

**TUNDRA SWAN AND BRANT SURVEYS
ON THE ARCTIC COASTAL PLAIN,
COLVILLE RIVER TO STAINES RIVER, 1991**

Final Report

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In the Prudhoe Bay study area, 115 Tundra Swans and 20 nests were observed between 20 and 26 June 1991. Densities of swans and nests in this area were similar to those in the Kuparuk/OGL 54 study area.

Between 17 and 21 August 1991, 126 adult swans and 53 cygnets were recorded in the Prudhoe Bay study area. The increase in broods from the number of nests recorded in this area suggested that immigration had occurred and/or some nests were missed. Mean brood size was 2.2 cygnets, lower than that recorded in 1990 and lower than the mean brood size in the Kuparuk/OGL 54 in both years. Densities in August in Prudhoe Bay for adult swans, broods, and young were similar to those in the Kuparuk/OGL 54 study area.

The increase in numbers of Tundra Swans in 1991 in all areas probably resulted from previous years of high productivity. The slight decrease in the number of young produced in 1991 may have been influenced by cool weather in early June and a snowstorm on 10 June. Densities in both study areas in 1991 were lower than those that have been reported elsewhere in northern Alaska, such as the Colville River delta and ANWR.

To evaluate the effectiveness and accuracy of our aerial surveys, random sampling plots were selected within the Kuparuk/OGL 54 study area for intensive surveys in June. Eleven nests were located in the 19 plots during the intensive surveys, whereas 8 nests were located there during the regular surveys; hence some nests are missed during regular surveying. For studies requiring extremely accurate site-specific nesting information, the more intensive method would be preferable.

BRANT SURVEYS

In the region between the Colville and Staines rivers, at least 319 Brant nests in 47 nesting locations were counted during aerial and ground surveys. Nesting data for colonies on the Sagavanirktok River delta, in the Lisburne Development Area (LDA), and at selected sites in the Kuparuk oil field were collected by ground surveys. Aerial surveys in June 1991 collected data on Brant nesting elsewhere in the region. Data on brood-rearing Brant throughout the region were collected solely by aerial surveys in late July and early August 1991.

During June aerial surveys, 112 Brant nests were located in the region; only 8 sites had greater than 5 nests, and no new large colonies were found during these surveys. Ground crews located 252 nests at 16 sites, with 206 of the nests not having been recorded previously by aerial surveys. These sites included colonies that were not covered by the aerial surveys (such as Duck Island and Surfcote) and colonies that had failed by the time of the aerial survey (e.g., the Kuparuk River delta). As in previous years, most Brant nests

EXECUTIVE SUMMARY

Tundra Swans and Brant traditionally have been important in planning oil field development in northern Alaska. Because information about the distribution and productivity of these species is limited, ABR, under contract to ARCO Alaska, Inc. and BP Exploration (Alaska) Inc., undertook aerial waterfowl surveys in the region between the Colville and Staines rivers and ground surveys in 3 general locations between the Sagavanirktok River delta and the Kuparuk oil field.

The goals of the Tundra Swan study were to locate Tundra Swans by aerial surveys in the Kuparuk oil field, the Oil and Gas Lease Sale 54 (OGL 54), and Prudhoe Bay, and to count pairs, flocks, nests, and broods. The major goals of the cooperative Brant studies were to collect information on the abundance, distribution, and productivity of Brant on the Coastal Plain between the Colville and Staines rivers. Aerial surveys were used to locate Brant nesting colonies and brood-rearing areas throughout the region. Ground surveys on the Sagavanirktok River delta, the Lisburne Development Area (LDA), and the Kuparuk oil field were used to determine the numbers of Brant nests and their fates at selected locations.

In 1991, a cooperative effort was initiated to capture and mark Brant within the oil fields with colored legbands. The marking of Brant is intended to supply additional information about Brant migration and movement of Brant between nesting areas within and outside of the oil fields.

TUNDRA SWAN SURVEYS

In the Kuparuk/OGL 54 study area, 625 Tundra Swans and 126 nests were observed between 20 and 26 June 1991. In general, swans were distributed uniformly wherever large lakes and drained-lake basins occurred. Densities of Tundra Swans and nests were estimated at 0.16 swans/km² and 0.03 nests/km², respectively. Numbers of swans and nests in the study area in 1991 were the highest of 4 years of surveys.

Between 17 and 21 August 1991, 818 adult Tundra Swans and 283 cygnets in 106 broods were recorded in the Kuparuk/OGL 54 study area. Nesting success was 84%, and mean brood size was 2.7 cygnets, similar to that observed in 1990 (85% success and 2.8 cygnets, respectively). Densities during August were 0.22 adults/km² and 0.03 broods/km², similar to estimates from in previous years.

were located in wet tundra vegetation within 5 km of the coast; 14 nests were on offshore islands and gravel spits.

Numbers of Brant in the study area in late June 1991 (at least 937) were lower than those in both 1989 and 1990 (1232 and 1489 Brant, respectively). Of the 1991 total, 750 were assumed to be non- or failed breeders.

The number of Brant nests found by ground crews in 1991 was much lower than that found in 1990, although some locations (e.g., Duck Island) had record numbers of nests. In the Sagavanirktok River delta, this decrease was due primarily to the complete abandonment of the Howe Island colony because of the presence of a pair of arctic foxes there during the arrival of Brant. This factor, in combination with cool weather during initiation and a snowstorm on 10 June, contributed to low nesting success and poor productivity throughout most of the study area. Surfcote had the highest nesting success (66%) of all nest locations visited by ground crews and a mean brood size at dispersal of 2.9 goslings. Another large colony in the study area, the Kuparuk River delta, was abandoned for undetermined reasons.

Aerial surveys and photo censuses in late July and early August 1991 indicated that approximately 1800 Brant (~ 700 goslings; 38% of the total) used coastal habitats between the Colville and Staines rivers. Numbers of both adults and goslings were substantially lower in 1991 than in 1990, but were higher than in 1989. As in previous years, few Brant were recorded at inland sites in the study area. No Brant were recorded east of the Shaviovik River delta.

Brant were banded within the study area for the first time in 1991. As part of this study, 135 Brant were banded in 2 locations: 14 Brant were banded near the mouth of the Kuparuk River on 8 August, and 121 Brant were banded on the western shore of Prudhoe Bay on 8 and 9 August. Each Brant was aged, sexed, and marked with 2 tarsal bands: a stainless steel USFWS band was placed on the left tarsus, and an aqua-colored, plastic band with black alpha-numeric codes was placed on the right tarsus. Two recaptures were recorded during banding: 1 bird originally banded on the Colville River delta, and 1 bird originally banded on the Yukon-Kuskokwim Delta.

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INTRODUCTION

Tundra Swans (*Cygnus columbianus*) are a conspicuous and important component of waterbird communities in northern Alaska. These arctic-nesting swans winter primarily on the mid-Atlantic coast of the United States (Sladen 1973) and are among the first migrants to arrive on the Arctic Coastal Plain in mid-May (Bergman *et al.* 1977). Early arrival on the breeding grounds is critical, because swans have a protracted breeding season. After an incubation and brood-rearing period of approximately 120 days, they depart the Arctic Coastal Plain during freeze-up in early October (Salter *et al.* 1980). Several previous surveys on the coastal plain (King 1970; Bartels and Doyle 1984; Conant and Cain 1987; Ritchie *et al.* 1990, 1991) have provided basic information on the distribution, productivity, and abundance of swans.

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

Historically, Tundra Swans and Brant have received considerable attention from both the regulatory agencies and the oil industry. Swans have been considered an indicator species of the productivity and well-being of all waterfowl in a given habitat (King 1973, King and Hodges 1980), and Brant of

the western flyway have experienced recent population declines (O'Neill 1979, Raveling 1984). Because these two species are traditional in their selection of nesting and brood-rearing areas and, hence, potentially are vulnerable to changes in these areas, it is important to assess the distribution, productivity, and abundance of these two species as development expands into previously undisturbed areas. While under contract to ARCO Alaska, Inc., in 1988, Alaska Biological Research, Inc. (ABR), initiated intensive aerial surveys that primarily were for swans in the Kuparuk oil field and in Oil and Gas Lease Sale 54 (OGL 54) (Figure 1). Survey efforts were coordinated with the U.S. Fish and Wildlife Service (USFWS), which was conducting similar surveys in the area. Aerial surveys for Tundra Swans were expanded in 1990 and 1991 to include the Prudhoe Bay oil field. In 1989, BP Exploration (Alaska) Inc. became a partner in the survey program, due to an increasing interest in the status of Brant in the vicinity of these oil fields. That year, aerial surveys for Brant were extended to Brownlow Point, and ground surveys were conducted in colonies in the Sagavanirktok River delta (1989-1991), the Lisburne Development Area (LDA; 1990-1991), and the Kuparuk oil field (1991). Surveys for Tundra Swans and Brant in 1991 included the following components:

- 1) continued aerial surveys to determine numbers of nests and productivity of Tundra Swans in the Kuparuk oil field, OGL 54, and the Prudhoe Bay oil field;
- 2) intensive surveys of a random sample of plots, to evaluate the effectiveness and accuracy of the swan survey technique;
- 3) aerial surveys of the coastal region between the Miluveach River and Brownlow Point, to locate and count nesting colonies of Brant;
- 4) aerial surveys of the coastal region between the Miluveach River and Brownlow Point, to locate Brant brood-rearing areas and count Brant;
- 5) ground censuses of Howe and Duck islands and Surfcote, to determine numbers of nests, distribution, and productivity of Brant and other waterbird species;

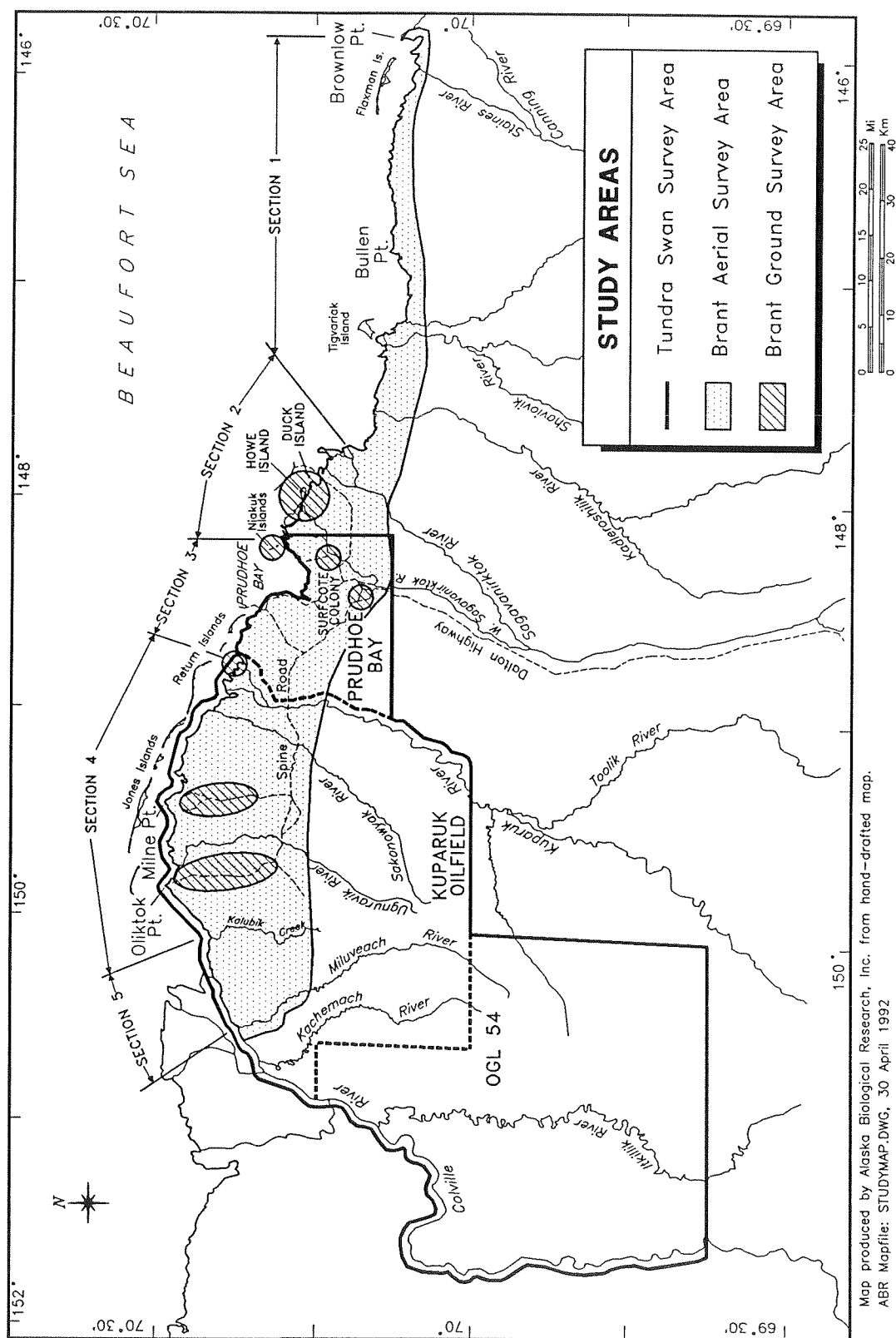


Figure 1. Study areas for Tundra Swan and Brant investigations in 1991.

- 6) ground surveys at selected sites in the Kuparuk River and Milne Point units, to determine numbers of nest and productivity of Brant; and
- 7) capture and color-banding of Brant in the area between the Kuparuk River and Prudhoe Bay.

STUDY AREA

As in 1989 and 1990, surveys for Tundra Swans and Brant were conducted on the Arctic Coastal Plain between Brownlow Point (near the mouth of the Staines River) and the eastern channel of the Colville River (Figure 1). Landforms and vegetation of the Arctic Coastal Plain have been described in detail by Walker *et al.* (1980).

Aerial surveys for Tundra Swans covered the entire Kuparuk and Prudhoe Bay oil fields and OGL 54 (~5000 km² in area; see Ritchie *et al.* 1991). In 1991, however, the upland portion just south of the Kuparuk oil field and east of the Itkillik River was not surveyed.

Surveys for Brant were conducted between Brownlow Point and the Miluveach River near its junction with the Colville River (Figure 1). (This region will be referred to as the 'Colville to Staines' region in the text.) The areas surveyed were similar to those described by Ritchie *et al.* (1991) and included offshore islands, inland areas in the Kuparuk and Prudhoe Bay oil fields, and the area between the Sagavanirktok and Staines rivers and within 5 km of the coast.

PART 1: TUNDRA SWAN SURVEYS

METHODS

Aerial survey methods in 1991 were similar to those used in 1989 and 1990 (Ritchie *et al.* (1990, 1991). A Cessna 185 aircraft was flown according to the USFWS Tundra Swan Survey Protocol (USFWS 1987), along 2375 km of fixed-width (1.6 km) transects. The aircraft was flown 150 m above ground level (agl) and at an airspeed of 145 km/h. The flightline was directly over township and section lines, and all observations were recorded on 1:63,360 USGS maps. During sampling, two observers scanned a transect approximately 800 m wide on each side of the aircraft, while the pilot navigated and scanned ahead of the aircraft. A standardized set of codes for pairs, single birds, flocks, nests, and broods was employed (USFWS 1987). When possible, observations of other wildlife (primarily species of geese, loons, and Glaucous Gulls [*Larus hyperboreus*]) were recorded.

Survey dates were selected to be consistent with the timing of previous surveys. Nesting surveys were conducted between 20 and 26 June 1991, and brood-rearing surveys were conducted between 17 and 21 August 1991 (Appendix 1). Estimates of the area (km²) of aerial survey coverage were obtained with a Minerva planimeter. Densities of swan were calculated for only that area that was covered by survey transects and not for the entire area within the boundaries of the study area. Although the study area was 10% smaller in 1991 than in previous years, the difference between absolute numbers was only 3% and between density estimates only 7%. Estimates of survey-coverage for each USGS quadrangle in the study areas are summarized in Appendix 2. Summary statistics for nesting and brood-rearing surveys followed the format established in 1988 and modified in 1990 (Ritchie *et al.* 1989, 1991). The data presented are census counts and not statistical estimates; therefore, no statistical tests were performed.

In 1991, a random sample of plots was selected within the study area for intensive surveys in June, to evaluate the accuracy of the regular aerial surveys. The areas selected for resurveying were determined according to techniques in Cochran (1977). To provide a sampling error of slightly less than 10%, 19 plots that each were 13 km² (1.6 x 8 km) in size were selected. The total number of nests per plot was selected as the variable of comparison between the 2 survey types. Within each plot, a Cessna 185 flew 8-km transects. Two observers each scanned an area 400 m wide, which was half the standard sampling distance. Any site that appeared to be a potential nest was circled for confirmation. The intensive survey of each plot was done within 24 h after the initial survey. The number of nests detected in each plot during the intensive survey was compared with the number observed in the same plot during the initial, regular survey.

RESULTS AND DISCUSSION

KUPARUK OIL FIELD AND OIL AND GAS LEASE 54 STUDY AREAS

Distribution in June

Six hundred twenty-five Tundra Swans were observed at 305 locations during nesting surveys conducted in June (Table 1, Appendix 3). One hundred twenty-six Tundra Swan nests also were determined to be active. Fifty-eight percent of the swans were located in the Kuparuk oil field, and 42% were located in OGL 54.

Swans were distributed uniformly wherever large lakes and drained lake basins occurred (Figure 2; Ritchie *et al.* 1990, 1991). Mean densities of nests in the Kuparuk and OGL 54 areas were identical (0.03 nests/km²), and total densities of swans were similar between the two areas (Appendix 4).

The numbers of swans and nests were the highest recorded since surveys were initiated in 1988; however, increases in 1991 were small (e.g., nest numbers in 1991 were 2% higher than they were in 1990; Table 2). The

Table 1. Numbers of Tundra Swans and nests recorded during aerial surveys in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 20-26 June 1991.

Study Area	Adults ¹ With Nests	Total Nests	Adults ² Without Nests	Total Swans
Kuparuk oil field	112	78	251	363
OGL 54	80	48	182	262
TOTAL	192	126	433	625

¹ "Breeding Adults" in previous reports.

² "Nonbreeding Adults" in previous reports.

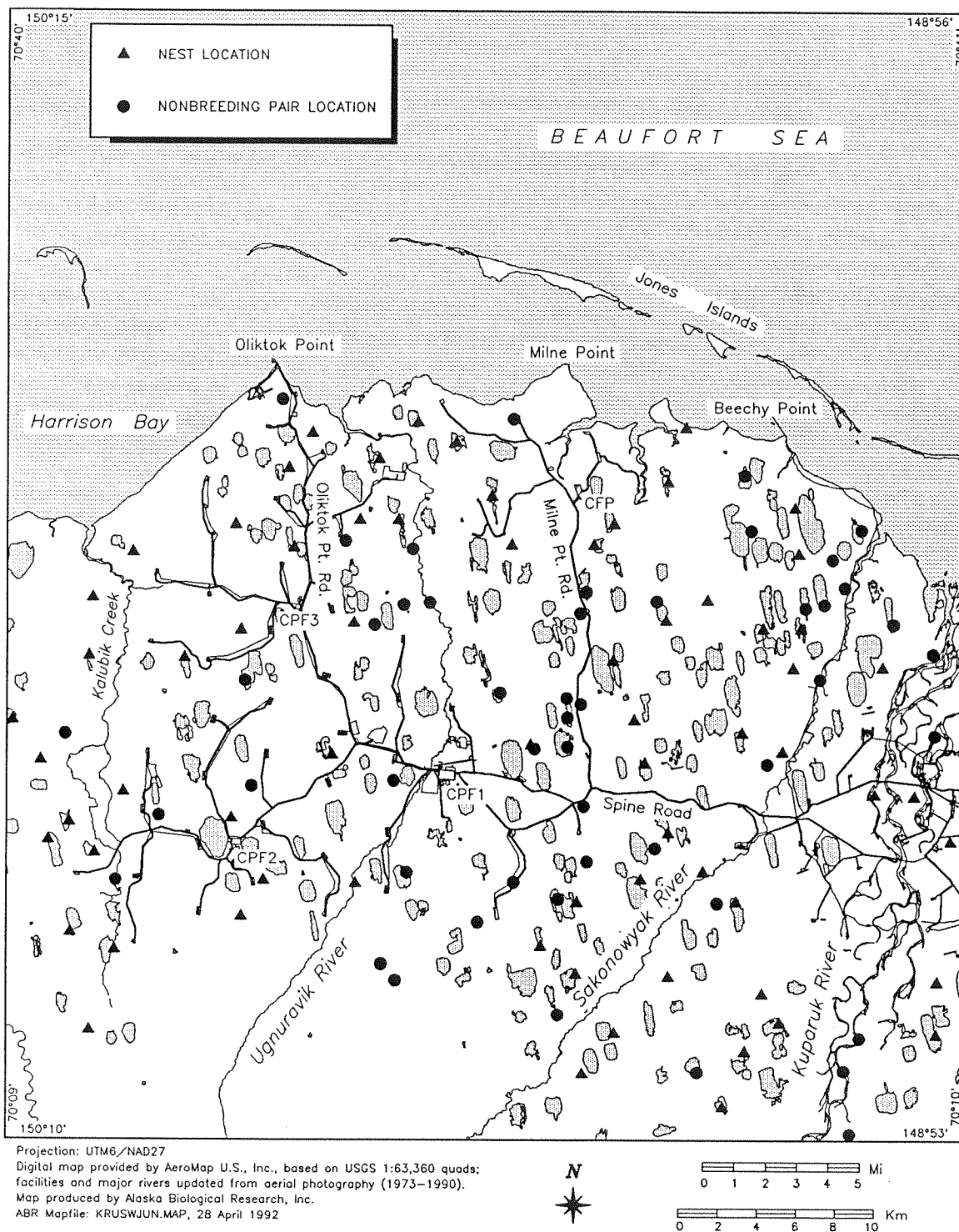


Figure 2. Locations of Tundra Swan nests and nonbreeding pairs observed during aerial surveys in the central Kuparuk oil field, Alaska, 20-26 June 1991.

Table 2. Summaries of numbers of Tundra Swans and nests recorded during aerial surveys in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June 1988-1991.

Study Area	Year	Adults ¹ With Nests	Total Nests	Adults ² Without Nests	Total Swans
Kuparuk oil field	1988 ³	50	26	148	198
	1989	70	44	186	256
	1990	122	74	177	299
	1991 ³	112	78	251	363
OGL 54	1988	45	28	185	230
	1989	53	34	170	223
	1990	82	49	158	240
	1991	80	48	182	262
TOTAL	1988	95	54	333	428
	1989	123	78	356	479
	1990	204	123	335	539
	1991	192	126	433	625

¹ "Breeding Adults" in previous reports.

² "Non-breeding Adults" in previous reports.

³ Portions of the Kuparuk oil field were not surveyed in 1988 and 1991.

increased number of swans in 1991 was due mainly to a large number of non-nesting birds.

Productivity and Distribution in August

A total of 1,101 Tundra Swans (818 adults and 283 cygnets) was observed at 385 locations in the Kuparuk/OGL 54 study area (Figure 3, Table 3, Appendix 5). One hundred six broods were recorded, and young of the year constituted 26% of the total number of swans that were observed.

Between June and August 1991, the number of adult swans in the Kuparuk oil field increased from 363 to 490 (a 35% increase), while the number of adult swans in OGL 54 increased from 262 to 328 (a 25% increase) in the same period (Tables 2 and 3). Most of these additional swans probably were birds without broods (i.e., failed breeders or subadult nonbreeding birds). The number of adults observed with nests or broods in the entire study area also increased slightly (8%) from June to August. This increase probably was attributable to the tendency for both adults to stay near their brood and, consequently, be more conspicuous during August. In addition, some redistribution apparently occurred within the area; the number of breeding adults in the Kuparuk oil field rose to 134 birds (a 20% increase) while it dropped to 73 birds (a 9% decrease) in OGL 54. One explanation for this apparent difference is emigration of adults and broods from OGL 54 to more favorable brood-rearing habitats in the Kuparuk oil field. Other studies have found that densities of swans were higher in coastal lowlands than in adjacent areas (McLaren and McLaren 1984, Stewart and Bernier 1989). Densities of adult swans and young during August were similar between the Kuparuk oil field and OGL 54 areas.

One hundred twenty-six active nests were recorded in June, and 106 broods recorded during August surveys. The number of broods suggested a minimum of 84% nesting success in the study area as a whole, which is similar to that observed in previous years. The number of broods (2.7) and mean

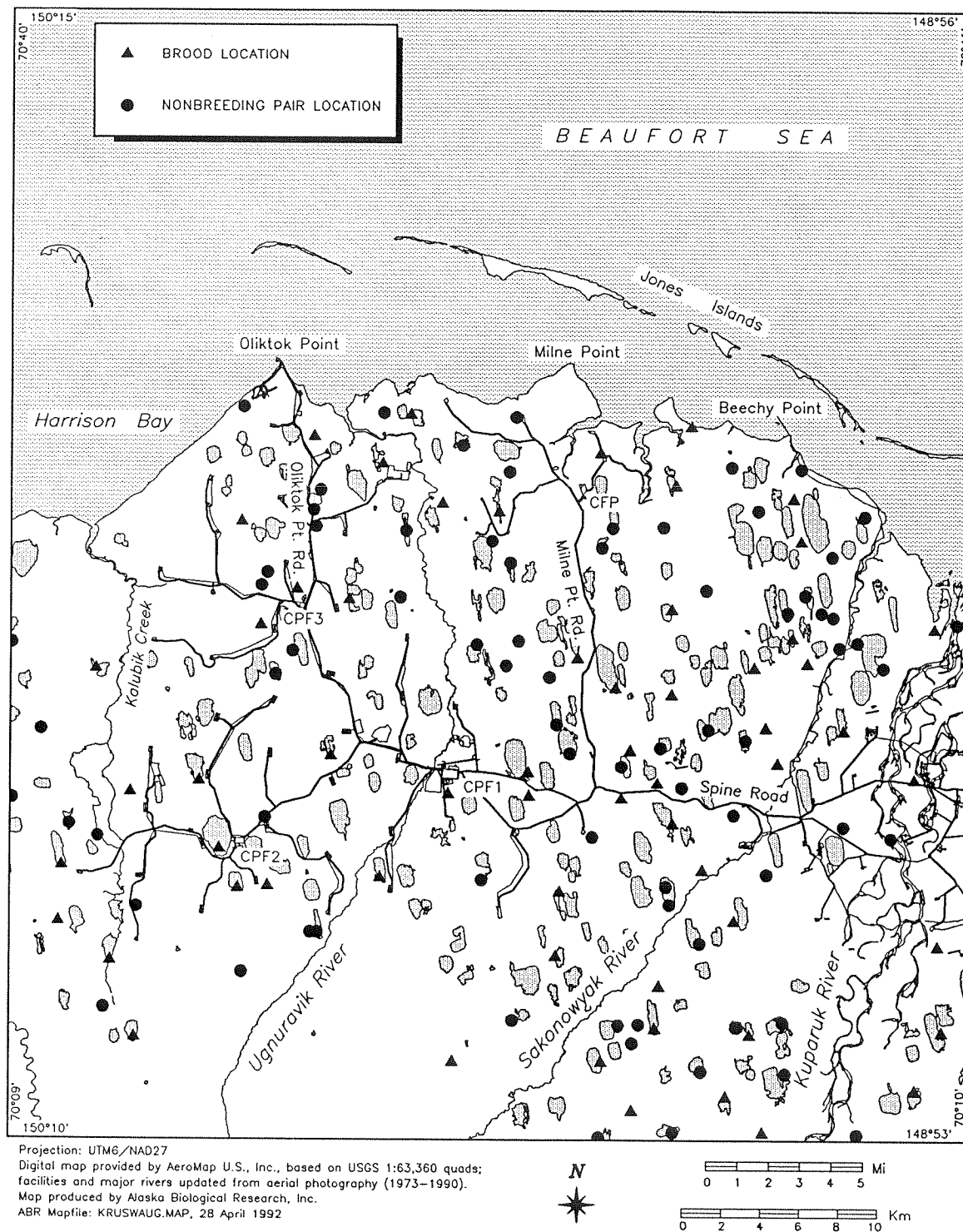


Figure 3. Locations of Tundra Swan broods and nonbreeding pairs observed during aerial surveys in the central Kuparuk oil field, Alaska, 17-21 August 1991.

Table 3. Numbers of Tundra Swans and broods recorded during aerial surveys in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 17-21 August 1991.

Study Area	Adults ¹ With Broods	Total Broods	Total Young	Mean Brood Size	Adults ² Without Broods	Total Adults	Total Swans	Percent Young
Kuparuk oil field	134	69	175	2.5	356	490	665	26.3
OGL 54	73	37	108	2.9	255	328	436	24.8
TOTAL	207	106	283	2.7	611	818	1,101	25.7

¹ "Breeding Adults" in previous reports.

² "Nonbreeding Adults" in previous reports.

brood size in 1991 were slightly lower than in 1990 but were higher than in both 1988 and 1989 (Table 4).

The total number of adults (818) observed in August 1991 was 16% higher than the 706 observed in August 1990. This increase probably was due to the return of large numbers of nonbreeders produced in previous seasons. Densities of adults in the two study areas in 1991 were similar to the 1989 and 1990 values but were slightly higher than in 1988. Densities of total swans in the two study areas were higher in 1990 and 1991 than in 1988 and 1989 due to the increased number of nonbreeding swans.

In comparison with studies done in other areas of northern Alaska, such as the Colville River delta and ANWR (King 1979, Hawkins 1983, Platte and Brackney 1987, ADF&G 1990, Campbell and Rothe 1990), mean densities of swans in both the Kuparuk oil field and OGL 54 were low. Mean brood sizes in these study areas were similar to those recorded in these other areas (King 1970, Hawkins 1983, Bartels and Doyle 1984, Conant and Cain 1987, Platte and Brackney 1987, ADF&G 1990, Campbell and Rothe 1990), however. Mean brood sizes in these study areas also were similar to or higher than those reported for Tundra Swans in the northern part of their range in Canada (McLaren and McLaren 1984, Stewart and Bernier 1989), and percentages of young in these two study areas were within ranges reported for other populations in Alaska and Canada (McLaren and McLaren 1984, Platte and Brackney 1987, Wilk 1988, Stewart and Bernier 1989, ADF&G 1990).

PRUDHOE BAY OIL FIELD STUDY AREA

Distribution in June

One hundred fifteen Tundra Swans were observed at 50 locations in the Prudhoe Bay oil field study area during nesting surveys conducted in June (Figure 4, Table 5, Appendix 6). At this time, 21 Swan nests were located in the study area. As seen in the Kuparuk oil field and OGL 54 study areas, swans in the Prudhoe Bay study area were distributed uniformly wherever large

Table 4. Summaries of numbers of Tundra Swans and broods recorded during aerial surveys in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, August 1988-1991.

Study Area	Year	Adults ¹ With Broods	Total Broods	Total Young	Mean Brood Size	Adults ² Without Broods	Total Adults	Total Swans	Percent Young
Kuparuk oil field									
	1988	86	44	93	2.1	225	311	404	23.0
	1989	84	45	103	2.3	308	392	495	20.8
	1990	141	72	199	2.8	289	430	629	31.6
	1991	134	69	175	2.5	356	490	665	26.3
OGL 54									
	1988	32	16	38	2.4	281	313	351	10.8
	1989	38	19	39	2.1	240	278	317	12.3
	1990	64	32	97	3.0	212	276	373	26.0
	1991	73	37	108	2.9	255	328	436	24.8
TOTAL									
	1988	118	60	131	2.2	506	624	755	17.4
	1989	122	64	142	2.2	548	670	812	17.5
	1990	205	104	296	2.8	501	706	1002	29.5
	1991	207	106	283	2.7	611	818	1101	25.7

¹ "Breeding Adults" in previous reports.

² "Nonbreeding Adults" in previous reports.

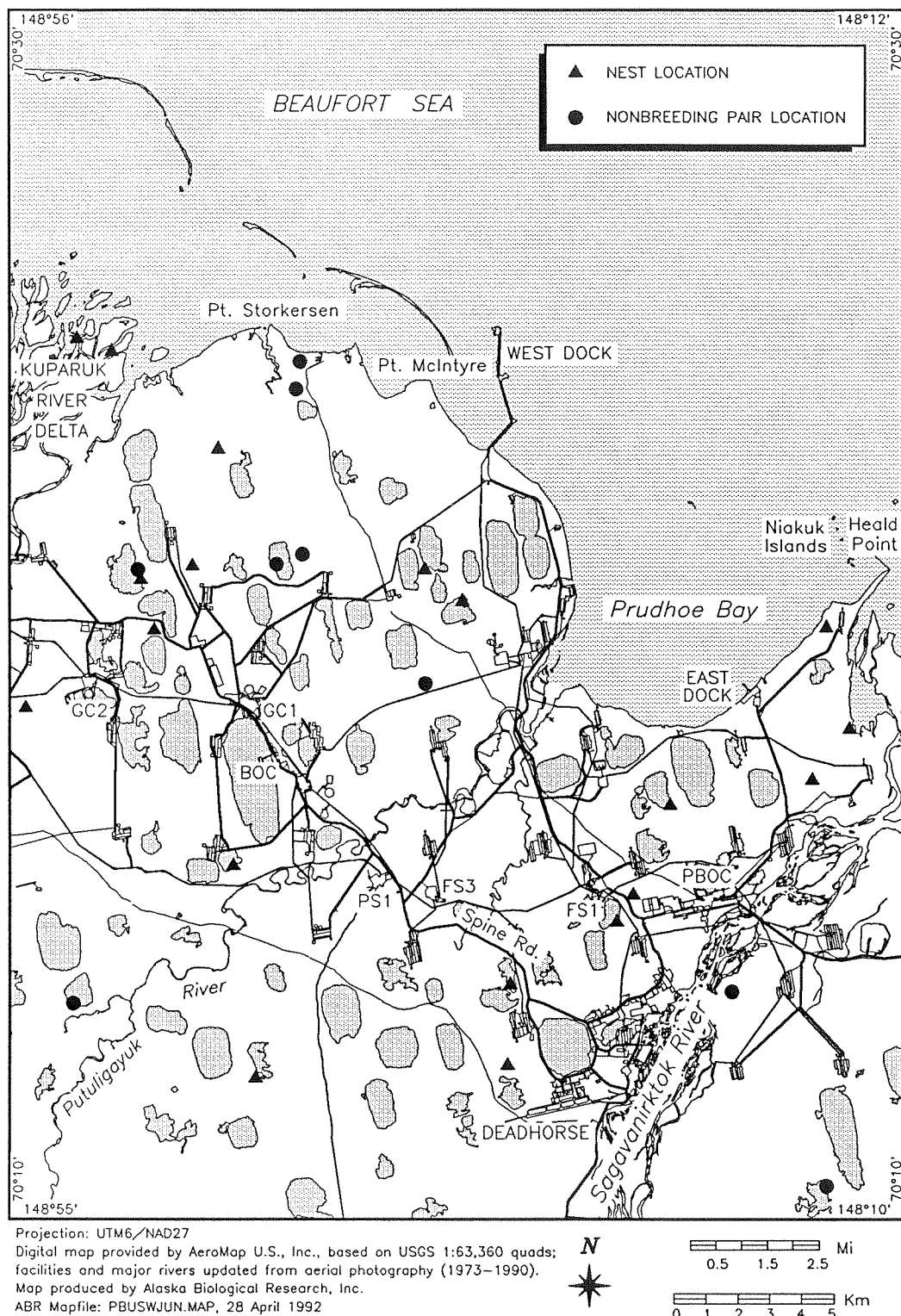


Figure 4. Locations of Tundra Swan nests and nonbreeding pairs observed during aerial surveys in a portion of the Prudhoe Bay study area, 20–26 June 1991.

Table 5. Numbers of Tundra Swans and nests recorded during aerial surveys in the Prudhoe Bay oil field study area, Alaska, 20-26 June 1991.

Year	Adults¹ With Nests	Total Nests	Adults² Without Nests	Total Swans
TOTAL 1991	33	21	82	115
TOTAL 1990	40	26	42	82

¹ "Breeding Adults" in previous reports.

² "Nonbreeding Adults" in previous reports.

lakes and drained lake basins occurred. The density of nests located during June surveys in the Prudhoe Bay oil field study area was equal to that in the Kuparuk and OGL 54 study areas. Densities of total adults were similar in these areas ($0.15/\text{km}^2$ in Prudhoe Bay vs. $0.16/\text{km}^2$ in Kuparuk and OGL 54 study areas; Appendices 4 and 7). The number of swans in the Prudhoe Bay unit in 1991 increased, but the number of nests decreased over the number recorded in 1990.

Productivity and Distribution in August

One hundred seventy-nine Tundra Swans were observed at 62 locations in the Prudhoe Bay study area during August surveys. This count included 126 adults and 24 broods containing 53 cygnets (Figure 5, Table 6, Appendix 8). The number of adult swans increased by 11 birds (10%) between June and August.

Twenty-one Tundra Swan nests were located in June, and 24 broods were observed in August, suggesting that some nests were missed and/or some immigration had occurred. The mean brood size was 2.2 and young swans composed 30% of the population (Table 6). Densities of adult swans ($0.16 \text{ adults}/\text{km}^2$), broods ($0.03 \text{ broods}/\text{km}^2$), and young ($0.07 \text{ young}/\text{km}^2$) in the Prudhoe Bay study area were similar to those in the Kuparuk and OGL 54 study areas (Appendices 4 and 7).

In 1991, numbers of adults and broods were higher than they were in 1990. Mean brood size decreased from 2.8 in 1990 to 2.2 in 1991, however, resulting in fewer young recorded in 1991 than in 1990 (Table 6). Densities of swans differed slightly ($0.14/\text{km}^2$ vs. $0.16/\text{km}^2$) and broods were identical between 1990 and 1991.

REGIONAL CONDITIONS AND PRODUCTIVITY IN 1991

Comparisons between 1990 and 1991 and between the more coastal Kuparuk and Prudhoe Bay oil field study areas and the more inland OGL 54

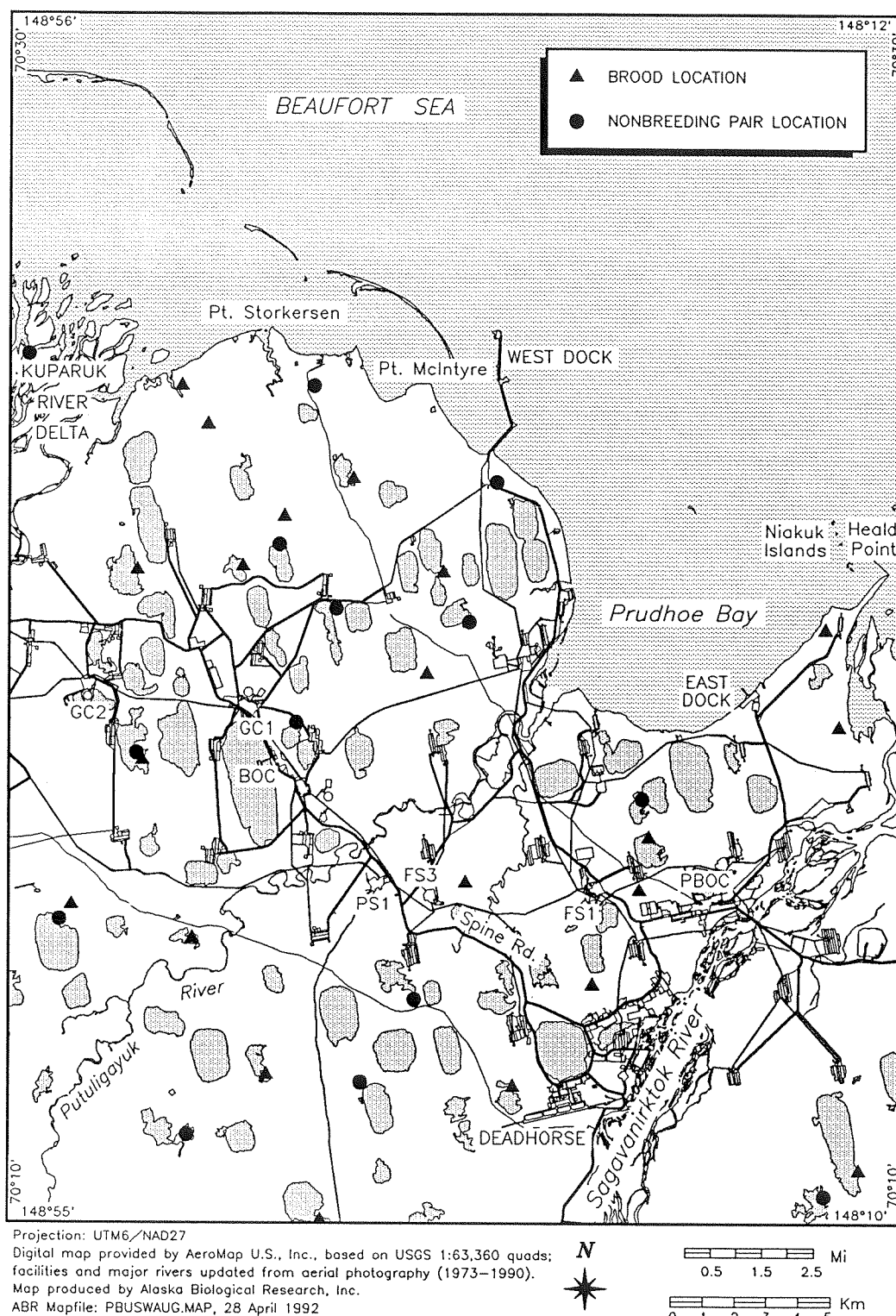


Figure 5. Locations of Tundra Swan broods and nonbreeding pairs observed during aerial surveys in a portion of the Prudhoe Bay study area, 17–21 August 1991.

Table 6. Numbers of Tundra Swans and broods recorded during aerial surveys in the Prudhoe Bay oil field study area, Alaska, 19-24 August 1990.

Year	Adults¹ With Broods	Total Broods	Total Young	Mean Brood Size	Adults² Without Broods	Total Adults	Total Swans	Percent Young
TOTAL 1991	47	24	53	2.2	79	126	179	29.6
TOTAL 1990	43	22	61	2.8	65	108	169	36.1

¹ "Breeding Adults" in previous reports.

² "Nonbreeding Adults" in previous reports.

study area in 1991 suggest that climatic conditions influenced productivity. In the Kuparuk and Prudhoe Bay oil field study areas, conditions for nesting apparently were less favorable in 1991 than in 1990. Numbers of nests in the Kuparuk study area in 1991 were higher than in 1988-1990, but mean brood size and numbers of broods and young in 1991 all were slightly lower than in 1990. Although numbers of nests and broods in 1991 were slightly higher in the Prudhoe Bay study area than in 1990, mean brood size and total number of young were lower than in 1990. In the OGL 54 study area, brood sizes were similar to those in 1990, whereas numbers of broods and young in 1991 were higher than in any of the 3 previous years of study.

Both cool weather and a snowstorm on 10 June may have reduced both the number of eggs laid and nesting success in coastal areas. Timing of snow melt and spring phenology has been identified as a major factor influencing productivity of Tundra Swans (Lensink 1973, McLaren and McLaren 1984, Campbell *et al.* 1989). The total number of adults observed, however, was higher in 1991 than in any previous year of the study. This increase in adults was probably due to the return of large numbers of nonbreeding and immature birds from the preceding productive years of the study.

In all three study areas, the survey data suggest a continuing increase in numbers of nesting swans. A subset of the study areas, the Beechey Point B-5 quadrangle, has been surveyed each year since 1986; these additional data also suggest an upward trend in the number of nonbreeding swans and a general increase in breeding adults and young since 1986 (Figure 6). The nesting habitat in all three study areas probably is less favorable than that at other locations. The Colville River delta becomes snow-free earlier and is more protected from predators than our study areas. However, the Kuparuk, OGL 54, and Prudhoe Bay study areas may be less saturated than is the Colville River delta and may provide greater potential for additional breeding swans.

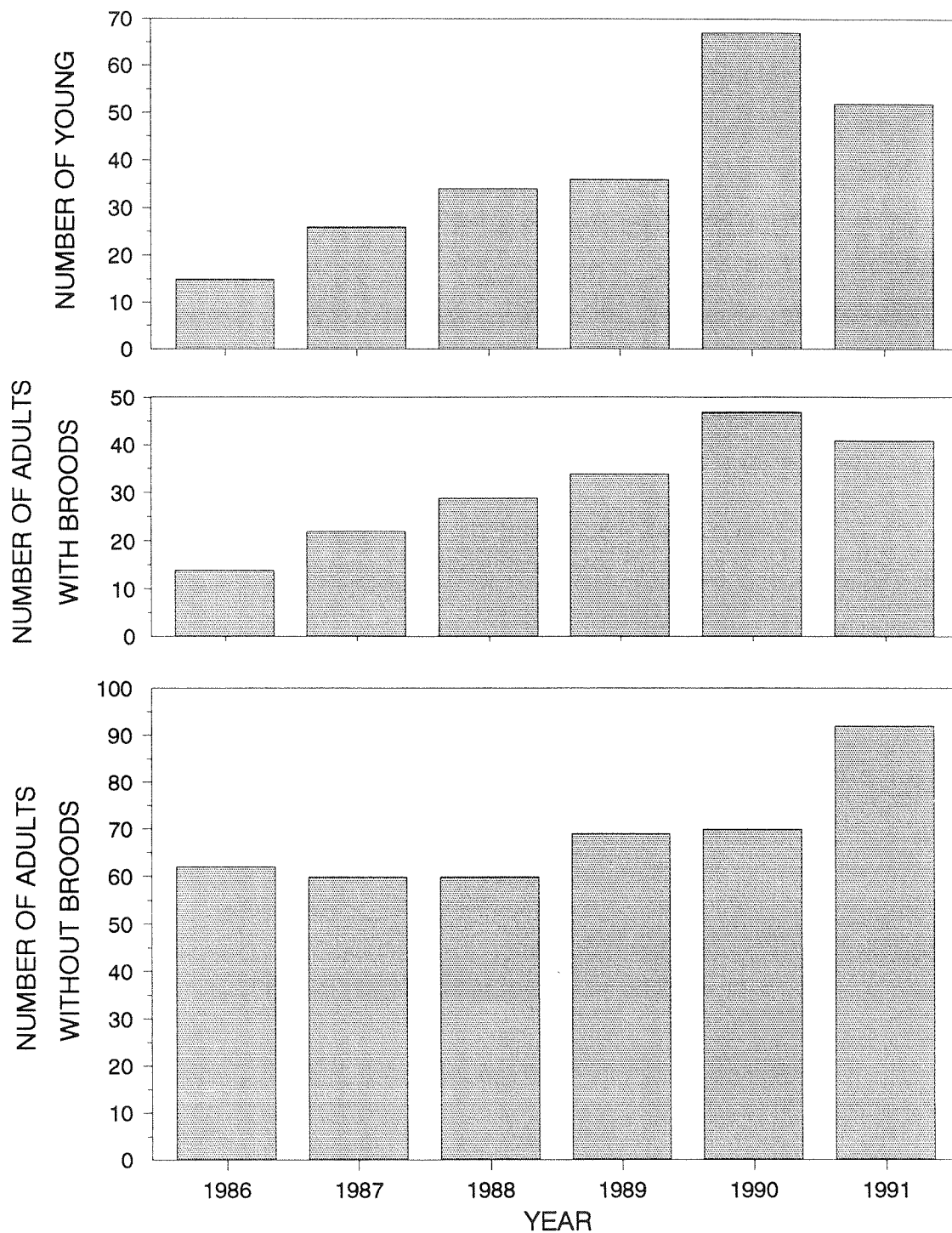


Figure 6. Numbers of Tundra Swans observed during aerial surveys in the Beechey Point B-5 quadrangle (central Kuparuk oil field), Alaska, August 1986-1991.

SURVEY EFFICIENCY

During the intensive survey in June, 11 nests were recorded in the 19 13-km² plots, compared with 8 during the initial survey, a difference of 27%. Nests were missed during the initial, regular surveys, indicating that for studies requiring extremely accurate site-specific nesting information or precise population estimates, the intensive method would be preferable. For the purposes of this study, however, the survey timing and data collection techniques are similar in all years, and the numbers represent comparable indices of Tundra Swan numbers in the study areas.

PART 2: REGIONAL BRANT SURVEYS

METHODS

AERIAL SURVEYS

Aerial surveys were used to locate Brant nesting areas in June 1991, and to locate brood-rearing areas and count adults and goslings in July and early August 1991 (Figure 7). Methods were similar to those used in 1989 and 1990 (Ritchie *et al.* 1990, 1991).

The nesting aerial survey was conducted on 22 June. Locations of all observations were recorded on 1:63,360 USGS maps. Data recorded for each nesting area included estimated numbers of adults and nests. A nest was recorded if either a down-filled bowl or an adult in incubation posture was observed. Counts are conservative, because of the difficulty of observing incubating Brant and because the number of aerial passes was limited to minimize disturbance.

Generally, nesting surveys were flown (lake to lake) within broad east-west transects (~3.2 km wide). These transects extended inland to approximately 70°10'N in all areas west of and 70°15'N in all areas east of the Sagavanirktok River. Surveys included more intensive coverage of the Kuparuk, Kadleroshilik, and Kavik river deltas (Ritchie *et al.* 1991). In addition, all nesting sites identified in 1988-1990 were revisited to see if they were being used for nesting in 1991.

Two photographic surveys were conducted on 31 July and 3-4 August, after most Brant broods had congregated in coastal habitats. The survey route followed the coastline as closely as possible extending inland to include bays and the shorelines of deltaic islands. Nesting sites were revisited during these surveys, to determine whether these areas also were used for brood-rearing.

Additional brood-rearing surveys were conducted between Tigvariak Island and the western side of the Kuparuk River Delta on 12-13 and 20 July. More specific information on distribution of Brant in this area was gathered

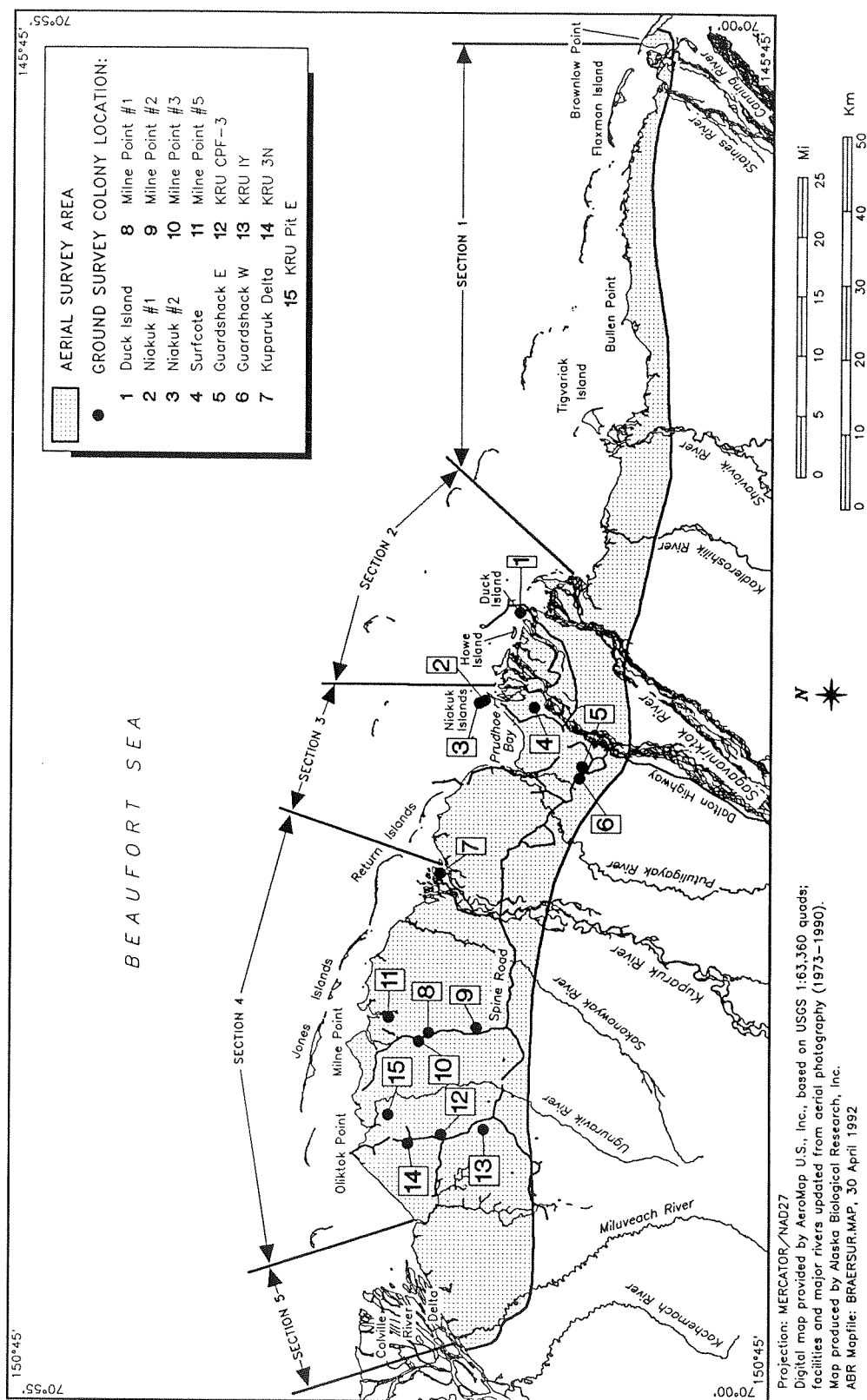


Figure 7. Study area for aerial and ground surveys for Brant in 1991. Not all ground survey locations are indicated on the map. The five sections of coastline are described in Ritchie *et al.* (1991).

because of proposed oil spill training exercises and Brant banding activities in the region.

Brant in small brood-rearing groups (< 50 individuals) were counted directly. Individuals in larger groups (≥ 50 individuals) were counted from aerial photos taken with a 35-mm camera, a 135-mm lens, and Ektachrome (200 ASA) film.

Numbers of Brant per kilometer of coastline were determined for the 5 sections delineated in Figure 7. Linear densities were computed from measurements of coastline taken from USGS 1:63,360 maps. The proportion of goslings in the total number of Brant was calculated for each section and for the region as a whole.

GROUND SURVEYS

Ground surveys in 1991 were intended to provide information on nesting success and productivity and more precise estimates of the number of nests in colonies identified from aircraft (Figure 7). Phenological information also was collected for colonies that included Howe and Duck islands in the Sagavanirktok River delta, Surfcote in the Lisburne Development Area (LDA), and the Kuparuk River delta. Smaller nesting aggregations in the LDA, the Niakuk Islands, and at various locations along the road systems in the Kuparuk and Milne Point oil fields also were visited. Ground surveys included reconnaissance visits in June, monitoring during the hatch, and post-hatch visits in July.

Nesting Phenology

Prior to 1989, phenological (as well as productivity and distribution) information on Brant was obtained through daily scans of Howe Island in conjunction with ongoing Snow Goose research (Burgess *et al.* 1992). In 1989 and 1990, however, studies focusing specifically on the distribution, phenology, and productivity of Brant were conducted on the Sagavanirktok River delta. Only preliminary phenological information was available in 1991,

because 2 arctic foxes (*Alopex lagopus*) present on Howe Island (late May through late June) prevented Brant from nesting there that year.

Estimated distributions of dates of nest initiation and hatching were based on observations at Surfcote in the LDA. For each brood observed, the date of hatching was assumed to be 1 day before the date of dispersal (following Barry 1956). The date of initiation of each nest was calculated by subtracting the combined incubation (24 days; Barry 1956) and laying periods from the estimated hatching date. The laying period was estimated by multiplying the brood size at dispersal by the rate of laying (1.3 days/egg; Barry 1956).

Productivity

Nest visits were conducted after hatching (mid-July) at the following locations (Figure 7):

- 1) Duck Island in the Sagavanirktok River delta (Section 2 on Figure 7);
- 2) the LDA (Section 3 on Figure 7). (Within this area, surveys were conducted at Surfcote, on the Niakuk Islands, and at 2 lakes near Lake Coleen.);
- 3) (Section 4 on Figure 7) two islands near the mouth of the Kuparuk River ; and
- 4) along the road system in the Kuparuk oil field (Section 5). (Surveys in this oil field were conducted only at locations where nesting Brant had been observed during a preliminary survey in June.)

Methods used during the nesting censuses were described by Ritchie *et al.* (1991). Nesting success was estimated for each nest site visited. Estimates of gosling production and survival were not feasible in 1991, because the sample of broods at hatching/dispersal was inadequate.

Banding

Brant were banded near the mouth of the Kuparuk River on 8 August and along the western shore of Prudhoe Bay on 9 August. A Bell 206 Helicopter was used to deploy a 5-person ground crew near the Kuparuk River site and to herd Brant into traps at both locations. A trap was constructed from 4 sections of 25-mm mesh nylon netting that each were 15 m long x 1.5 m high and that were strung between pieces of aluminum conduit. The latter supports were driven into the ground and secured with nylon cord to tent stakes. Two sections of net were arranged in an oval ("corral") shape with a ~1.5-m-wide opening facing the water. The other 2 sections formed wings that extended at a 45° angle from the opening, creating a funnel-shaped approach to the corral. Nets had been dyed gray-green to blend into the background.

Brant were herded toward and into the funnel by the helicopter. Personnel on the ground slowly moved in from the sides and behind the Brant, limiting possible escape routes. Once in the trap, Brant were moved into a smaller holding pen to limit their movement and the potential for injuries.

Following procedures outlined in a Draft Procedures Manual (ABR 1991), each Brant was aged by plumage characteristics, sexed by cloacal examination, and marked with 2 tarsal bands. A stainless steel, size 7B band was placed on the left tarsus, and an aqua-colored, plastic band, with engraved black, alpha-numeric codes was placed on the right tarsus. A sample of adult Brant also was weighed, and 4 measurements were taken: exposed culmen, tarsal length, primary length, and flattened wing chord.

Goslings were banded first, followed by all other Brant. After all birds in the pen had been banded, the sides of the corral were lowered slowly and the Brant were allowed to move as a group into open water. The birds were observed for 10-30 minutes following their release, and any injuries were noted.

Bird banding schedules were completed and sent to the U.S. Fish and Wildlife Service (USFWS) Bird Banding Laboratory in Laurel, Maryland.

Information also was sent to USFWS researchers studying fall movements of Brant at Izembek Lagoon on the Alaska Peninsula.

RESULTS AND DISCUSSION

NESTING

Abundance and Distribution

No new large Brant colonies were located in the study area in 1991. Ground and aerial surveys indicated that there were at least 319 Brant nests at 47 locations between the Colville and Staines rivers (Figure 8; Table 7). Of this total, 112 nests were identified at 35 locations (15 solitary nest sites and 20 sites with ≥ 2 nests) during aerial surveys; only 8 of these locations had ≥ 5 nests. Ground crews located 252 nests at 16 sites; 206 of these nests had not been recorded previously by aerial surveys. The locations included colonies that were not covered by aerial surveys, such as Surfcote in the LDA (29 nests), Duck Island in the central Sagavanirktok River delta (41 nests), and colonies that had failed by the time of the aerial surveys (Kuparuk River delta). Because of difficulty in detecting colonies and nests that already had failed, our estimate of the total number of nests is conservative.

Aerial surveys indicated that at least 937 adult Brant were present in the study area in late June. Of this total, 750 were recorded in areas without nests and were assumed to be failed or nonbreeders (Table 8). Approximately 488 (65%) of these nonbreeders occurred in 12 large flocks that ranged in size from 20 to 110 birds. The number of adults without nests in 1991 was larger than in the previous 2 years, whereas the number of breeding adults was lower than in the previous 2 years. As in previous years, most of the nonbreeders (over 600; 80% of the total) were observed on the coast in areas that later were used by brood-rearing Brant.

Most Brant nests were located in wet tundra vegetation, including islets in ponds and lakes and flooded tundra in drained basin-complexes; 14 nests were found on offshore islands and gravel spits. As was found in 1989 and

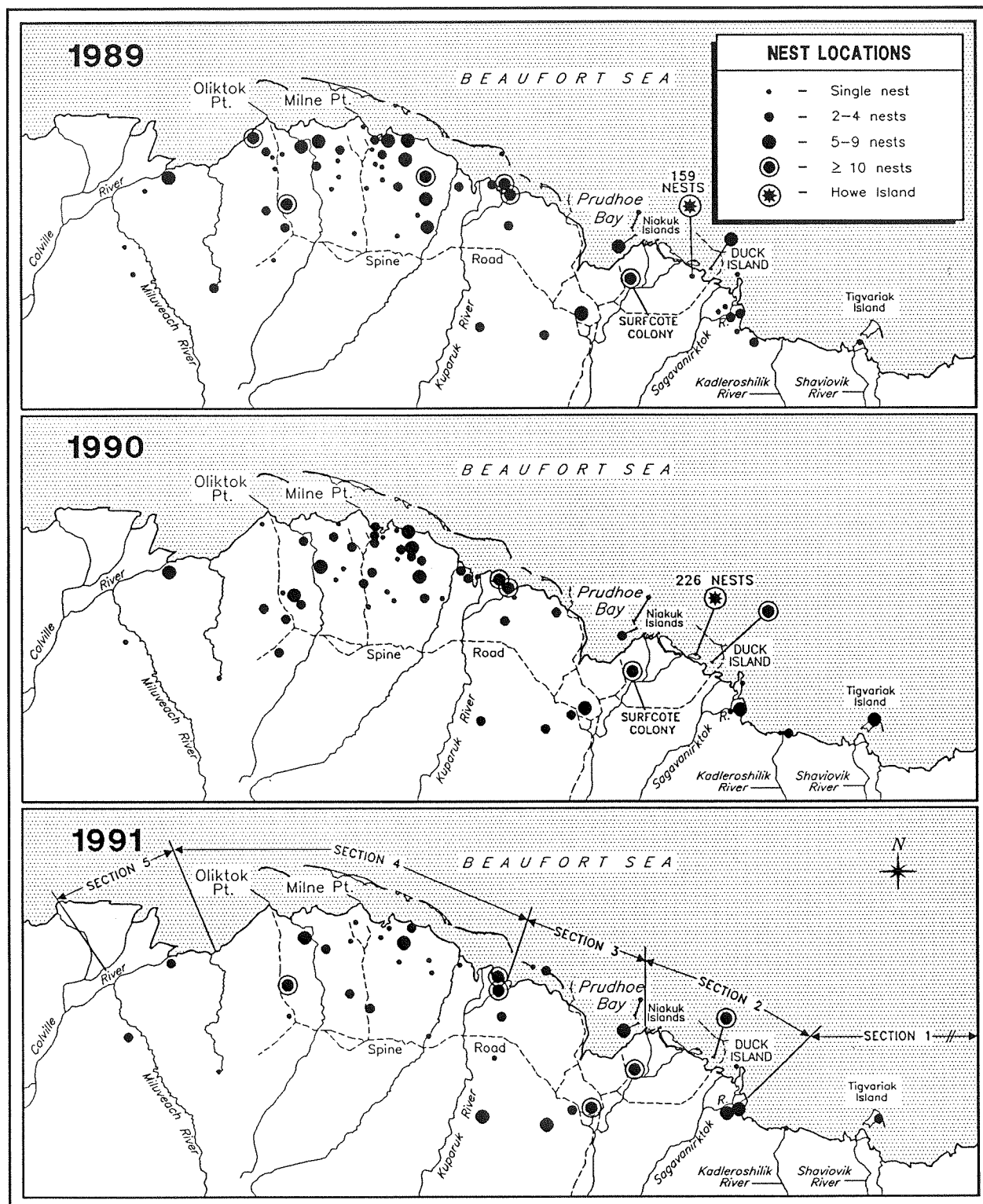


Figure 8. Location and sizes of Brant colonies and solitary nests on the Arctic Coastal Plain between the Colville and Staines rivers, Alaska, June 1989-1991.

Table 7. Distribution of Brant nests (and locations) in sections of the Arctic Coastal Plain between the Colville and Staines rivers, Alaska, June 1989 -1991. Sections are delineated in Figure 7.

Section of Study Area	Year	Number of Brant nests (locations ¹)		
		Aerial Survey Count	Ground Survey Count	Combined ² Count
1. Brownlow Point to Sagavanirktok River	1989	11 (5)	- (-)	11 (5)
	1990	19 (6)	- (-)	19 (6)
	1991	14 (4)	- (-)	14 (4)
2. Sagavanirktok River delta	1989	4 (4)	166 (3)	170 (7)
	1990	1 (1)	240 (3)	241 (4)
	1991	1 (1)	42 (2)	43 (3)
3. Heald Point to Kuparuk River	1989	21 (6)	16 (5)	37 (11)
	1990	24 (8)	17 (1)	41 (9)
	1991	32 (9)	67 (4)	83 (11)
4. Kuparuk River to Kalubik Creek	1989	151 (39)	- (-)	151 (39)
	1990	130 (38)	143 (13)	208 (38)
	1991	58 (18)	143 ³ (10)	172 (26)
5. Kalubik Creek to Miluveach River	1989	13 (5)	- (-)	13 (5)
	1990	8 (4)	- (-)	8 (4)
	1991	7 (3)	- (-)	7 (3)
TOTAL	1989	200 (59)	182 (8)	382 (67)
	1990	182 (57)	400 (17)	517 ⁴ (61)
	1991	112 (35)	252 (16)	319 ⁴ (47)

¹ () = number of locations or colonies.

² Some sites were surveyed by both and ground observers; combined count includes the minimal number of different nests.

³ Includes abandoned nests on the Kuparuk River delta.

⁴ Total is conservative, because more nests were found on ground surveys, and not all locations checked from the air were resurveyed on the ground.

Table 8. Distribution of nonbreeding adult Brant in sections of the Arctic Coastal Plain recorded during aerial surveys between the Colville and Staines rivers, Alaska, June 1989 - 1991. Sections are delineated in Figure 7.

Section of Study Area	Year	Nonbreeding Adults			
		Total Number	\bar{X}	Flock Size Range	n ¹
1. Brownlow Point to Sagavanirktok River	1989	101	14.4	2-40	7
	1990	46	9.2	1-30	5
	1991	94	10.4	4-25	9
2. Sagavanirktok River delta ²	1989	85	28.3	1-80	3
	1990	98	12.3	3-28	8
	1991	143	13.0	3-32	11
3. Heald Point to Kuparuk River ²	1989	73	12.2	2-30	6
	1990	57 ³	28.5	22-35	2
	1991	230	28.8	1-110	8
4. Kuparuk River to Kalubik Creek	1989	124	9.5	1-30	13
	1990	176	11.7	1-60	15
	1991	189	11.8	1-80	16
5. Kalubik Creek to Miluveach River	1989	85	42.5	27-58	2
	1990	100	50.0	40-60	2
	1991	94	13.4	2-40	7
TOTAL	1989	468	15.1	1-80	31
	1990	477	14.9	1-60	32
	1991	750	14.7	1-110	51

¹ n = number of flocks.

² Does not include nonbreeding birds at large colonies (Howe Island, Duck Island, Surfcoote).

³ Includes ground count of nonbreeders at mouth of Putuligayak River.

1990, most (64 sites; 57% of the total) of the nesting sites found during the aerial surveys were within 5 km of the coast, and the overall mean distance was 6.7 km from the coast.

The number of nesting Brant in the study area in 1991 was lower than in 1989 and dramatically lower than in 1990 (Table 7). Consequently, numbers of nonbreeding Brant in 1991 increased substantially from the previous 2 years (Table 8). The decrease in nesting effort was due largely to the complete abandonment of the Howe Island colony, the Kuparuk River delta colony, and many small colonies in the Beechey Mound area, due to factors described below. Small colonies adjacent to Howe Island had increased numbers of nests, suggesting that Brant destined for Howe Island may have selected adjacent areas as alternative nesting areas. Numbers of nests in the Duck Island and adjacent Surfcote colonies, for example, were higher than were numbers in previous years. These small increases did not offset losses caused by abandonment of Howe Island and the Kuparuk delta (~300 nests), however. At locations in the Kuparuk oil field where ground searches were made, numbers of nests in 1991 were similar to those in 1989 and 1990 (Table 7), but were lower than in 1988 (Hampton *et al.* 1988).

Section 1: Staines River (Brownlow Point) to Sagavanirktok River

Fourteen nests (13% of nests recorded on aerial surveys) were found at 4 locations in this region; all locations were within 2 km of the coast (Figure 8, Table 7); no nests were recorded east of Tigvariak Island. In addition, 94 nonbreeding adults were recorded, primarily in the Kadleroshilik River delta (Table 8). No ground observations were undertaken in this section.

Numbers of nests in this region ranged from 11 to 19 between 1989 and 1991. Nesting sites used in 1991 also had been used in 1989 and 1990. Locations of nonbreeding adults were similar to those observed in previous years (Table 8).

Section 2: Sagavanirktok River Delta

Forty-three nests were at 3 sites in this region (Figure 8, Table 7); only 1 of these nests (on a gravel spit west of Point Brower) was located during aerial surveys. Forty-one nests were on Duck Island in 1991 (Figure 9, Table 9), and a solitary nest also was located near the Endicott road by personnel on the ground. In addition, 143 nonbreeding Brant were recorded at 11 locations on the delta (Table 8).

The number of Brant nests in this section in 1991 was much lower than in 1989 (170 nests) and 1990 (241 nests; Table 7). This decrease was due primarily to abandonment of the Howe Island colony in 1991 because of the presence of a pair of arctic foxes on the island during the arrival of Brant. The decrease in nests was in dramatic contrast to 1990, when there were 226 nests on Howe Island. The number of nests on Duck Island in 1991 was the largest recorded in 7 years (Ritchie *et al.* 1991), however, and may have included birds that had abandoned Howe Island. As in previous years, nests on Duck Island appeared to be restricted to the vegetated eastern half of the island.

Section 3: Heald Point to Kuparuk River

Eighty-three Brant nests in 11 locations were recorded in this section. Thirty-two of these nests (29% of the total from aerial surveys) were recorded at 9 locations during aerial surveys (Figure 8, Table 7); ground surveys identified an additional 51 nests at 2 colonies. Nesting locations included the Niakuk Islands (12 nests) and lakes associated with the upper Putuligayuk River and Prudhoe Bay. Six of these 11 locations had been used in 1989, and all had been used in 1990. In addition, two hundred and thirty nonbreeding Brant were recorded at 8 locations on the western shoreline of Prudhoe Bay and near the mouth of the Putuligayuk River (Table 8).

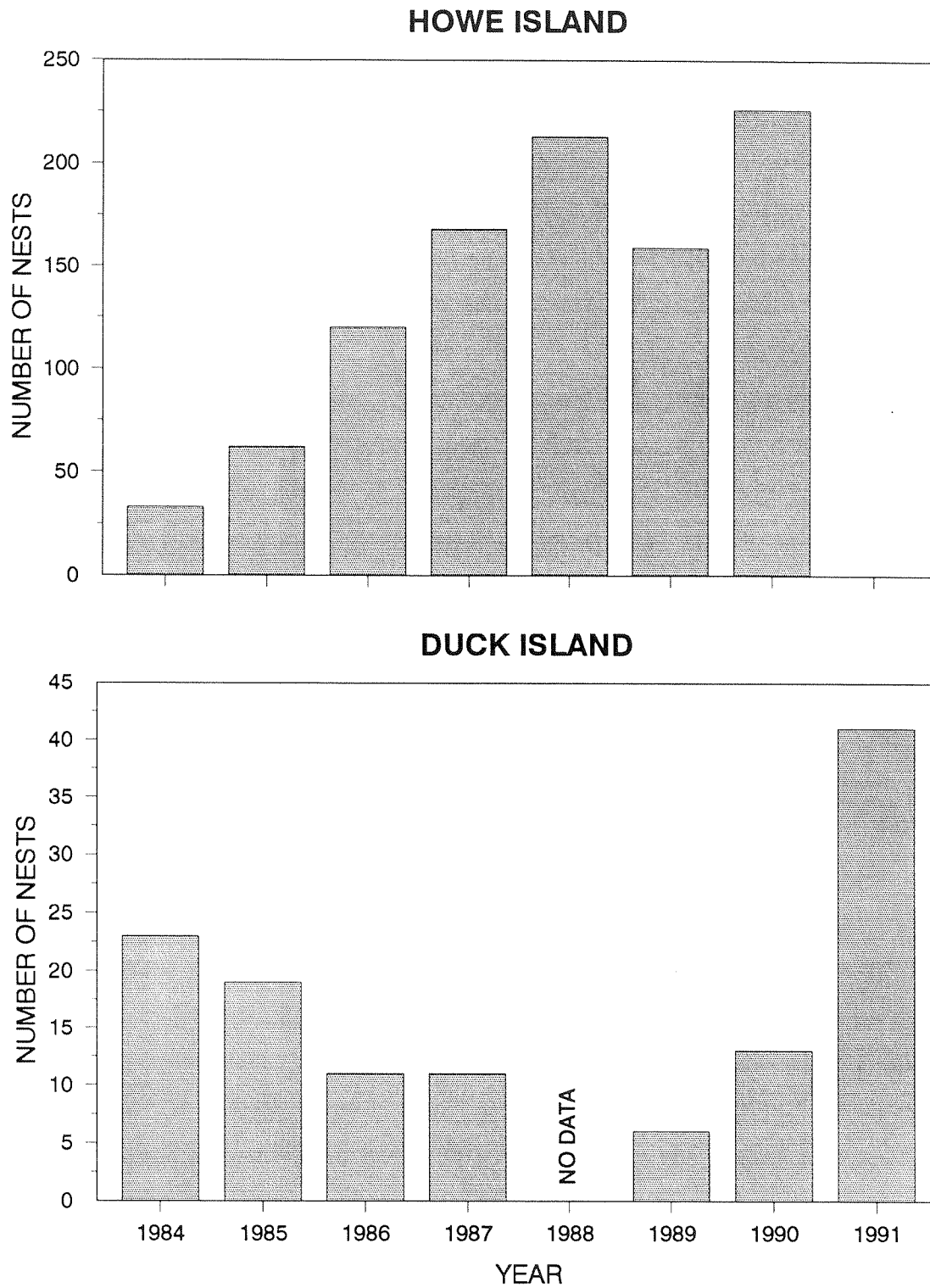


Figure 9. Numbers of Brant nests in the Howe and Duck island colonies, Alaska, 1984-1991.

Table 9. Numbers of Brant nests, and percent success, located during ground surveys on the Sagarinirktok River delta, in the Lisburne Development Area, and in the Kuparuk oil field, 1991. Most nest locations shown in Figure 5.

Nesting Location	Total Nests	No. Successful	No. Failed	No. Unknown	% Success
Sagavanirktok River Delta					
Duck Island	41	8	4	29	20
Endicott Road	1	0	1	0	0
Lisburne Development Area					
Surfcote	29	19	3	7	66
Guardshack E	22	9	8	5	41
Guardshack W	4	0	4	-	0
Niakuk # 1	11	0	11	-	0
Niakuk # 2	1	0	1	-	0
Kuparuk Oilfield					
Milne Point #1	3	1	2	-	33
Milne Point #2	2	0	2	-	0
Milne Point #3	1	0	1	-	0
Milne Point #5	2	0	2	-	0
Kuparuk Delta #1	64	0	64	-	0
Kuparuk Delta #2	19	0	19	-	0
KRU CPF-3	28	12	9	7	43
KRU 3N	3	0	1	2	0
KRU Pit E	12	5	6	1	42
KRU IY	9	5	2	2	56
TOTAL	252	59	140	53	23

Ground surveys located 29 nests in the Surfcote colony in the LDA (not covered by the aerial survey). Two lakes northwest of Lake Coleen had 22 and 4 Brant nests, respectively (Table 9).

The number of Brant nests was substantially higher in this region than recorded in 1989 (37 nests) or 1990 (41 nests; Table 7). This was due in part to more intensive ground efforts, as well as actual increases in some colonies. Surfcote, for example, had the largest number of nests since monitoring began in 1983 (range = 12-29; Murphy *et al.* 1990; this study). Increased numbers of adults in the area probably were associated with the abandonment of colonies adjacent to this region (Howe Island and Kuparuk River delta).

Section 4: Kuparuk River to Kalubik Creek

One hundred seventy-two Brant nests at 26 locations were identified in this section during ground and aerial surveys. Most nesting locations (18; 51%) and nests (58; 52%) identified on aerial surveys were located in this section (Figure 8, Table 7). When aerial surveys were conducted, however, many nests east of the Milne Point road had been abandoned or depredated. For instance, only 12 failed nests were recorded on aerial surveys of the Kuparuk River delta, but 83 were located during a ground visit. One hundred eighty-nine nonbreeding Brant were recorded at coastal and inland locations (Table 8).

One hundred forty-three nests were checked by ground crews within the Kuparuk oil field (Table 9). Of these, 8 occurred at 4 locations along the Milne Point road system, 83 were recorded on 2 islands in the Kuparuk River delta, and 52 were recorded at 8 locations in the Kuparuk River Unit.

The general distribution and locations of nests were similar to those reported in 1989-1990. Some sites (KRU 2C, KRU 3B/2W) in the Kuparuk oil field that supported nesting in 1990 were not used in 1991. At least 3 (KRU CPF-3, KRU PIT E, KRU 1Y) of the nesting locations in the Kuparuk River Unit

had more nests in 1991 than in 1990. Similar numbers of nonbreeders were counted in this region in 1990.

Section 5: Kalubik Creek to Miluveach River

Seven Brant nests were recorded at 3 locations in this section of the study area (Figure 8, Table 7). Most Brant in this area were in large groups of nonbreeders (Table 8). The Colville delta was not surveyed, and ground surveys were not undertaken in this section.

Brant had been recorded at these colony sites in previous years (Ritchie *et al.* 1990, 1991). The occurrence of most Brant in this section in large nonbreeding flocks was similar to observations made in 1989 and 1990 (Table 8).

Phenology and Productivity

Weather strongly influenced both nesting phenology and nesting success of Brant in 1991. The average temperature for May (-3°C) was warmer than the long-term mean (-6°C ; NOAA 1991). Breakup of the Kuparuk River (18 May) was the earliest recorded (A. Schuyler, Kuparuk River Unit, ARCO, unpubl. data). The monthly mean temperature in June was equal to the long-term mean (3°C ; NOAA 1991), but temperatures during nest initiation generally were below average (by as much as 6°C). In addition, a snowstorm on 10 June (early incubation) deposited approximately 75 mm of snow.

Despite early availability of nesting habitat on Howe Island, there were never more than 20 Brant visible on the island between 25 May (arrival) and when observers left on 4 June (R. Burgess, ABR, unpubl. data). Because of the presence of foxes on Howe Island, Brant did not initiate nests there. Several hundred Brant were seen flying east over Stefansson Sound on 2 June; none landed on or near Howe Island, however.

Observations at Surfcote in 1991 suggest that nest initiation was asynchronous (Figure 10). Nests were initiated as early as 2 June and at least

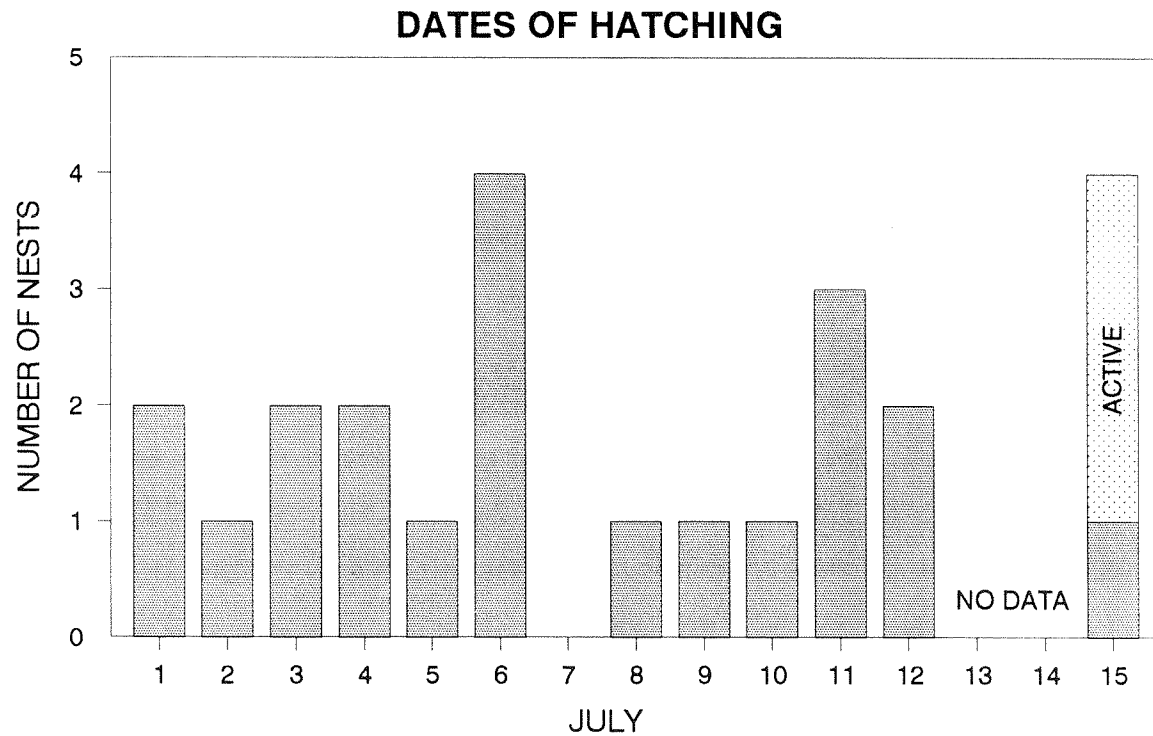
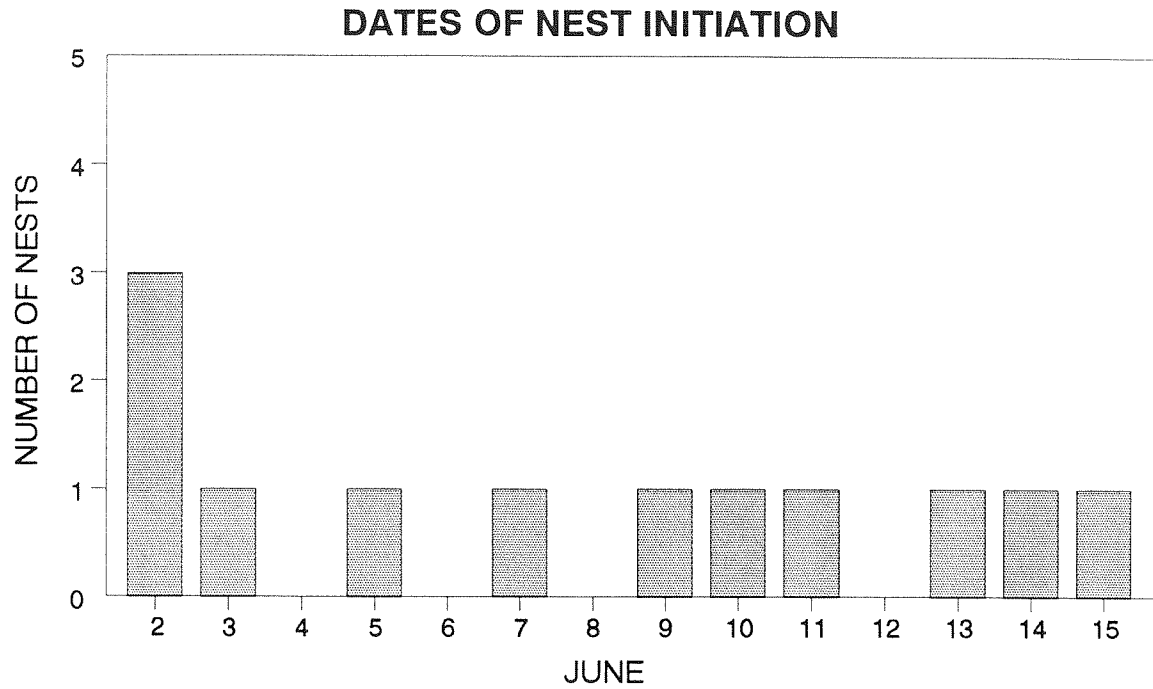


Figure 10. Dates of initiation and hatching for Brant nests in the Surfcote colony, 1991.

as late as 15 June. High meltwater levels in the lake reduced habitat availability, and combined with the snowstorm on 10 June, probably were responsible for the asynchrony at this colony. Hatching at Surfcote began on 1 July; 3 nests were still active when the colony was visited on 15 July. Hatching peaked on 6 July, a week later than on Howe Island in 1990, but similar to data for Howe Island in 1989. The average brood size was 2.9 (SD = 1.2, range = 1-5, n = 12), similar to brood sizes recorded for Howe Island in 1989 and 1990. Most Brant had departed Surfcote by 13 July.

Productivity of Brant on the Sagavanirktok River delta (Section 2 on Figure 7, Table 9) in 1991 was the lowest recorded since monitoring of Howe and Duck islands began in 1984. Because no Brant nested on Howe Island in 1991, productivity from that colony was zero. In addition, although the number of nests on Duck Island was higher than in previous years, nesting success was low (20%); there apparently was a high rate of abandonment of nests after the June 10 snowstorm. In addition, no goslings from Duck Island could be confirmed on the mainland at the time of hatching. Predation by Glaucous Gulls from the large colony (n = 42 nests) on the island also may have been a factor. A solitary nest near the Endicott Road also failed.

Productivity at nesting locations in the Prudhoe Bay area (Section 3 on Figure 7) ranged from 0% (Niakuk Islands and one lake northwest of Lake Coleen) to 66% for Surfcote (Table 9). Nesting success at Surfcote was the highest recorded for any colony in 1991. The June 10 snowstorm probably influenced the failure of many nests in this section, but gull predation also may have contributed to nesting failure on the Niakuk Islands.

Casual observations suggested that nesting phenology of Brant in the Kuparuk oil field (Section 4 on Figure 7) lagged slightly behind that of Surfcote. Availability of nesting habitat was reduced by high meltwater levels and persistent ice in many lakes through mid-June. Some lake colonies (KRU 2C, KRU 3B/2W, Milne Point #4) were not occupied in 1991. All but one of the nests in lakes along the Milne Point road system failed (Table 9). Nesting

success at locations in the Kuparuk River Unit ranged from 0% (Kuparuk River delta) to 56% (KRU 1Y). As in other coastal sections, many failed nests in the Kuparuk oil field probably were abandoned. On the Kuparuk River delta, there were no signs of predation by foxes or bears, but some eggs had been punctured by avian predators. Two goose fecal pellets contained eggshells, suggesting that the Brant themselves may have experienced nutrient stress (Ryder 1969).

BROOD-REARING/MOLTING BRANT

Abundance and Distribution

Aerial surveys and photo censuses indicated that approximately 1,800 Brant used coastal habitats between the Colville and Staines rivers in late July 1991 (Figure 11, Table 10). Almost 700 (38%) of these Brant were goslings, compared with 1,567 goslings (48%) in 1990 and 608 goslings (40%) in 1989. Numbers of both adults and goslings in 1991 were substantially lower than in 1990 (combined adults and goslings = 3,239) but higher than in 1989 (1520 Brant; Table 11). Correspondingly, densities of adult and gosling Brant were much lower in 1991 than in 1990 (3.7 adults vs. 5.5 adults/km of coast; 2.2 goslings vs. 5.2 goslings/km; Figure 12).

Except for 1 small inland group (2 adults, 3 goslings), most Brant (> 99% of adults and goslings) were observed at coastal locations in or near arctic salt-marsh vegetation on tidal flats, lagoons, creek mouths, and river deltas within 0.8 km of the coast (Figure 11). As in 1989 and 1990, few Brant were recorded in inland portions of the study area. No Brant were recorded east of the Shaviovik River delta.

Areas used by large brood-rearing groups of Brant in 1991 (Figure 11) were similar to those used in 1989 and 1990 (Ritchie *et al.* 1991). The largest groups were recorded on the western shore of Prudhoe Bay near the mouth of the Putuligayuk River, at creek mouths and embayments within 10 km of Milne Point, near Kalubik Creek, and on the Kadleroshilik River delta. Few Brant were

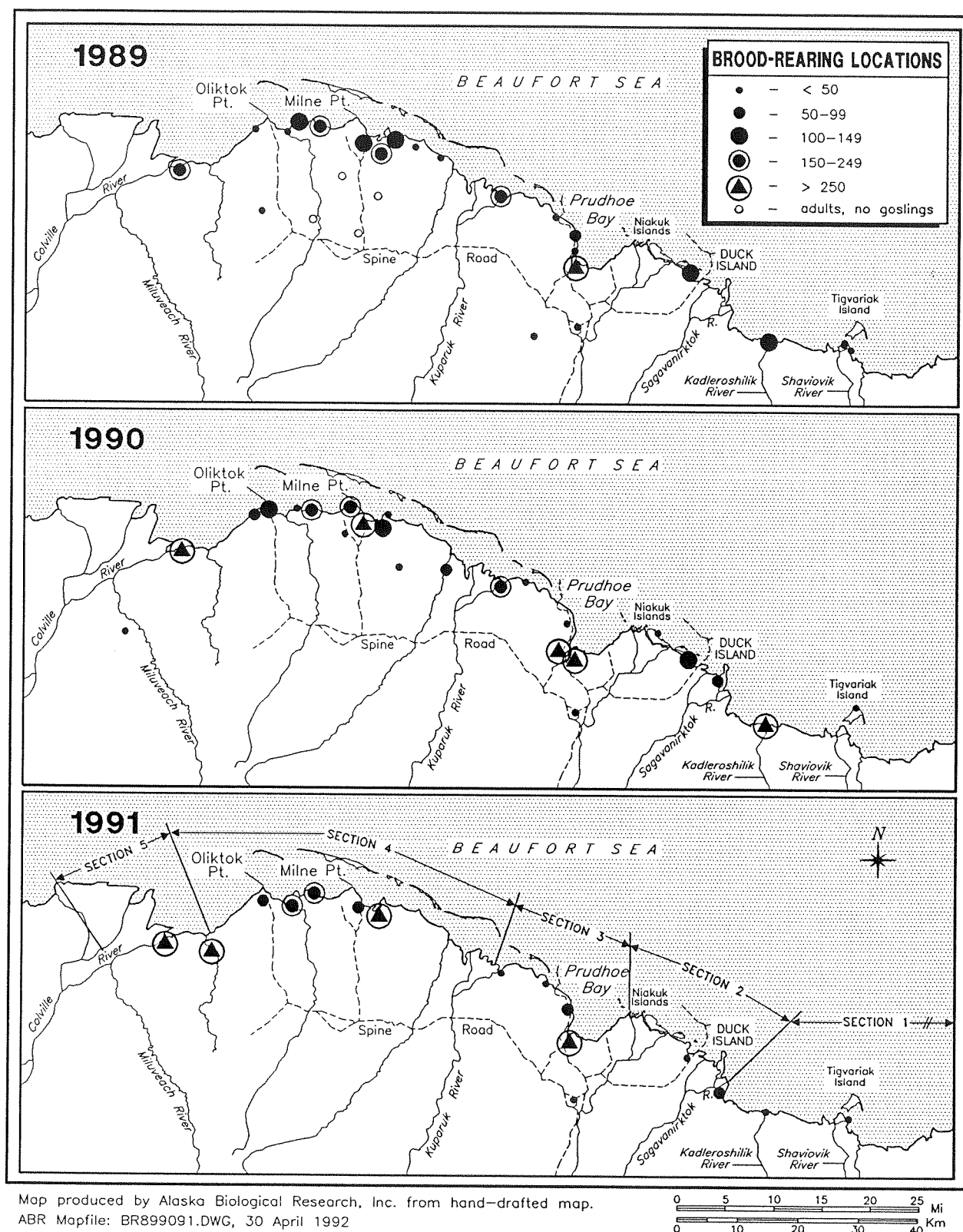


Figure 11. Locations and sizes of Brant brood-rearing groups on the Arctic Coastal Plain between the Colville and Staines rivers, Alaska, July 1989-1991.

Table 10. The distribution, size, and composition of brood-rearing groups of Brant, as determined by two aerial surveys on the Arctic Coastal Plain between the Colville and Staines rivers, Alaska, 31 July and 3-4 August 1991.

Location	Km of Coastline	<u>31 July Survey²</u>			<u>3-4 August Survey</u>		
		Adults	Goslings	Total	Adults	Goslings	Total
<u>Coastal Sections³</u>							
1: Brownlow Pt. to Sagavanirktok R.	97	75	30	105	97	35	132
2: Sagavanirktok R. Delta	32	6	7	13	6	9	15
3: Heald Point to Kuparuk R.	45	364	105	469	355	99	454
4: Kuparuk R. to Kalubik Ck.	80	391	257	648	469	301	770
5: Kalubik Ck. to Miluveach R.	48	241	313	554	226	238	464
TOTAL (coast)	302	1077	712	1789	1153	682	1835

¹ Numbers are counts from photos and aerial counts (if photos were not available).

² Includes an inland group: 2 adults + goslings near Lake Coleen.

³ Coastal sections are as shown in Figure 1.

recorded at sites used in previous years adjacent to the Kuparuk River and Sagavanirktok River deltas.

The differences in numbers of Brant among years probably are not unusual. Extreme yearly variation in productivity has been reported in other Brant populations (Barry 1962, Pacific Flyway Council 1981). Numbers of Brant on fall staging areas in southwestern Alaska also have varied widely among years (Conant 1989), reflecting annual variation in productivity in the western Arctic.

Section 1: Staines River (Brownlow Point) to Sagavanirktok River

Mean counts of 119 Brant (33 goslings; 27% of the total) were recorded in channels of the Kadleroshilik and Shaviovik river deltas during aerial surveys (Figure 11, Table 10). No Brant were recorded east of the Shaviovik River. Numbers decreased substantially along this section of coast in 1991 from those in 1990 (551 birds; Figure 11, Table 11) but were similar to those recorded in 1989 (146 birds). Although the proportion of goslings was lower than that for the entire region, it was higher than the proportion for this section in 1989 (23%; Figure 12).

Section 2: Sagavanirktok River delta

In late July, a lone brood-rearing group (6 adults, 7-9 goslings) was recorded on the Sagavanirktok River delta near the Endicott Road (Figure 11). This level of use was substantially lower than that recorded in 1989 (range = 10-60 birds/group) and 1990 (range = 141-198 birds/group). Large groups of brood-rearing Brant were not expected, however, because productivity was nonexistent on Howe Island and low on Duck Island in 1991.

Section 3: Heald Point to Kuparuk River

Mean counts of 462 Brant (102 goslings; 22% of the total) were made in this region during aerial surveys (Figure 11, Table 10). Most birds (> 260

Table 11. A comparison of average counts of brood-rearing Brant (as determined by two late July aerial surveys) for the coastal regions between the Colville and Staines rivers, Alaska, 1989 - 1991.

Location	Average No. Adults			Average No. Goslings		
	1989	1990	1991	1989	1990	1991
1. Brownlow Point to Sagavanirktok R.	113	286	86	33	265	33
2. Sagavanirktok R. Delta	50	87	6	73	83	8
3. Heald Point to Kuparuk R.	234	439	360	121	315	102
4. Kuparuk R. to Kalubik Cr.	406	684	430	294	701	279
5. Kalubik Cr. to Miluveach R.	109	176	234	87	203	276
TOTAL	912	1672	1116	608	1567	698

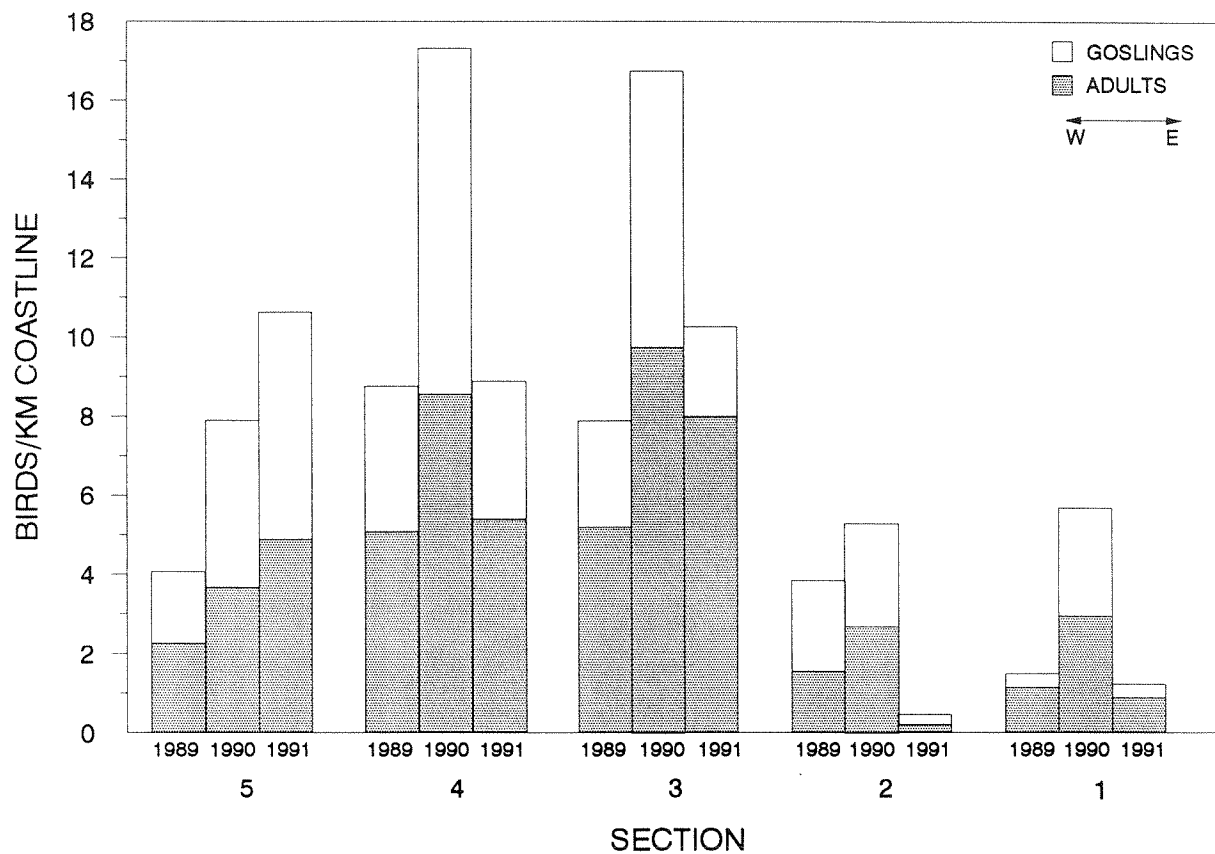


Figure 12. Linear densities of adult Brant and goslings in each of 5 coastal sections of the study area between the Colville and Staines rivers, Alaska, late July-early August 1989 - 1991.

adults, > 50 goslings) were observed at the mouth of the Putuligayuk River, an area that was used heavily in 1989 and 1990. Small brood-rearing groups also were observed near Pt. Storkersen and along the northwestern coast of Prudhoe Bay (Figure 11). Five Brant (2 adults, 3 goslings) were observed 6 km inland at Lake Coleen (31 July). This site also was used in 1989 and 1990.

Numbers of both adults and goslings in this section in 1991 were substantially lower than in 1990 (755 Brant, 41% goslings) but higher than numbers in 1989 (355 Brant; 34% goslings; Table 11). In addition, as in previous years, this section had the highest density (8.0/km of coast) of adult Brant but the lowest proportion of goslings, among the 5 sections (Figure 12, Table 10). The decrease, especially in goslings, may have been due to low productivity in the Sagavanirktok River delta, which in previous years has been the largest contributor to brood-rearing groups in this section (Ritchie *et al.* 1991).

Section 4: Kuparuk River delta to Kalubik Creek

Mean counts of 709 Brant (279 goslings; 39% of the total) were observed in this section during aerial surveys (Figure 11, Table 10). Primary areas of use included bays and salt-marsh near Milne Point, north and east of the mouth of the Ugnuravik River, and near Oliktok Point (Figure 11).

As in 1989 and 1990, brood-rearing groups were not recorded on the central Kuparuk River delta or coastal areas and embayments west to Back Point. Numbers, and consequently densities (5.4 adults/km; 3.5 goslings/km; Figure 12), were substantially lower than in 1990 (1,385 Brant; 8.6 adults/km; 8.8 goslings/km), but were nearly identical with those recorded in 1989 (700 Brant; 5.1 adults/km, 3.7 goslings/km; Figure 12, Table 11). The decrease from 1990 (especially goslings) may have been due to the abandonment of colonies at the mouth of the Kuparuk River and near Beechey Mound (east of Milne Point Road).

Section 5: Kalubik Creek to Miluveach River

An average of 510 Brant (276 goslings; 54% of the total) were recorded in this area on aerial surveys (Figure 11, Tables 10 and 11). Brant occupied large tidal flats next to the eastern channel of the Colville River and the mouth of Kalubik Creek.

This coastal section was the only one in which Brant numbers were higher (131 birds; a 35% increase) in 1991 than in 1990 (Table 11). Numbers in this region are influenced by immigration of Brant from Colville River colonies, however. The number of Brant observed west of Oliktok Point increased from June (108 adults) to July (241 adults). There also was an increase in numbers near Milne Point from late July to early August, as reflected in the increase of > 170 birds in the section 4 survey counts. Most of the increase in both areas probably was due to Brant moving east from the Colville Delta, the only colony in the area large enough to be a source for the additional birds. Results of banding activities in the area also support wide-ranging movements of Colville River Brant.

BRANT BANDING

Fourteen Brant were captured and banded on 8 August near the mouth of the Kuparuk river, and 121 were captured and banded on 9 August on the western shore of Prudhoe Bay (Table 12). These flocks included 63 goslings that ranged in developmental stages from large but still completely downy, to fully feathered with only a few downy plumes left on the heads. Some adult Brant could fly, and approximately 7-10 birds escaped during capture or from the corral. Two recaptures were recorded during banding: AH6 (white code on green band; Colville River band) near the Kuparuk River and R1H (black code on yellow band; Yukon-Kuskokwim Delta band) near Prudhoe Bay. Banding summaries have been included in Appendix 10.

Brant banded in 1991 already are generating information about staging and wintering areas for North Slope birds. There were 20 sightings in Izembek

Table 12. Sex- and age-composition of Brant captured and banded near the Kuparuk River and Prudhoe Bay, Alaska, August 1991.

Location	Age	Unbanded Birds			Recaptures			Total	
		Male	Female	Unknown Total	Male	Female	Unknown Total	Male	Female Unknown Total
Kuparuk	Goslings	4	1	2	7	0	0	0	0
	Subadults	0	0	0	0	0	0	0	0
	Adults	2	4	0	6	0	1 ¹	2	5
	TOTAL	6	5	2	13	0	1	6	2
Prudhoe Bay	Goslings	31	25	0	56	0	0	31	25
	Subadults	2	2	0	4	0	0	2	2
	Adults	26	33	1	60	12 ²	0	27	33
	TOTAL	59	60	1	120	1	0	60	60
TOTAL	Goslings	35	26	2	63	0	0	35	26
	Subadults	2	2	0	4	0	0	2	2
	Adults	28	37	1	66	1	1	29	38
	TOTAL	65	65	3	133	1	1	66	66

¹ Colville River Band (white on green)

² Yukon-Kuskokwim Band (black on yellow)

Lagoon on the Alaska Peninsula of Brant banded in the oil fields by 4 October 1991, but fewer sightings of these banded birds in the wintering areas in Mexico (Dave Ward, USFWS, pers. comm.). Continued banding and resightings will provide further information on migration of North Slope Brant as well as the relationships between birds banded in different areas within the oil fields and with those banded in other areas of the state.

LITERATURE CITED

- Alaska Biological Research, Inc. 1991. Procedures Manual for Brant Banding in the North Slope Oil Fields, 1991. Working Draft prepared for 1991 Brant Banding Cooperators by Alaska Biological Research, Inc., Fairbanks, AK.
- Alaska Department of Fish and Game (ADF&G). 1990. Unpubl. rep. prepared by ADF&G, Div. Wildl. Conserv., Anchorage, AK. 2 pp.
- Bailey, A.M., C.D. Brower, and L.B. Bishop. 1933. Birds of the region of Point Barrow, Alaska. Program of Activities, Chicago Acad. Sci. 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.
- 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. USFWS, Fairbanks, AK.
- 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. USFWS, Resour. Publ. 129: 1-38 p.
- Campbell, B.H., T.C. Rothe and D.H. Rosenberg. 1989. Annual Report of Survey Inventory Activities, Vol. XVIII, Part XIII: Waterfowl. Fed. Aid Wildl. Restor. Proj. W-22-6, Job 11.0. ADF&G, Juneau, AK.
- Campbell, B.H., and T.C. Rothe. 1990. Annual Report of Survey Inventory Activities, Vol. XIX, Part XIII: Waterfowl. Fed. Aid Wildl. Restor. Proj. W-23-2, Job 11.0. ADF&G, Juneau, AK.
- Cochran, W.G. 1977. Sampling techniques. Wiley, New York, NY. 428 pp.
- Conant, B., and S.L. Cain. 1987. Alaska Tundra Swan status report, 1987. Unpubl. report prepared by USFWS, Off. Migr. Bird Manage., Juneau, AK. 17 pp.

- Conant, B. 1989. Alaska productivity surveys of geese, swans, and Brant. Unpubl. report prepared by USFWS, Off. Migr. Bird Manage., Juneau, AK. 28 pp.
- Derksen, D.V., W.D. Eldridge, and T.C. Rothe. 1979. 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. USF&WS, Anchorage, AK.
- Divoky, G.J. 1978. Identification, documentation, and delineation of coastal migratory bird habitat in Alaska: Breeding bird use of barrier islands in the northern Chukchi and Beaufort seas. Pages 482-548 *in* Environ. Assess. Alaskan Cont. Shelf, Annu. Rep. Principal Invest., Vol. 1, OCSEAP BLM/NOAA, Boulder, CO.
- Gavin, A. 1977. Ecological and environmental report: Prudhoe Bay region, North Slope of Alaska 1977. Unpubl. report prepared for ARCO, Alaska, Inc., Anchorage, AK. 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.
- Hampton, P.D., L.C. Orr, and L.C. Byrne. 1988. An evaluation of the effects of noise on waterfowl in the vicinity of CPF-3, Kuparuk Field, Alaska. Unpubl. Report prepared by ESE, for ARCO Alaska, Inc., Anchorage, AK.
- Hansen, H.A. 1957. Annual waterfowl report, Alaska. Unpubl. report prepared by U.S. Bur. Sport Fish. and Wildl., Fairbanks, AK. 7 pp.
- Hawkins, L. 1983. Tundra Swan study, 1983 progress report. Unpubl. report prepared by USFWS, Anchorage, AK. 6 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. Pages 1-53 *in*: B.J. Gallaway and S.R. Johnson, eds., Environmental Monitoring Studies (Summer 1984) for the Endicott Development. Unpubl. Report for Sohio Alaska Petroleum Company, Inc., Anchorage, AK by LGL Alaska Research Associates, Inc., Anchorage, AK.

- 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, J.G., and J.I. Hodges. 1980. A correlation between *Cygnus Columbianus columbianus* territories and water bodies in western Alaska. Pages 26-33 in G.V.T. Matthews and M. Smart. Proceedings 2nd International Swan Symposium, Sapporo, Japan. IWRB Slimbridge, Gloucester, England.
- 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. USFWS, Anchorage, AK.
- Lensink, C.J. 1973. Population structure and productivity of Whistling Swans on the Yukon Delta, Alaska. *Wildfowl* 24:21-25.
- McLaren, M.A., and P.L. McLaren. 1984. Tundra Swans in northeastern Keewatin District, N.W.T. *Wilson Bull.* 96:6-11.
- 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. Fifth Annual Report prepared for ARCO Alaska, Inc., Anchorage, AK., by Alaska Biological Research, Inc., Fairbanks, AK. 275 pp.
- National Oceanic Atmospheric Administration. 1991. Local climatological data: monthly summaries for Prudhoe Bay, Alaska. National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC.
- O'Neill, E.J. 1979. Fourteen years of goose populations and trends at Klamath Basin refuges. Pages 316-322 in R.L. Jarvis and J.C. Bartonek, eds. Management and biology of Pacific Flyway geese. Oregon State University Press, Inc., Corvallis, OR.
- Pacific Waterfowl Flyway Council. 1981. Management plan, Pacific coast Brant. Unpubl. report prepared for Pacific Waterfowl Flyway Council Technical Committee. 75 pp.

- 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.
- Raveling, D.G. 1984. Geese and hunters of Alaska's Yukon Delta: management problems and political dilemmas. Trans. N. A. M. Wildl. Nat. Resour. Conf. 49:555-575.
- 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. report prepared for ARCO, Alaska, Inc., Anchorage, AK. by Alaska Biological Research, Inc. Fairbanks, AK. 26 pp.
- Ritchie, R.J., P.W. Banyas, A.A. Stickney, R.M. Burgess, and J.G. King. 1990. Tundra Swan and Brant surveys on the Arctic Coastal Plain, Colville River to Staines River, 1989. Unpubl. report prepared for ARCO Alaska, Inc., and BP Exploration (Alaska), Inc., Anchorage, AK. 138 pp.
- Ritchie, R.J., A.A. Stickney, P.W. Banyas, and J.G. King. 1991. Tundra Swan and Brant surveys on the Arctic Coastal Plain, Colville River to Staines River, 1990. Unpubl. report prepared for ARCO Alaska, Inc. and BP Exploration (Alaska), Inc., Anchorage, AK. 103 pp.
- Ryder, J.P. 1969. Egg-eating by wild Lesser Snow Geese (*Anser caerulescens*). Avicult. Mag. 75:23-24.
- 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.
- 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. ADF&G, Div. Game, Juneau, AK.
- 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. report prepared by USFWS, Fairbanks, AK. 83 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.
- U.S. Fish and Wildlife Service (USFWS). 1987. Trumpeter and Tundra swan survey protocol update. Unpubl. memorandum prepared by USFWS, Off. Migr. Bird Manage., Juneau, AK. 8 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 Engineering, Hanover, NH. 69 pp.
- Wilk, R.J. 1988. Distribution, abundance, population structure, and productivity of Tundra Swans in Bristol Bay, Alaska. *Arctic* 41:288-292.

Appendix 1. Summary of Tundra Swan and Brant aerial surveys conducted in the Kuparuk and Prudhoe Bay oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June-August, 1991.

Survey Type	Location ¹	Date	Aircraft	Flight Time (hrs)	Transect Length (km)
<u>Swan</u>					
Nesting	Kuparuk oil field and OGL 54	20-26 June	C-185	25	2375
	Prudhoe Bay oil field	20-26 June	C-185	5	484
Intensive Nesting	Kuparuk oil field	20-26 June	C-185	7	306
Brood-Rearing	Kuparuk oil field and OGL 54	17-21 August	C-185	25	2375
	Prudhoe Bay oil field	17-21 August	C-185	5	484
<u>Brant</u>					
Nesting	Miluveach R. to Staines R. inland to 20 km	27-28 June	C-180		
Brood-rearing	Kuparuk Delta and coastline (Tigvariak Island to Milne Point)	12-13 July	PA-18		
		20 July			
	Coastline, Miluveach R. to Staines R.	31 July	PA-18		
	Resurvey of coastline (Miluveach R. to Staines R.)	3-4 August	PA-18		

¹ Locations are mapped on Figure 1.

Appendix 2. Aerial survey coverage of USGS quadrangles in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) and Prudhoe Bay oil field study areas, Alaska, 1991.

Location	USGS Quadrangle	Transect Length (km)	Aerial Coverage (km ²)	Percent* Coverage
Kuparuk oil field				
Beechey Point	A-4	172	275	100
	A-5	138	221	35
	B-4	283	453	100
	B-5	390	624	100
	C-4	1	1	100
	C-5	8	13	100
Harrison Bay	A-1	124	199	32
	B-1	260	417	100
	B-2	41	65	100
OGL 54				
	A-2	191	306	76
	A-3	63	101	100
Umiat	C-2	91	146	47
	C-3	94	150	100
	D-2	291	465	74
	D-3	228	365	100
Kuparuk oil field Total		1417	2268	
OGL 54 Total		958	1533	
Kuparuk/OGL 54 Total		2375	3801	
Prudhoe Bay oil field				
Beechey Point	A-3	198	318	100
	A-4	73	115	100
	B-3	173	275	100
	B-4	44	70	100
Total		484	778	

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

Appendix 3.

Numbers of Tundra Swans and Tundra Swan nests recorded (by quarter quads) during aerial surveys in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 21 - 26 June 1991.

Location (USGS quadrangle)	Quarter Quad	Adults		Nests		Adults Without Nests					Total Swans
		With Nests	With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
Beechey Point	A-4	0	0	0	0	0	1	0	0	5	6
		-	-	-	-	-	-	-	-	-	-
		2	1	0	1	1	1	1	7	10	12
		12	2	8	10	1	5	1	3	10	22
		14	3	8	11	4	8	2	10	25	40
	A-5	3	1	1	2	3	3	0	0	9	12
		0	0	0	0	0	0	1	5	5	5
		-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0
		3	1	1	2	3	3	1	5	14	17
	B-4	5	2	1	3	6	2	0	0	14	19
		4	1	2	3	1	3	0	0	5	9
		14	4	6	10	3	9	0	0	15	29
		19	8	3	11	4	7	2	6	21	40
		42	15	12	27	14	21	2	6	55	97
	B-5	11	5	1	6	6	6	0	0	18	29
		3	0	3	3	11	10	0	0	32	35
		8	3	2	5	4	2	0	0	10	18
		8	1	6	7	3	3	1	4	13	21
		30	9	12	21	24	21	1	4	73	103
	C-4	-	-	-	-	-	-	-	-	-	-
		-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0
		-	-	-	-	-	-	-	-	-	-
		0	0	0	0	0	0	0	0	0	0

Appendix 3. Continued.

Location (USGS quadrangle)	Quarter Quad	Adults With Nests	Nests			Adults Without Nests					Total Swans
			With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	
C-5	NE	-	-	-	-	-	-	-	-	-	-
	SE	0	0	0	0	0	0	0	0	0	0
	SW	0	0	0	0	0	0	0	0	0	0
	NW	-	-	-	-	-	-	-	-	-	-
	Total	0	0	0	0	0	0	0	0	0	0
Harrison Bay A-1	NE	4	1	2	3	1	3	0	0	5	9
	SE	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-
	NW	1	0	1	1	5	4	0	0	14	15
	Total	5	1	3	4	6	7	0	0	19	24
A-2	*NE	0	0	0	0	5	0	0	0	10	10
	SE	4	1	2	3	3	3	0	0	9	13
	*SW	9	4	1	5	5	4	1	11	25	34
	*NW	0	0	0	0	0	0	0	0	0	0
	Total	13	5	3	8	13	7	1	11	44	57
A-3	NE	-	-	-	-	-	-	-	-	-	-
	*SE	2	1	0	1	1	3	1	12	17	19
	*SW	0	0	0	0	1	0	0	0	2	2
	NW	-	-	-	-	-	-	-	-	-	-
	Total	2	1	0	1	2	3	1	12	19	21
B-1	NE	2	0	2	2	0	2	1	9	11	13
	SE	10	3	4	7	4	2	1	14	24	34
	*SW	5	2	1	3	6	3	0	0	15	20
	*NW	0	0	0	0	0	0	0	0	10	10
	Total	18	5	8	13	13	9	2	23	58	76

Appendix 3. Continued.

Location (USGS quadrangle)	Quarter Quad	Adults With Nests	Nests			Adults Without Nests					
			With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	Total	Total Swans
B-2	NE	-	-	-	-	-	-	-	-	-	-
	*SE	0	0	0	0	2	2	0	0	6	6
	SW	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-
	Total	0	0	0	0	2	2	0	0	6	6
C-1	NE	-	-	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-
C-2	NE	0	0	0	0	0	0	0	0	0	0
	SE	-	-	-	-	-	-	-	-	-	-
	*SW	0	0	0	0	0	0	0	0	0	0
	NW	17	8	1	9	6	1	0	0	13	30
	Total	17	8	1	9	6	1	0	0	13	30
C-3	*NE	8	3	2	5	4	2	0	0	10	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	8	3	2	5	4	2	0	0	10	18
D-1	NE	-	-	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-

Appendix 3. Continued.

Location (USGS quadrangle)	Quarter Quad	Adults With Nests	Nests		Adults Without Nests					Total Swans
			With Pair	Single Adult	Total	Pairs	Singles	Flocks	Flocked Swans	
D-2	NE	5	2	1	3	2	1	0	0	5
	SE	2	1	0	1	4	0	0	0	8
	SW	9	3	3	6	4	5	0	0	13
	NW	12	5	2	7	10	8	0	0	28
	Total	28	11	6	17	20	14	0	0	54
Umiat	NE	5	2	1	3	5	4	0	0	14
	SE	7	2	3	5	10	3	0	0	23
	*SW	0	0	0	0	0	0	0	0	0
	*NW	0	0	0	0	1	0	1	3	5
	Total	12	4	4	8	16	7	1	3	42
Grand Total		192	66	60	126	127	104	11	74	433
										625

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

Appendix 4. Densities of Tundra Swans and nests (per km²) recorded during aerial surveys in the Kuparuk oil field and Oil and Gas Lease 54 (OGL 54) study areas, Alaska, June and August 1991.

Location	USGS Quadrangle	Nesting Survey (June)				Productivity Survey (August)							
		Adults With		Adults Without		Adults With		Adults Without		Total Adults	Total Swans		
		Nests	Nests	Nests	Nests	Broods	Broods	Young	Broods				
Kuparuk oil field													
Beechey Point	A-4	0.05	0.04	0.09	0.15	0.09	0.04	0.09	0.11	0.19	0.29		
	A-5	0.01	<0.01	0.06	0.08	0.02	<0.01	0.03	0.05	0.07	0.10		
	B-4	0.09	0.06	0.12	0.21	0.09	0.05	0.11	0.22	0.30	0.42		
	B-5	0.05	0.03	0.12	0.17	0.07	0.03	0.08	0.15	0.21	0.30		
	C-4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
	C-5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Harrison Bay	A-1	0.03	0.02	0.10	0.12	0.05	0.03	0.08	0.06	0.11	0.19		
	B-1	0.04	0.03	0.14	0.18	0.02	<0.01	0.03	0.25	0.27	0.30		
	B-2	0.00	0.00	0.09	0.09	0.11	0.06	0.20	0.12	0.23	0.43		
OGL 54													
Harrison Bay	A-2	0.04	0.03	0.14	0.18	0.05	0.03	0.08	0.22	0.27	0.35		
	A-3	0.02	0.01	0.19	0.21	0.04	0.02	0.07	0.09	0.13	0.20		
Umiat	C-2	0.12	0.06	0.09	0.21	0.08	0.04	0.12	0.08	0.16	0.28		
	C-3	0.05	0.03	0.07	0.12	0.04	0.02	0.07	0.12	0.16	0.23		
	D-2	0.06	0.04	0.11	0.17	0.05	0.03	0.07	0.20	0.25	0.31		
	D-3	0.03	0.02	0.12	0.15	0.03	0.02	0.05	0.16	0.19	0.24		
Kuparuk oil field Subtotal		0.05	0.03	0.11	0.16	0.06	0.03	0.08	0.16	0.22	0.29		
OGL 54 Subtotal		0.05	0.03	0.12	0.17	0.05	0.02	0.07	0.17	0.21	0.28		
Kuparuk/OGL 54 Total		0.05	0.03	0.11	0.16	0.05	0.03	0.07	0.16	0.22	0.29		

Appendix 5. Numbers of Tundra Swans and Tundra Swan broods recorded (by quarter quads) during aerial surveys in the Kuparuk oil field and the Oil and Gas Lease 54 (OGL 54) study areas, Alaska, 17-21 August 1991.

Location (USGS Quadrangle)	Quarter Quad	Adults with Broods	Broods		Mean Brood Size	Adults without Broods				Flocked Swans	Total Adults	Total Swans	Percent Young
			With Pair	With Single Adult		Young	Total	Adult	Pairs	Singles	Flocks		
Beechey Point	A-4	*NE	0	0	0	0	0	0	0	0	0	0	0
		SE	-	-	-	-	-	-	-	-	-	-	-
		*SW	2	1	4	4	1	1	1	0	0	3	5
		NW	22	11	22	2.0	9	0	2	8	26	48	70
		Total	24	12	26	2.2	10	1	2	8	29	53	79
A-5		NE	4	2	6	3.0	1	2	0	0	4	8	14
		SE	0	0	0	0	0	1	0	0	1	1	1
		SW	-	-	-	-	-	-	-	-	-	-	-
		NW	0	0	0	0	3	0	0	0	6	6	0
		Total	4	2	6	3.0	4	3	0	0	11	15	21
B-4		*NE	2	1	2	2.0	7	2	2	0	0	16	18
		*SE	4	2	5	2.5	2	1	0	0	5	9	14
		SW	18	8	26	2.6	10	5	3	13	38	56	82
		NW	16	8	16	2.0	9	3	5	18	39	55	72
		Total	40	19	50	2.4	28	11	8	31	98	138	188
B-5		NE	9	4	11	2.2	11	4	2	6	32	41	52
		SE	10	5	15	3.0	4	3	2	9	20	30	45
		SW	10	5	9	1.8	2	1	3	13	18	28	37
		NW	12	6	17	2.8	8	2	1	4	22	34	51
		Total	41	20	52	2.5	25	10	8	32	92	133	185
C-4		NE	-	-	-	-	-	-	-	-	-	-	-
		SE	-	-	-	-	-	-	-	-	-	-	-
		SW	0	0	0	0	0	0	0	0	0	0	0
		NW	-	-	-	-	-	-	-	-	-	-	-
		Total	0	0	0	0	0	0	0	0	0	0	0

Appendix 5. Continued.

Location (USGS Quadrangle)	Quarter Quad	Adults with Broods	Broods			Mean Brood Size	Adults without Broods					Total Adults	Total Swans	Total Percent Young
			With Pair	With Single Adult	Total		Young	Pairs	Singles	Flocks	Flocked Swans			
C-5	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	SW	0	0	0	0	0	0	0	0	0	0	0	0	0
	NW	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	0	0	0	0	0	0	0	0	0	0	0	0	0
Harrison Bay A-1	NE	6	3	0	3	2.7	8	3	0	0	0	6	12	20
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	4	2	0	2	3.5	7	2	2	0	0	6	10	17
	Total	10	5	0	5	3.0	15	5	2	0	0	12	22	37
A-2	*NE	1	0	1	1	2.0	2	4	1	2	8	17	18	20
	SE	8	4	0	4	3.5	14	2	2	3	17	23	31	45
	*SW	6	3	0	3	2.3	7	7	5	2	9	28	34	41
	*NW	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	15	7	1	8	2.9	23	13	8	7	34	68	83	106
A-3	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
	*SE	4	2	0	2	3.5	7	1	2	1	5	9	13	20
	*SW	0	0	0	0	0	0	0	0	0	0	0	0	0
	NW	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	4	2	0	2	3.5	7	1	2	1	5	9	13	20
B-1	NE	0	0	0	0	0	0	2	1	0	0	5	5	0
	SE	6	3	0	3	3.0	9	10	1	2	11	32	38	47
	*SW	2	1	0	1	4.0	4	12	1	4	18	43	45	49
	*NW	0	0	0	0	0	0	7	1	3	11	26	26	26
	Total	8	4	0	4	3.3	13	31	4	9	40	106	114	127

Appendix 5. Continued.

Location (USGS Quadrangle)	Quarter Quad	Adults with Broods	Broods			Mean Brood Size	Adults without Broods					Total Adults	Total Swans	Total Percent Young
			With Pair	With Single Adult	Total		Pairs	Singles	Flocks	Flocked Swans	Total			
B-2	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
	*SE	7	3	1	4	13	2	1	1	3	8	15	28	46.4
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	7	3	1	4	13	2	1	1	3	8	15	28	46.4
C-1	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-
C-2	NE	0	0	0	0	0	0	0	0	0	0	0	0	0
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-
	*SW	0	0	0	0	0	0	0	0	0	0	0	0	0
	NW	12	6	0	6	17	6	0	0	0	12	24	41	41.5
	Total	12	6	0	6	17	6	0	0	0	12	24	41	41.5
C-3	*NE	6	3	0	3	10	6	0	2	6	18	24	34	29.4
	*SE	0	0	0	0	0	0	0	0	0	0	0	0	0
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	*NW	0	0	0	0	0	0	0	0	0	0	0	0	0
	Total	6	3	0	3	10	6	0	2	6	18	24	34	29.4
D-1	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 5. Continued.

Location (USGS Quadrangle)	Quarter Quad	Adults with Broods	Broods			Mean Brood Size	Adults without Broods					Total Adults	Total Swans	Total Percent Young		
			With Pair	With Single Adult	Total		Pairs	Singles	Flocks	Flocked Swans	Total					
Umiat	D-2	NE	4	2	0	2	5	2.5	2	0	0	0	4	8	13	38.5
		SE	2	1	0	1	1	1.0	4	0	0	0	8	10	11	10.0
		SW	8	4	0	4	11	2.8	9	1	2	12	31	39	50	22.0
		NW	10	5	0	5	14	2.8	15	2	2	16	48	58	72	19.4
		Total	24	12	0	12	31	2.6	30	3	4	28	91	115	146	21.2
D-3	NE	8	4	0	4	13	3.3	8	2	1	4	22	30	43	30.2	
	SE	4	2	0	2	7	3.5	15	3	0	0	33	37	44	15.9	
	*SW	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	*NW	0	0	0	0	0	0	1	0	0	0	2	2	2	0	
	Total	12	6	0	6	20	3.3	24	5	1	4	57	69	89	22.5	
Grand Total		207	101	5	106	283	2.7	185	50	43	191	611	818	1101	25.7	

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

Appendix 6. Numbers of Tundra Swans and Tundra Swan nests recorded (by quarter quads) during aerial surveys in the Prudhoe Bay oil field study area, Alaska, 21 - 26 June, 1991.

Location (USGS quadrangle)	Quarter Quad	Adults With Nests		Nests With Single Adult		Adults Without Nests					Total Swans
		With Nests	With Pair	With Single Adult	Total	Pairs	Singles	No. Flocks	Flocked Swans	Total	
Beechey Point	A-3 NE	1	0	1	1	6	8	2	7	27	28
	SE	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-
	NW	7	2	3	5	1	7	0	0	9	16
	Total	8	2	4	6	7	15	2	7	36	44
A-4	*NE	4	2	0	2	4	3	1	5	16	20
	SE	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-
	NW	0	0	0	0	0	0	0	0	0	0
	Total	4	2	0	2	4	3	1	5	16	20
B-3	NE	0	0	0	0	0	0	0	0	0	0
	SE	8	3	2	5	0	5	1	3	8	16
	SW	7	3	1	4	3	1	2	8	15	22
	NW	1	0	1	1	2	1	0	0	5	6
	Total	16	6	4	10	5	7	3	11	28	44
B-4	*NE	0	0	0	0	0	0	0	0	0	0
	*SE	5	2	1	3	1	0	0	0	2	7
	SW	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-
	Total	5	2	1	3	1	0	0	0	2	7
Grand Total		33	12	9	21	17	25	6	23	82	115

Appendix 7. Densities of Tundra Swans and nests (per km²) recorded during aerial surveys in the Prudhoe Bay oil field study area, Alaska, during June and August 1991.

Location	USGS Quadrangle	Nesting Survey (June)				Productivity Survey (August)					
		Adults With Nests	Nests	Adults		Adults With Broods	Broods	Young	Adults		
				Without Nests	Total Adults				Without Broods	Total Adults	
Prudhoe Bay oil field											
Beechey Point	A-3	0.03	0.02	0.11	0.14	0.04	0.02	0.04	0.09	0.13	0.17
	A-4	0.03	0.02	0.14	0.17	0.05	0.03	0.06	0.09	0.14	0.20
	B-3	0.06	0.04	0.10	0.16	0.08	0.04	0.09	0.14	0.23	0.32
	B-4	0.07	0.04	0.03	0.10	0.09	0.04	0.09	0.03	0.11	0.20
TOTAL		0.04	0.03	0.11	0.15	0.06	0.03	0.07	0.10	0.16	0.23

Appendix 8. Numbers of Tundra Swans and Tundra Swan broods recorded (by quarter quads) during aerial surveys in the Prudhoe Bay oil field study area, Alaska, 17-21 August 1991.

Location (USGS Quadrangle)	Quarter Quad	Adults		Broods		Young		Adults Without Broods					Total Adults Swans	Total Swans
		With Broods	With Single Adult	With Pair	With Single Adult	Total		Pairs	Singles	Flocks	Flocked Swans	Total		
Beechey Point	A-3 NE	6	3	0	3	7	6	4	2	6	22	28	35	
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	6	3	0	3	6	3	0	0	0	6	12	18	
	Total	12	6	0	6	13	9	4	2	6	28	40	53	
A-4	*NE	6	3	0	3	7	3	1	1	3	10	16	23	
	SE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	0	0	0	0	0	0	0	0	0	0	0	0	
	Total	6	3	0	3	7	3	1	1	3	10	16	23	
B-3	NE	-	-	-	-	-	-	-	-	-	-	-	-	-
	SE	8	4	0	4	10	1	1	2	11	14	22	32	
	SW	11	5	1	6	13	5	4	1	9	23	34	47	
	NW	4	2	0	2	4	1	0	0	0	2	6	10	
	Total	23	11	1	12	27	7	5	3	20	39	62	89	
B-4	*NE	0	0	0	0	0	0	0	0	0	0	0	0	
	*SE	6	3	0	3	6	1	0	0	0	2	8	14	
	SW	-	-	-	-	-	-	-	-	-	-	-	-	-
	NW	-	-	-	-	-	-	-	-	-	-	-	-	-
	Total	6	3	0	3	6	1	0	0	0	2	8	14	
Grand Total		47	23	1	24	53	20	10	6	29	79	126	179	

Appendix 9. Summaries of Tundra Swan counts during brood-rearing in a portion of the Kuparuk oil field (Beechey Point, B-5 quadrangle), Alaska, August 1986-1991.

Year	Adults		Broods		Mean Brood Size	Adults Without Broods					Total Adults	Total Swans	Percent Young
	With Broods	With Pair	With Single Adult	Total		Total Young	Pairs	Singles	Flocks	Flocked Swans			
1986 ¹	14	7	0	7	2.1	15	25	8	1	6	78	93	16.1
1987 ¹	22	11	0	11	2.4	26	18	14	3	10	82	108	24.1
1988 ²	29	14	1	15	2.3	34	23	7	1	3	85	119	28.6
1988 ³	28	13	2	15	2.1	31	25	3	2	8	89	120	25.8
1989 ⁴	34	16	2	18	2.0	36	31	3	1	4	103	139	25.9
1990 ⁵	47	23	1	24	2.8	67	21	19	3	9	117	184	36.4
1991	41	20	1	21	2.5	52	25	10	8	32	133	185	28.1
Mean (\bar{x})	30.7	14.9	1	15.9	2.35	37.3	24.0	9.1	2.7	10.3	98.1	135.4	26.4

¹ USFWS Survey - Conant and Cain 1987

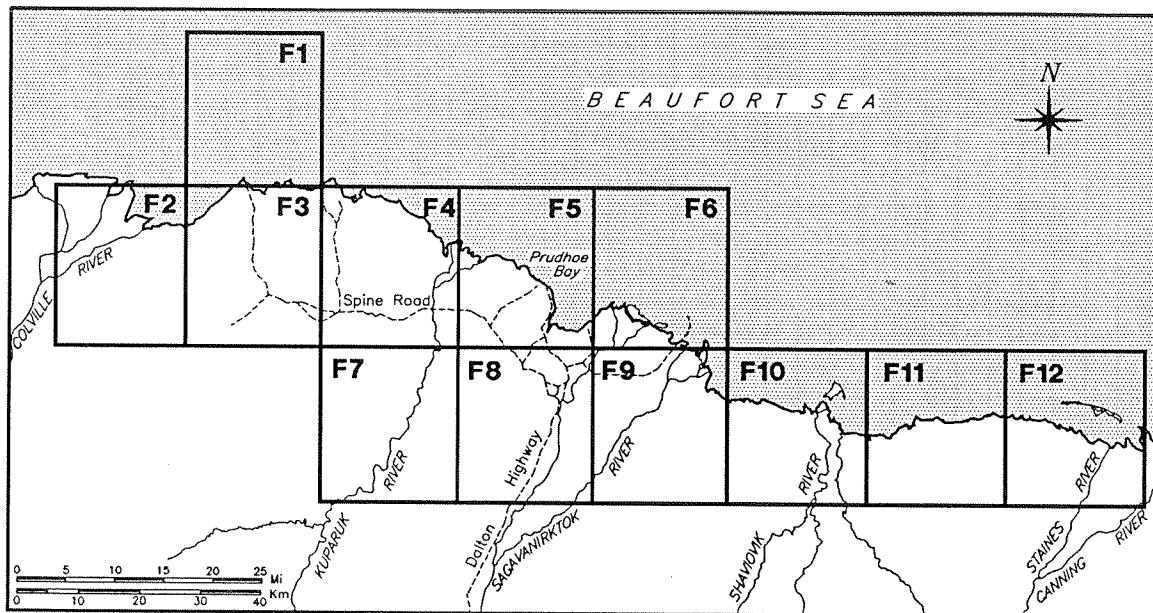
² USFWS Survey - R. King, USFWS, pers. comm.

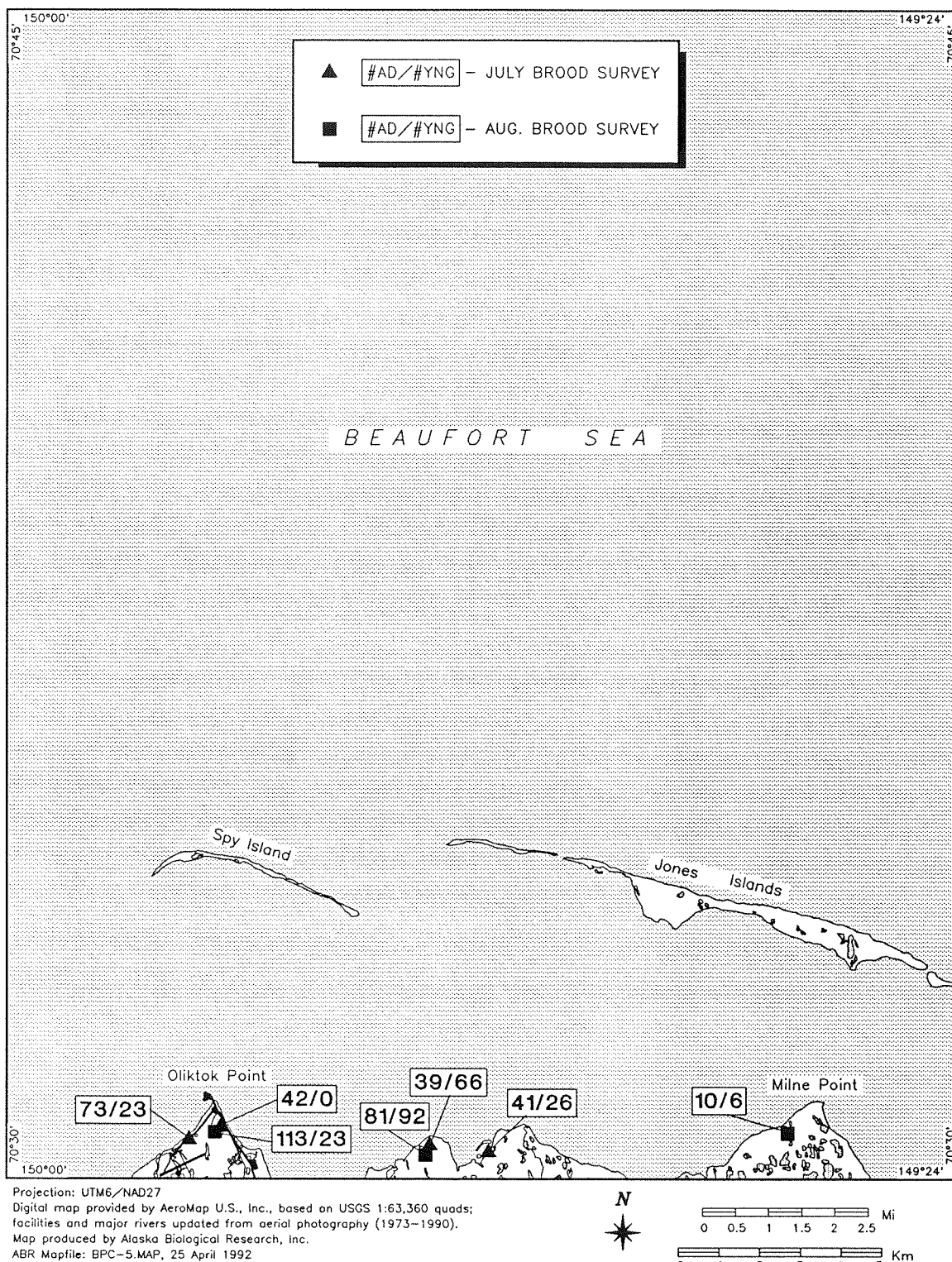
³ Ritchie et al. 1989

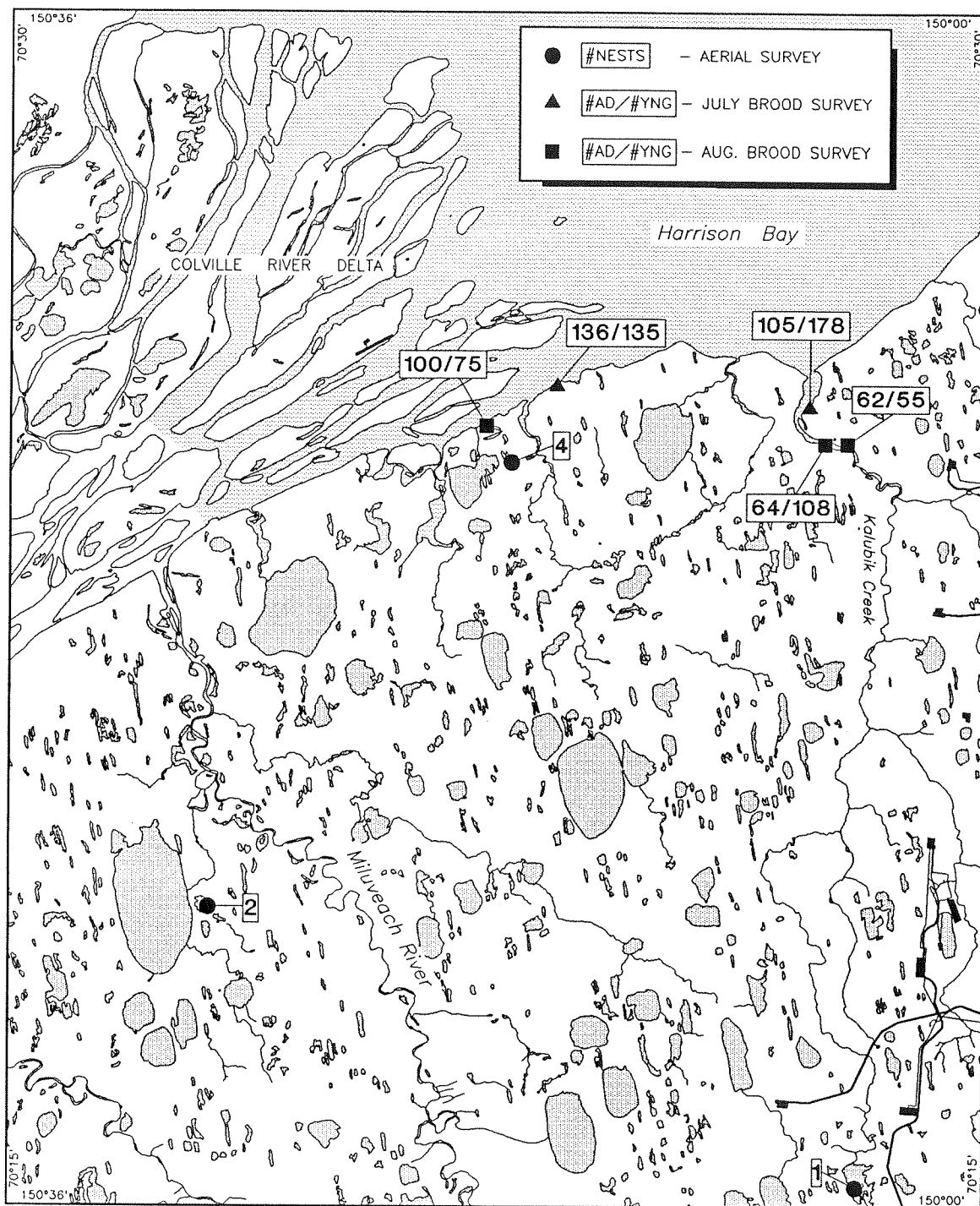
⁴ Ritchie et al. 1990

⁵ Ritchie et al. 1991

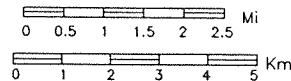
Appendix 10. Map locations of Brant nests and brood-rearing staging groups between the Colville and Staines rivers, Alaska, as determined from aerial and ground surveys in June and July, 1991.

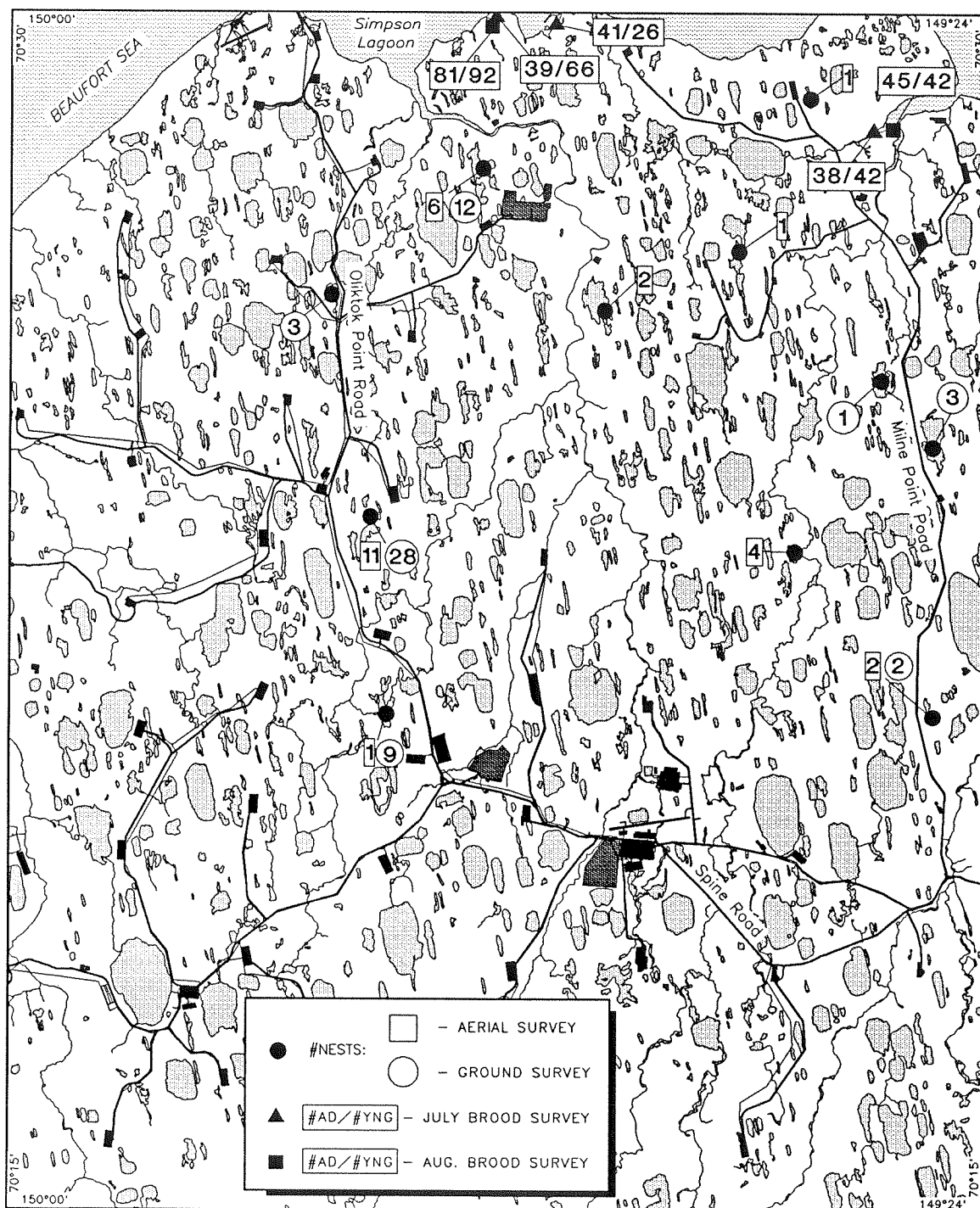




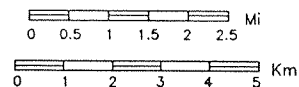


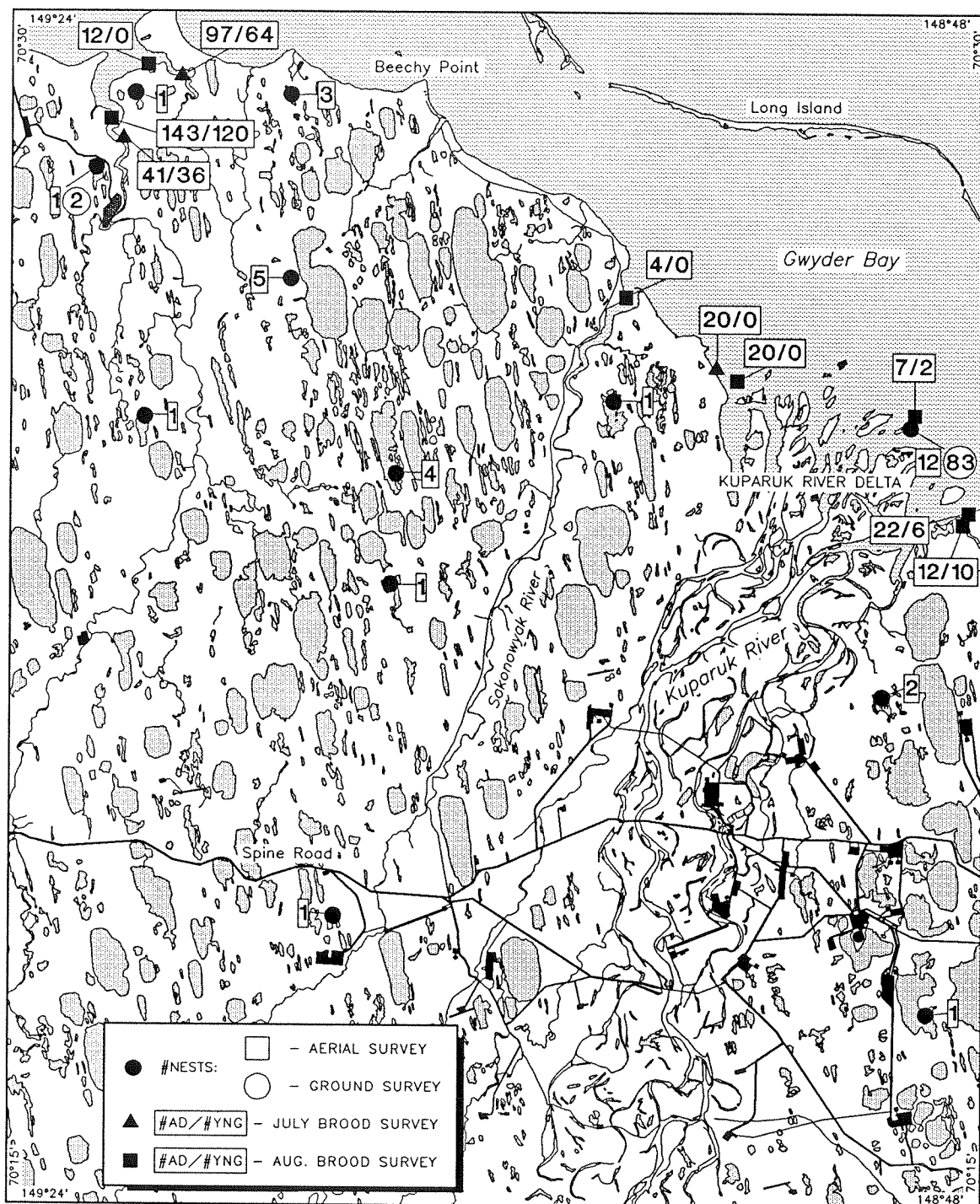
Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: HBB-1.MAP, 26 April 1992



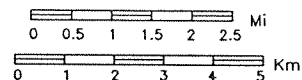


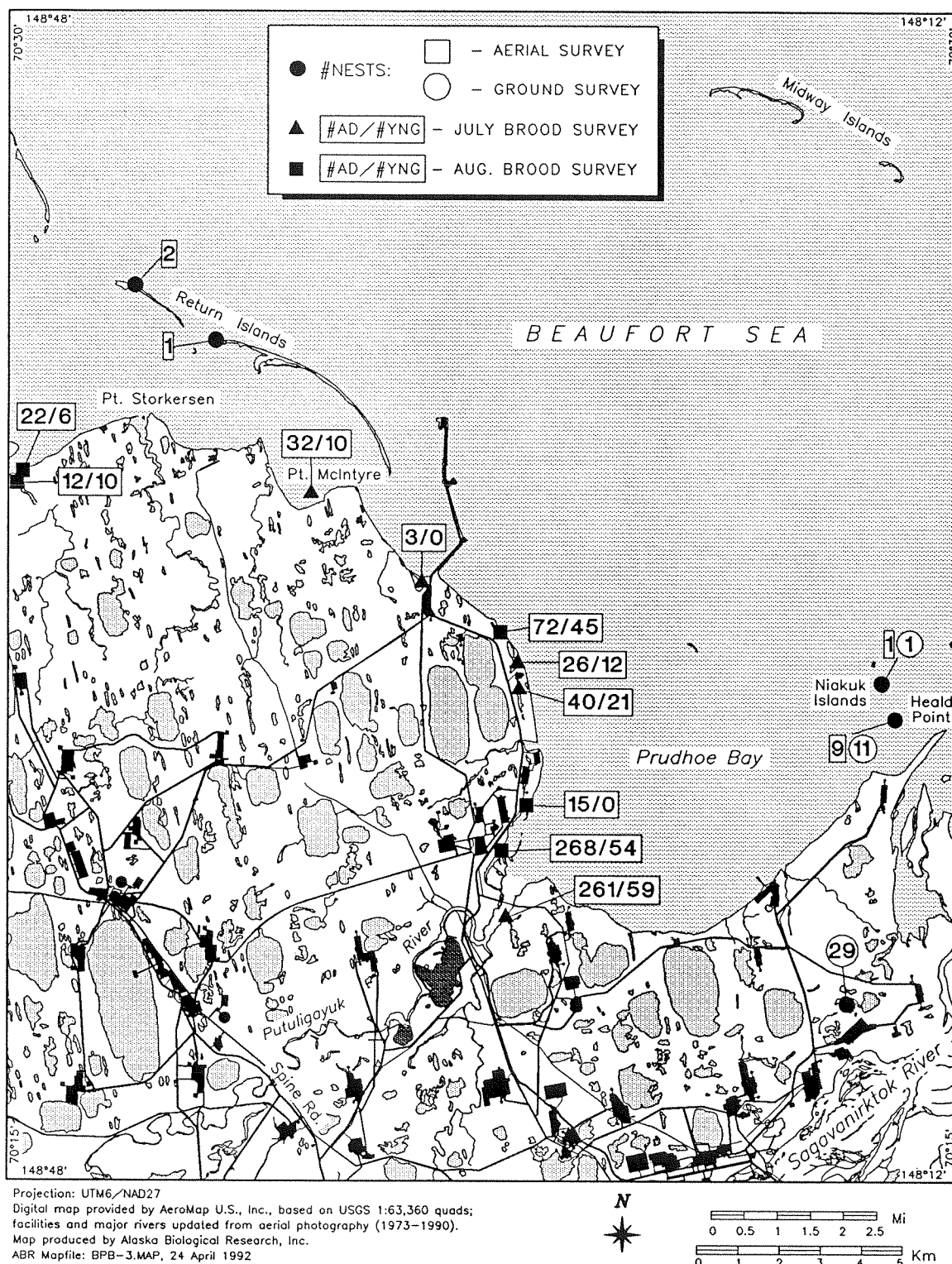
Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPB-5.MAP, 25 April 1992

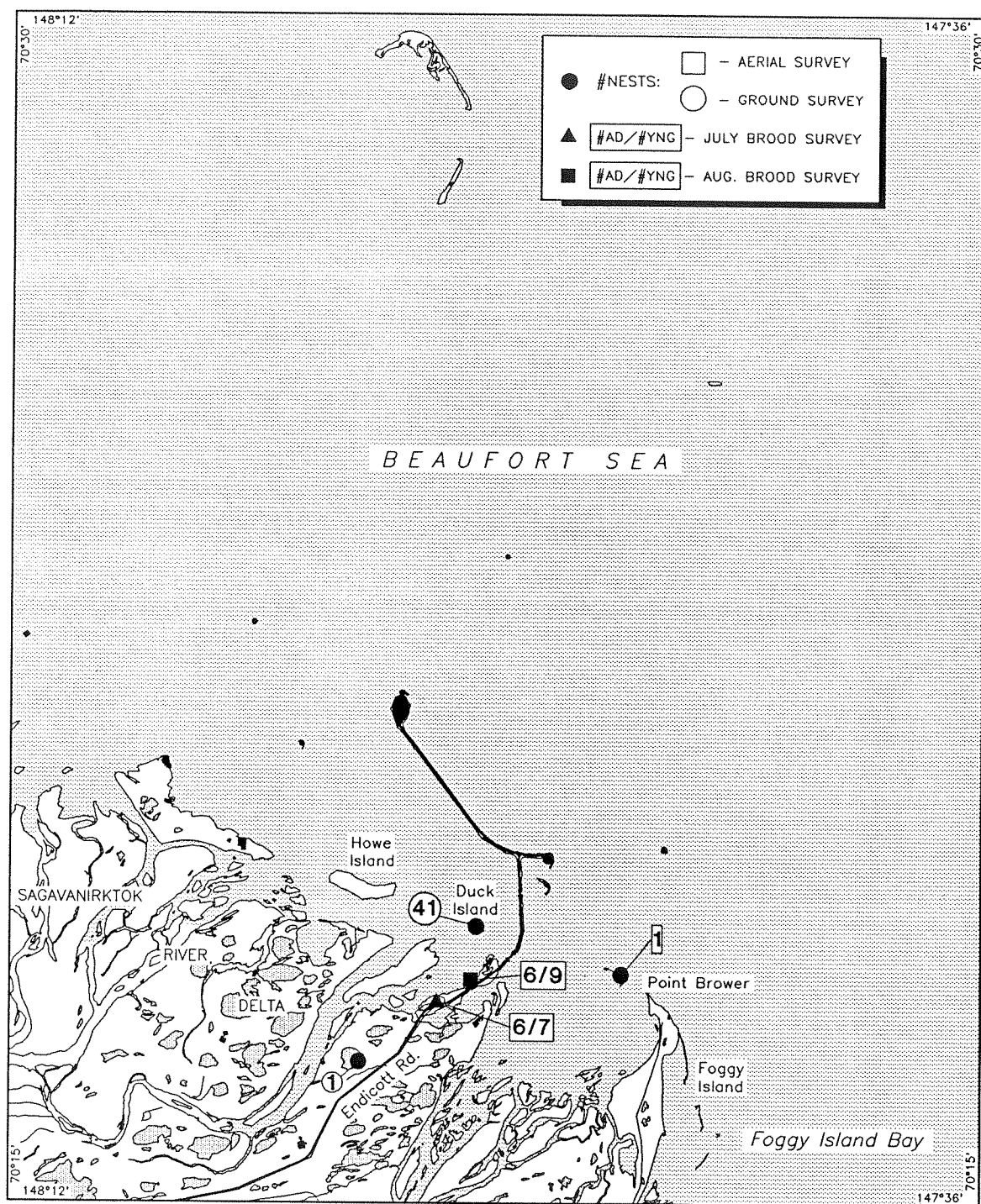




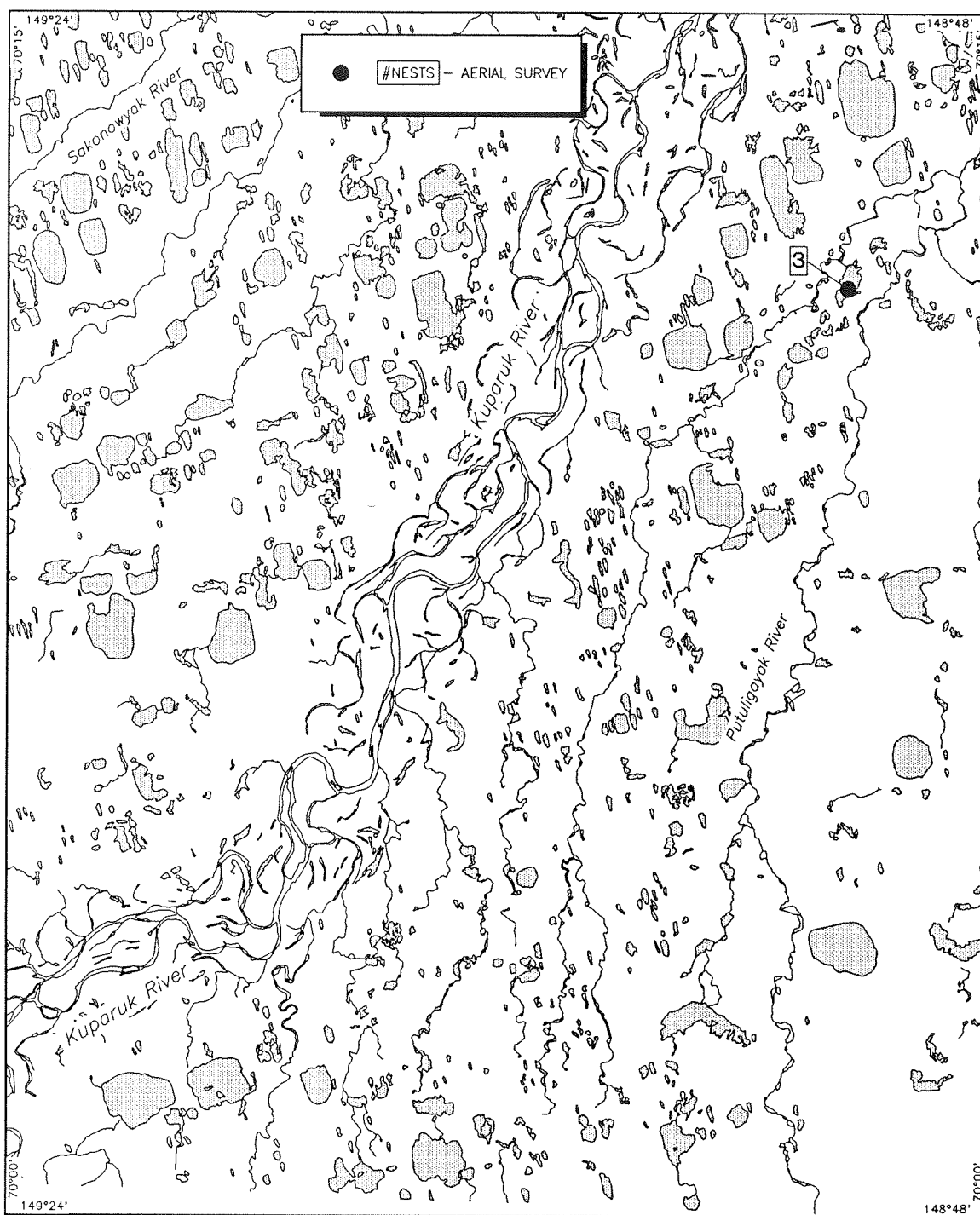
Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPB-4.MAP, 25 April 1992



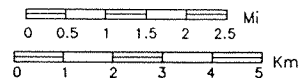


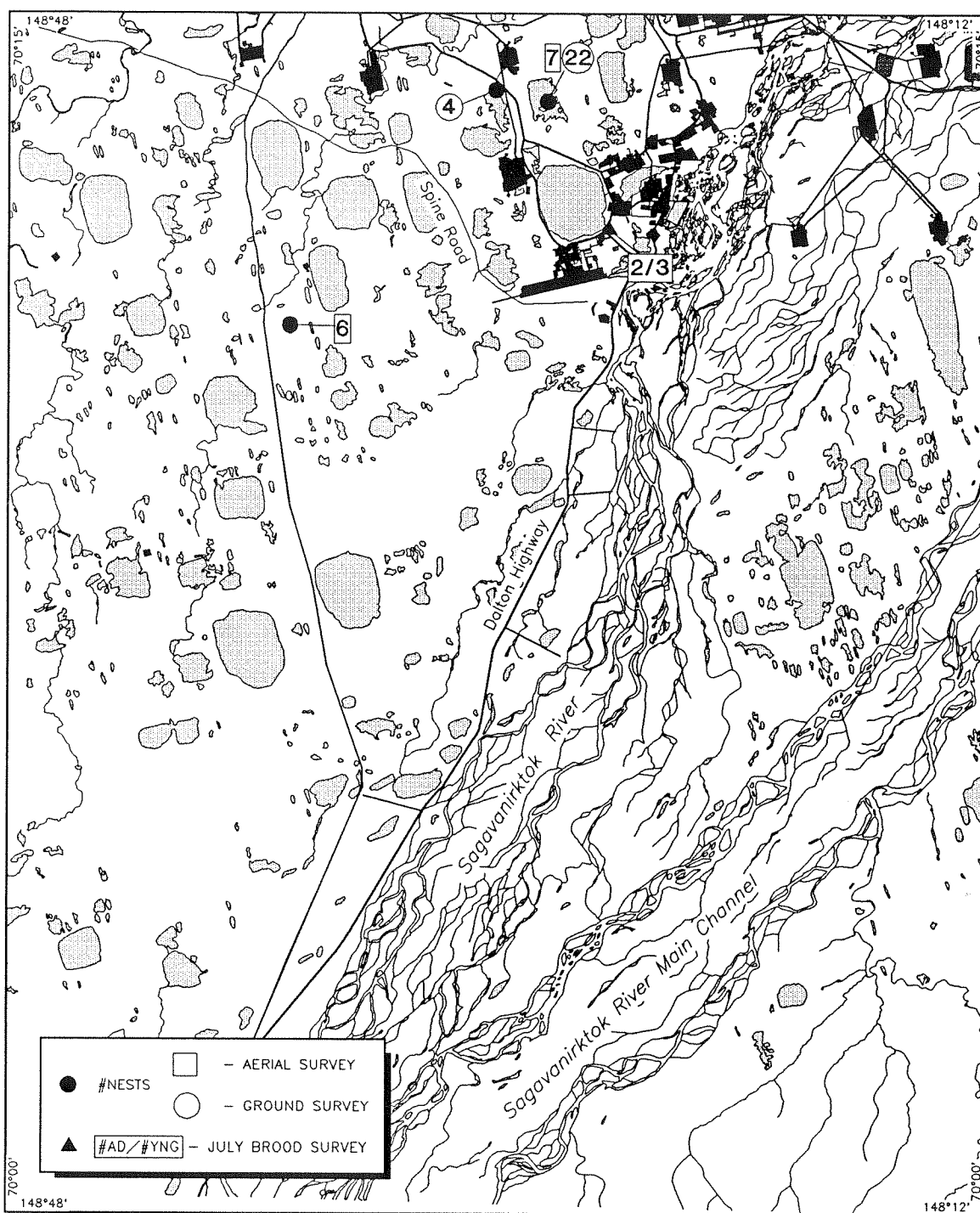


Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPB-2.MAP, 25 April 1992

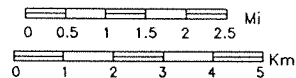


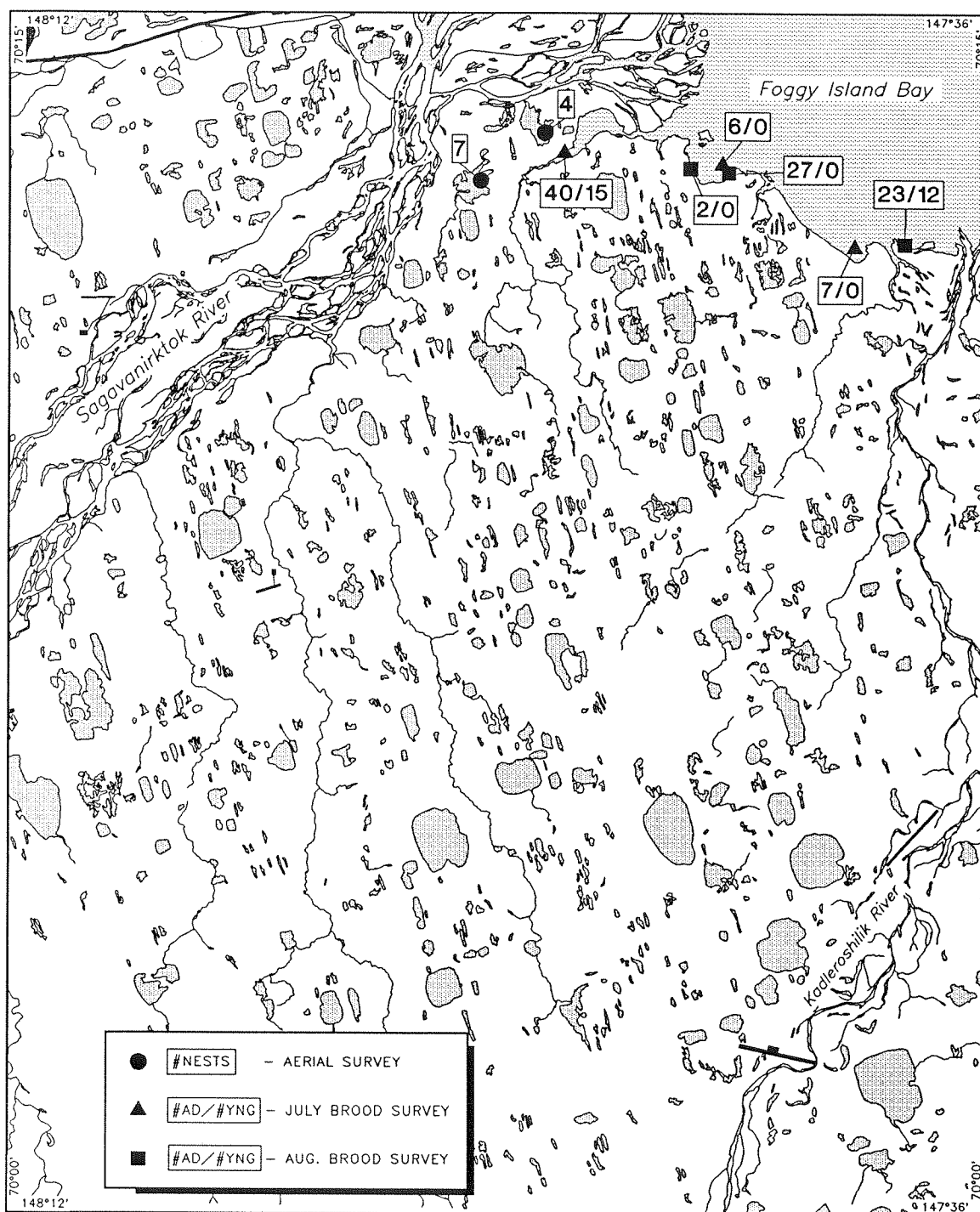
Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
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 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPA-4.MAP, 27 April 1992



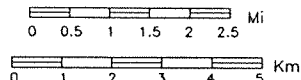


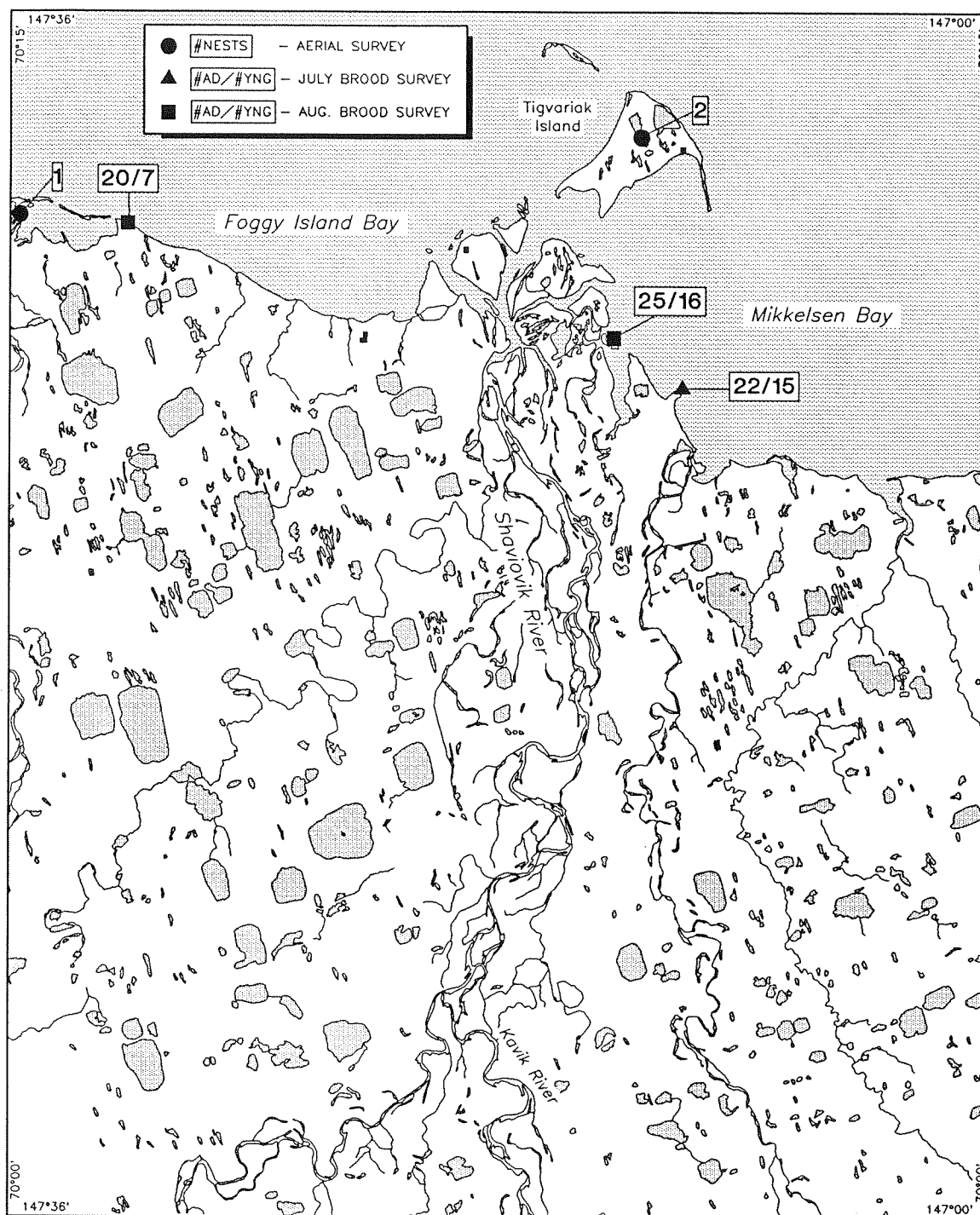
Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPA-3.MAP, 21 April 1992





Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPA-2.MAP, 25 April 1992





Projection: UTM6/NAD27
 Digital map provided by AeroMap U.S., Inc., based on USGS 1:63,360 quads;
 facilities and major rivers updated from aerial photography (1973-1990).
 Map produced by Alaska Biological Research, Inc.
 ABR Mapfile: BPA-1.MAP, 25 April 1992

