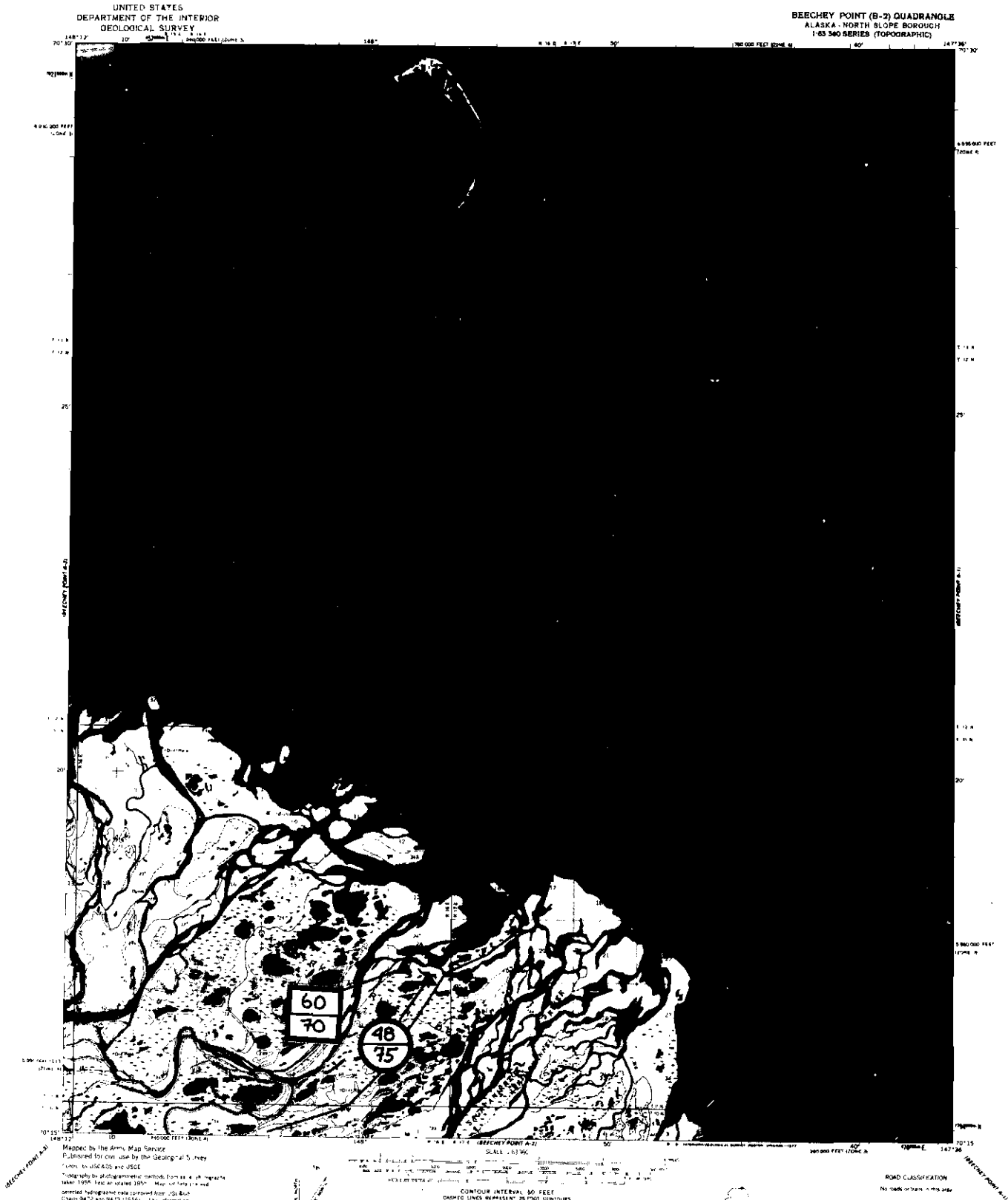
F4

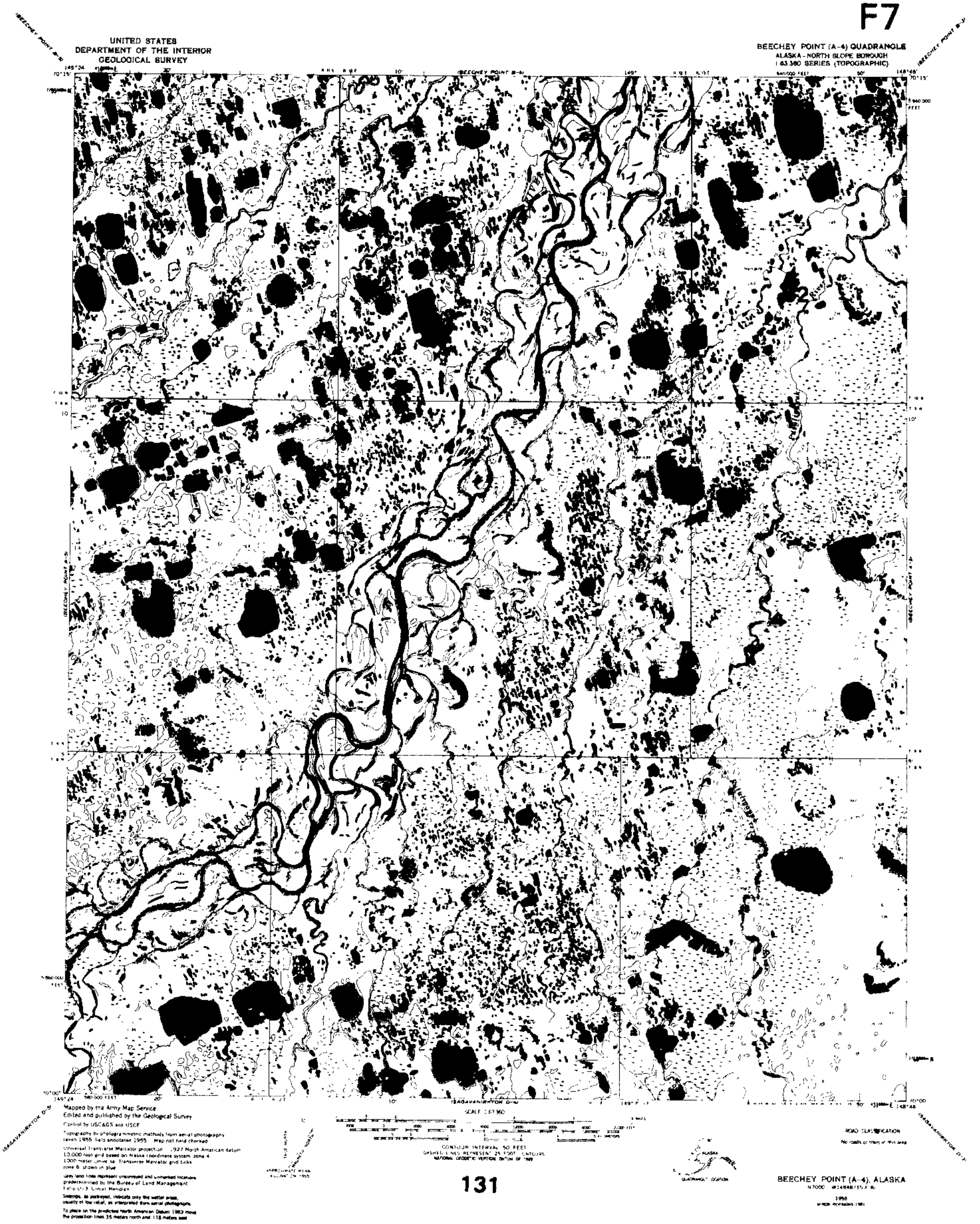

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (B-4) QUADRANGLE
ALASKA-NORTH SLOPE BOROUGH
1:63,360 SERIES (TOPOGRAPHIC)
SIMPSON LAGOON
BEAUFORT SEA
RETURN ISLANDS
Long Island
DYER BAY
52/54
46/46
8/7
59/98
28/10
26/10
108/90
119/93
2/0

F5


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (B-3) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)
10
7
4
0
34
18
38
25
16
22
150
100
215
69
SCALE 1:63 360
CONTOUR INTERVAL 50 FEET
BEECHEY POINT (B-3), ALASKA

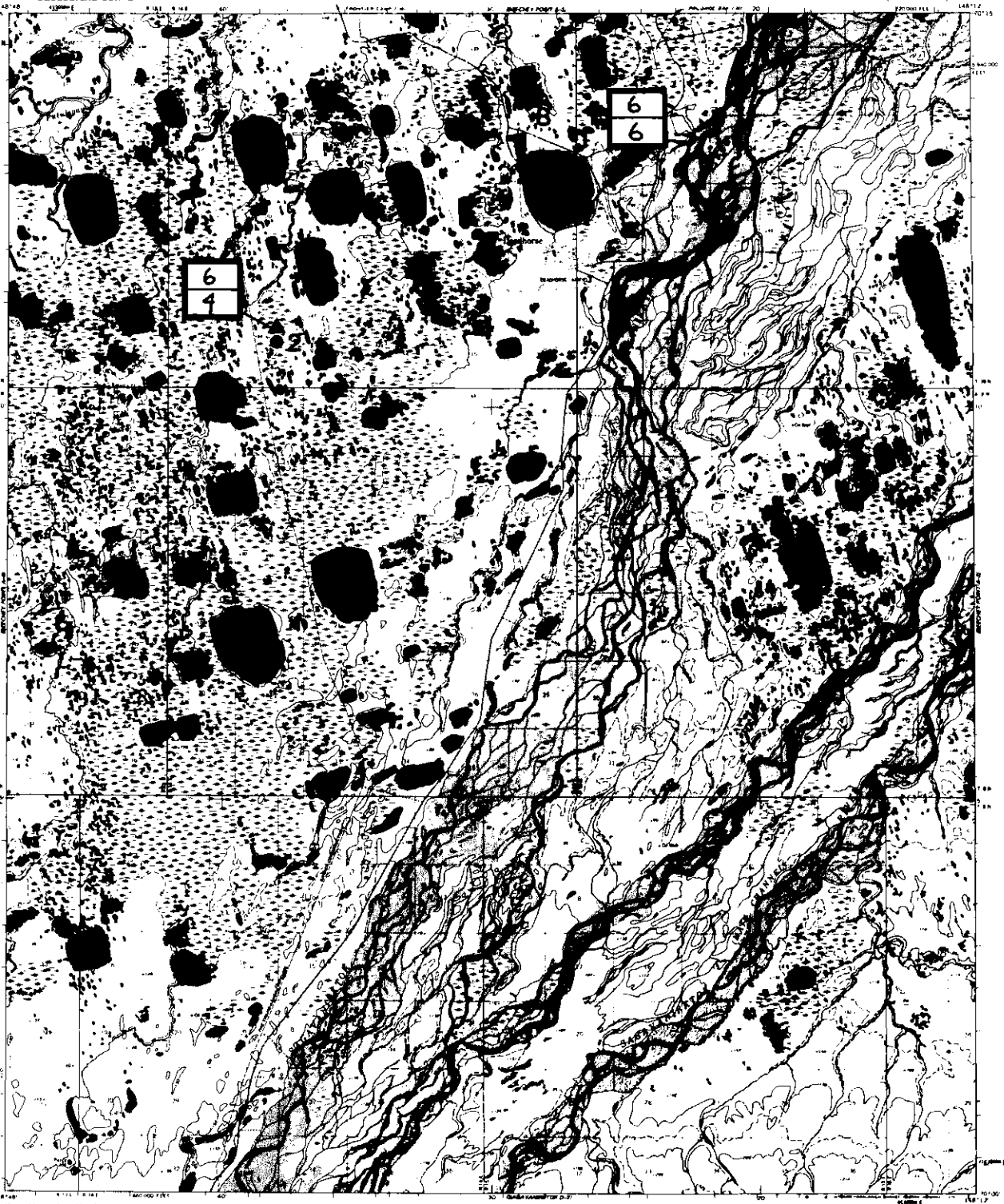
F6


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (B-2) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)
60
70
48
75
Mapped by the Army Map Service
Published for civil use by the Geological Survey
SCALE 1:63 360
CONTOUR INTERVAL 50 FEET
ROAD CLASSIFICATION
BEECHEY POINT (B-2), ALASKA


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (A-4) QUADRANGLE
ALASKA - NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)
Mapped by the Army Map Service
Edited and published by the Geological Survey
SCALE 1:63 360
CONTOUR INTERVAL 50 FEET
ROAD CLASSIFICATION
QUADRANGLE LOCATION
BEECHEY POINT (A-4), ALASKA

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 5, shown in blue

Grey land lines represent unsurveyed and unmarked locations predetermined by Bureau of Land Management
Fairbanks Meridian

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

SCALE 1:63 360

CONTOUR INTERVAL 50 FEET
DASHED LINES REPRESENT SUPPLEMENTARY CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

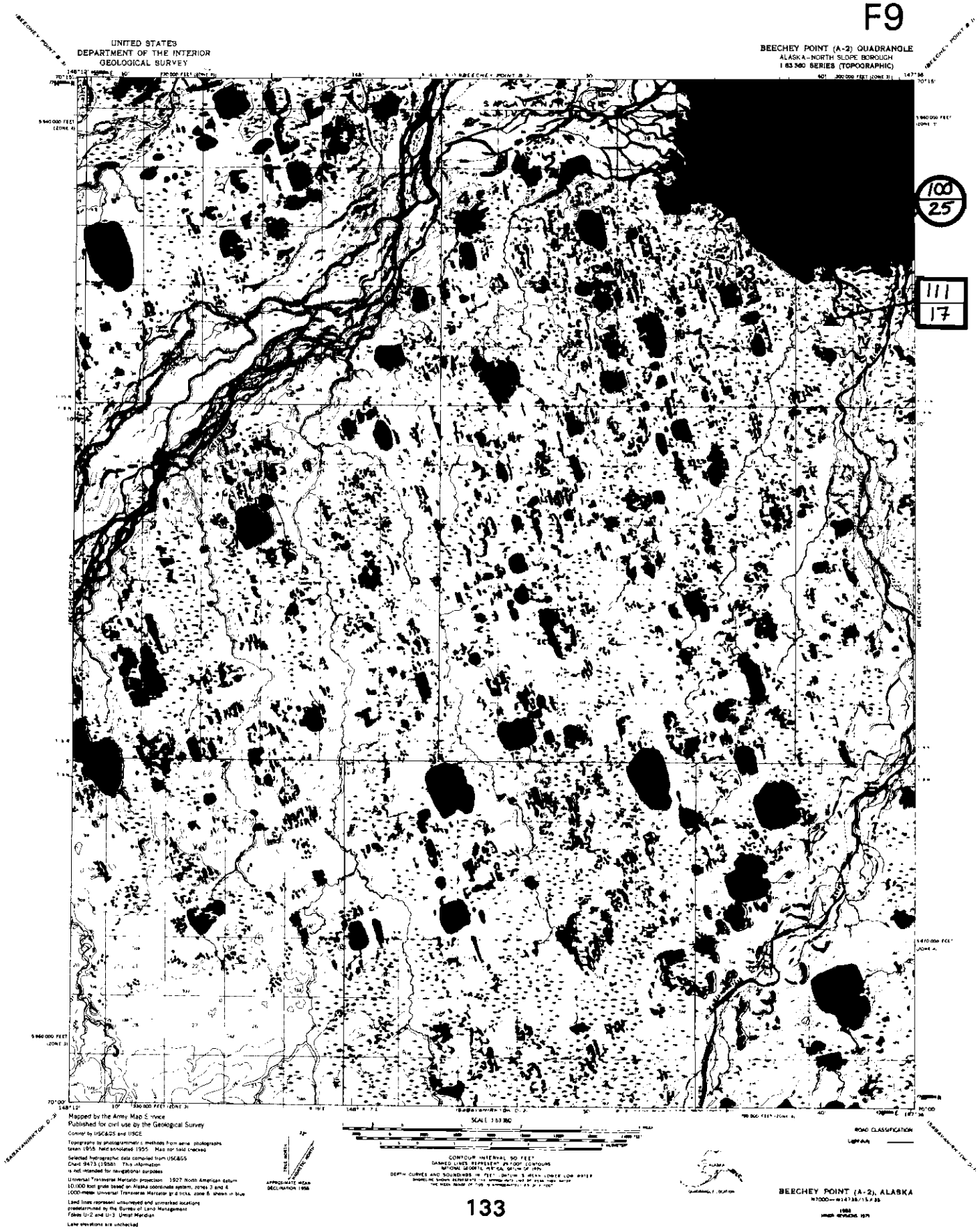
APPROXIMATE MEAN DECLINATION, 1975

ROAD CLASSIFICATION

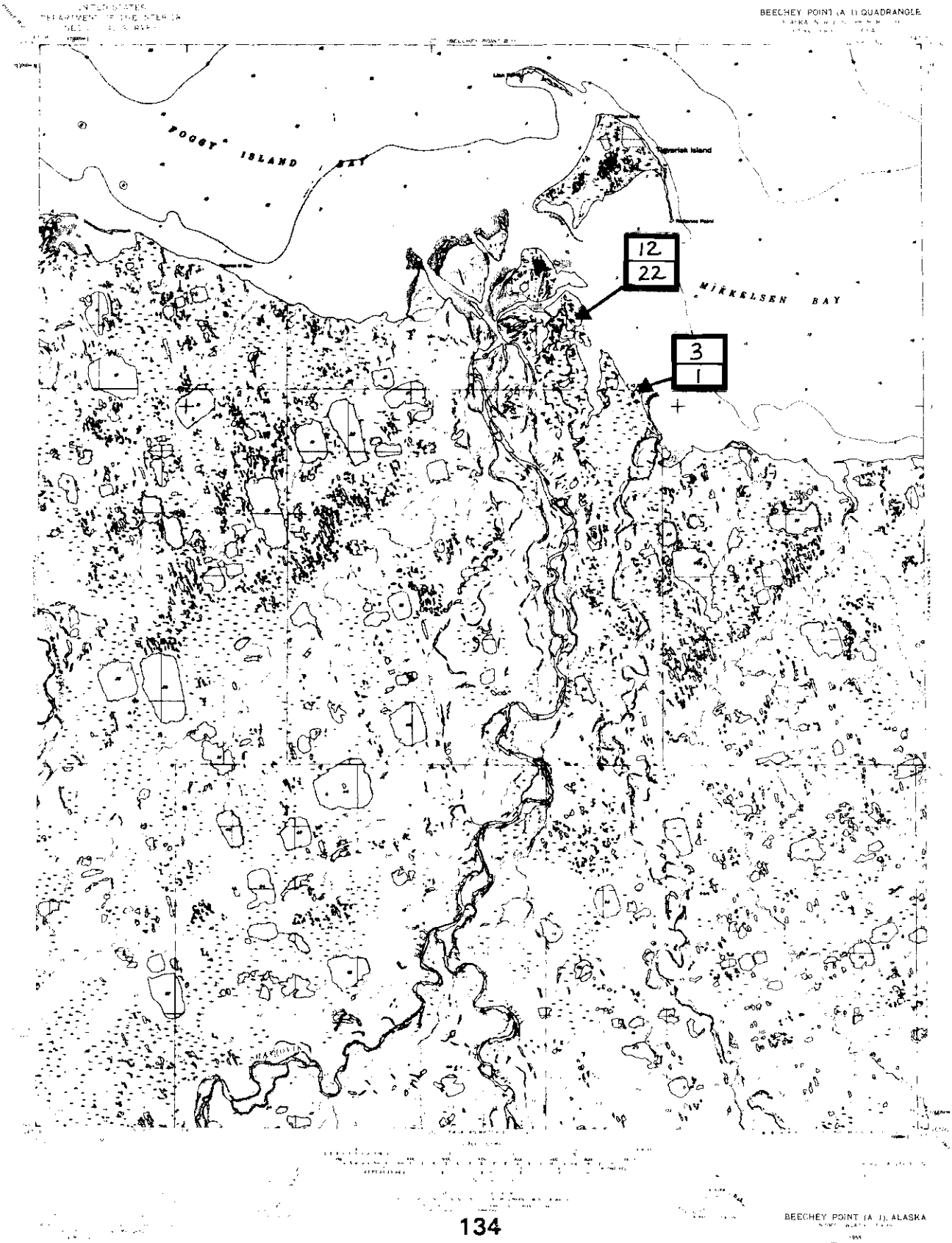
Light duty ——— Unimproved dirt .....

BEECHEY POINT (A-3), ALASKA

1956
photorevised 1975


UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
BEECHEY POINT (A-2) QUADRANGLE
ALASKA-NORTH SLOPE BOROUGH
1:63 360 SERIES (TOPOGRAPHIC)
100
25
111
17
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 1955. Map not field checked.
Selected hydrographic data compiled from USC&GS Chart 9473 (1958). 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, zones 3 and 4
1000-meter Universal Transverse Mercator grid ticks, zone 6, shown in blue
Land lines represent unsurveyed and unmarked locations predetermined by the Bureau of Land Management
Fokos U-2 and U-3, Umiat Meridian
Lake elevations are unchecked
SCALE 1:63 360
CONTOUR INTERVAL 50 FEET
DASHED LINES REPRESENT 25-FOOT CONTOURS
DEPTH CURVES AND SOUNDINGS IN FEET
APPROXIMATE MEAN DECLINATION 1958
ROAD CLASSIFICATION
BEECHEY POINT (A-2), ALASKA

F10


BEECHEY POINT (A 1) QUADRANGLE
FOGGY ISLAND BAY
MIKKELSEN BAY
12
22
3
1
BEECHEY POINT (A 1), ALASKA

Appendix G. The distribution of other birds during regional Brant surveys.

Nesting Surveys

Seventy-nine Canada Goose nests were observed; nests were relatively abundant east of the Kuparuk River, but were rare to the west. None was located west of Kalubik Creek and only 3 were recorded in the Kuparuk Oilfield and 2 on the Sagavanirktok River delta (on gravel islands east of Point Brower). The majority of Canada Goose nests (39) were dispersed throughout the Prudhoe Bay area and between the Sagavanirktok River and Bullen Point. No nests were located on Tigvariak Island, the Niakuk Islands, or barrier islands west of Prudhoe Bay. Flaxman Island was not searched.

Solitary Glaucous Gull nests were distributed across the coastal plain in the study area, often in close association with nesting Brant or Canada Geese. Counts of nests on the Coastal Plain probably do not accurately depict their numbers. However, accurate counts of gull colonies on the barrier islands between Spy Island and Tigvariak Island were possible. Excluding Duck Island, where aerial surveys were not undertaken, 150 Glaucous Gull nests were located on eight island groups (Appendix Table G-1). Nests were concentrated in three general areas: the Niakuk Islands (59), the Return Islands (44) (Stump Island to east end of Long Island), and spits east and west of Point Brower (43). Small Glaucous Gull colonies (4-7 nests) also were found inland in the Kuparuk and Prudhoe Bay Oilfields.

Other noteworthy observations include Sabine's Gull (*Xema sabini*) colonies at six locations and a Yellow-billed Loon nest on an island in a large lake (70°19′ N, 150°33′ W) 6.4 km south of the mouth of the Miluveach River.

Appendix Table G-1. Glaucous Gull nests located on barrier islands (Spy Island to Kadleroshilik River delta, Alaska) during aerial surveys, 24-26 June 1989.

Location	Gull Nests
Tigvariak Island	1
Kadleroshilik River delta	3
Spits west of Pt. Brower	26
Spits east of Pt. Brower	17
Niakuk Islands[1]	59
Stump Island	10
Egg Island	19
Long Island (east end)	15
Jones Islands	0
TOTAL	150

[1] Survey count from flight on 6 July.

Brood-rearing surveys

During the aerial surveys of brood-rearing Brant, information was collected on the distribution and relative abundance of Greater White-fronted Geese, Canada Geese, Snow Geese, and Tundra Swans. Densities of these species (birds/km of coastline) are presented in Figure 12; numbers of adults and young of each species are summarized in Appendix Table G-2.

After Brant, White-fronted Geese were the most abundant goose species in the coastal areas surveyed and were also abundant inland. However, they were observed only infrequently east of Prudhoe Bay. Canada Geese were also abundant, but in contrast to White-fronted Geese, they were most numerous east of Prudhoe Bay. Canada Goose broods were common east of the Kuparuk River. With the exception of four adults and four goslings (two broods) west of Kalubik Creek, Snow Geese were observed along the coast only on the Sagavanirktok and Kadleroshilik river deltas and at the mouth of the Putuligayuk River. Additionally, four adults (one collared) were observed inland with a flock of White-fronted Geese. Finally, Tundra Swans were common adjacent to the coast only on the Sagavanirktok River delta. They also were present east of the Sagavanirktok River delta and west of Kalubik Creek.

Appendix Table G-2. Numbers of geese (excluding Brant) and Tundra Swans observed within 0.8 km of the Arctic Coast, between Brownlow Point and the Miluveach River, Alaska, 24-29 July, 1989. Sections are as delineated in Figure 1.

Coastal Section	Canada Goose		White-fronted Goose		Snow Goose		Tundra Swans	
	Ad.	(Gos.)	Ad.	(Gos.)	Ad.	(Gos.)	Ad.	(Gos.)
1: Brownlow Pt. to Sagavanirktok R. delta	1077	(61)	84	(6)	99	(94)	38	(17)
2: Sagavanirktok River delta	95	(0)	0	(0)	138	(27)	29	(14)
3: Heald Point to Kuparuk R.	26	(16)	0	(0)	1	(0)	2	(0)
4: Kuparuk R. to Kalubik Ck.	3	(3)	661	(125)	0	(0)	11	(7)
5: Kalubik Ck. to Miluveach R.	0	(0)	723	(260)	3	(4)	14	(3)
TOTAL	1201	(80)	1468	(391)	241	(125)	94	(41)