WILDLIFE STUDIES ON THE COLVILLE RIVER DELTA, ALASKA, 1992

Final Report

Prepared for

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EXECUTIVE SUMMARY

The primary objective of the 1992 Colville River Delta Wildlife Study was to evaluate the distribution, abundance, and use of specific areas of the delta by several species of birds and mammals. Four species of waterbirds and two species of mammals were chosen for reconnaissance-level field surveys: Yellow-billed Loon, Tundra Swan, Brant, Spectacled Eider, caribou, and arctic fox. These species were selected because of their status (i.e., rare or resource agency concern) or because of the relative importance of the Colville Delta to the species. Additional data were gathered in the field for five other species of waterbirds and two other species of mammals: Red-throated Loon, Pacific Loon, Greater White-fronted Goose, Canada Goose, King Eider, red fox, and muskoxen.

Wildlife studies consisted of aerial and ground surveys for waterbirds and aerial surveys for mammals in different portions of the Colville Delta and adjacent area to the east, depending on the species, the season, and the location of proposed oil exploration. Extensive aerial surveys of the Colville Delta were flown during nesting and brood-rearing for Tundra Swans and during pre-nesting for eiders. Coastal surveys were flown between Kalubik Creek and the Nechelik Channel to locate geese during brood-rearing and fall migration. Intensive aerial surveys and ground (lake-edge) surveys to locate nesting and brood-rearing waterbirds were conducted in six study plots on the delta during nesting (June) and hatch or brood-rearing (July).

The Colville Delta supports some of the highest breeding densities of Yellow-billed Loons in Alaska. Six Yellow-billed Loon nests were found in 1992 on the shorelines of untapped wetlands in study plots along the Tamayayak Channel in the central delta, the area where the highest densities of Yellow-billed Loons were found in the early 1980s. In 1992, Yellow-billed Loon nests were located on the same wetlands as nests found in the early 1980s, indicating high fidelity of Yellow-billed Loons to nest sites and territories. Brood size of Yellow-billed Loons in 1992 averaged 1.6 young/successful pair.

The highest breeding densities of Tundra swans on the Arctic Coastal Plain are found on major river deltas, including the Colville Delta. Two-hundred eighty-seven Tundra Swans and 19 nests were found by the Alaska Department of Fish and Game (ADFG) on the Colville Delta. Intensive aerial and ground surveys of study plots yielded 16 widely distributed swan nests. Brood-rearing surveys in 1992 located 26 broods and 65 groups of swans without young. Brood size (2.4 young/pair) was similar to the mean brood size (2.3 young/pair) recorded during 1983-89. Three-hundred thirty-six adults and 62 young (16% young) were seen during the brood-rearing survey, lower than the average of 21% young during 1983-89. The density of swans on the Colville Delta in June and August 1992 was higher than the 7-year (1983-1989) average density. Although the Colville Delta is a major fall-staging area for Tundra Swans, none were seen on a mid-September survey because of early freeze-up of the river in 1992.

The Colville Delta supports the largest nesting concentration of Brant along the Arctic Slope of Alaska. In 1992, 738 Brant nests were found on or adjacent to the Colville Delta; 97% of these nests were on islands at the mouth of the Eastern Channel. Mammalian predation caused significant (>20%) nest losses in 1992 and few brood-rearing groups of Brant were observed on the delta in 1992. However, more than 200 Brant were observed along the outer delta in late August during fall staging.

The Spectacled Eider, which may soon be listed at a threatened species, is an uncommon breeding bird on the Colville Delta. Three pairs of Spectacled Eiders were located during aerial surveys of the six study plots. One Spectacled Eider nest was found during ground surveys, but no broods were found. Four Spectacled Eider nests were found during Brant nest surveys on the eastern delta. Although the Spectacled Eider population is declining over its range, the low number of nests found on the Colville Delta in 1992 may not be unusual. Only 11 nests and 9 broods were found on the delta by the USFWS between 1981 and 1987.

Pacific Loons are the most abundant loon on the Colville Delta. Fifteen Pacific Loon nests were found on the delta in 1992 during aerial and ground surveys of study plots. Twelve broods ($\bar{x}$ = 1.33 young/brood) were located during ground surveys. Sixty percent of nests located during ground surveys were on islands. Consistent with the results of

previous studies, the Pacific Loon was the only loon found nesting in the northern delta in 1992, the most marine-affected area of the delta.

The Red-throated Loon is a common breeding bird on the Colville Delta. Four nests and three breeding pairs, each with two young, were found in the six study plots. Because Red-throated Loons usually nest on smaller ponds than do Yellow-billed and Pacific Loons, our lake-edge survey technique undersampled the preferred nesting habitat of this species.

The Colville Delta is a regionally important nesting area for Greater White-fronted Geese. Densities of birds and nests are the highest reported for Greater White-fronted Geese along the Arctic Coast. Intensive searches for Greater White-fronted Goose nests were not conducted on the Colville Delta in 1992; however, 30 nests were located incidentally during nest searches for other species. Clutch size was similar to the mean of clutch size recorded in 1982 and 1983. Twelve groups (2324 birds) of Greater White-fronted Geese were located in the coastal portion of the delta during fall staging in late August 1992.

No Canada Goose nests or broods were found on the Colville Delta during the nesting and brood-rearing seasons. However, nearly 11,000 Canada Geese in 23 groups were recorded on the delta during fall staging in late August 1992.

King Eiders nest in low densities on the Colville Delta. Nine pairs and small groups of King Eiders were found during aerial surveys in the six study plots. Four additional pairs and a mixed flock of King and Spectacled eiders were seen during a pre-nesting survey of the entire delta. No King Eider nests were found during ground surveys of study plots, although one brood was observed. Five King Eider nests were found during Brant nest surveys on the eastern delta.

Although no cow/calf groups of caribou were recorded during calving surveys (early to mid-June) in the delta, the area west of the Kuparuk Oilfield and east of the Colville Delta has become increasingly important as a calving area for the Central Arctic Herd since the late 1980s. Caribou using the Colville Delta are primarily from the Central Arctic Herd, although a radio-collared Teshekpuk Lake Herd caribou was found on the delta by ADFG for the first time in summer in 1992. Caribou use the Colville Delta primarily during the insect season (late June - mid-August). As many as 3300 caribou, concentrated in the northern portion of the delta, were observed during July surveys. Caribou in the study area dispersed during August and September.

Arctic fox dens have been reported in a number of locations in the delta, but at lower densities than in the Prudhoe Bay area. Only one active arctic fox den was found in the Colville Delta study area in summer 1992, but this may be related in part to the reconnaissance nature of the surveys.

Field surveys for other mammal species were not undertaken. However, site-specific information on several species, including muskoxen, polar and grizzly bears, and red fox, has been presented.

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ACKNOWLEDGMENTS

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INTRODUCTION

Located about midway between Pt. Barrow and Prudhoe Bay, the Colville River Delta (referred to hereafter as the Colville Delta), is the largest (600 km^2) river delta in Arctic Alaska. The Colville drainage basin encompasses 60,000 km^2, or 30% of the drainages on the Arctic Slope of Alaska. The volume and heavy sediment load of the Colville River produce a dynamic deltaic system characterized by diverse geomorphologic and biologic processes. These processes have created a mosaic of wetlands that provide important habitats for numerous waterbirds. Regionally important breeding habitats for Yellow-billed Loons (*Gavia adamsii*), Tundra Swans (*Cygnus columbianus*), and Brant (*Branta bernicla*) occur on the delta. The delta is a regionally important area for many birds during spring migration, providing open-water and snow-free areas while adjacent mainland areas remain covered by snow. The salt marshes and mud flats of the outer delta are used extensively during fall migration by several species of geese and shorebirds. Seventy-six species of birds have been recorded on the Colville Delta during the open-water season (Meehan and Jennings 1988). The delta also provides seasonally important habitats for several species of mammals including insect-relief habitat for caribou and denning habitat for arctic and red foxes.

Recognizing these resource values and in preparation for petroleum exploration on the Colville Delta, ARCO Alaska, Inc. commissioned Alaska Biological Research, Inc. (ABR) to conduct field studies of geomorphology and wildlife during summer 1992. Information also was synthesized from previous studies to provide perspective for the 1992 results. This report summarizes the results of the wildlife portion of the overall study effort. The geomorphology portion of the study is summarized under separate cover.

Four species of birds and two species of mammals were selected for reconnaissance-level field surveys in 1992: Yellow-billed Loon, Tundra Swan, Brant, Spectacled Eider (*Somateria spectabilis*), caribou (*Rangifer tarandus*), and arctic fox (*Alopex lagopus*). These species were accorded priority because of their status as rare or sensitive species, because of resource agency concerns, or because of the relative importance of the delta to the species. In addition to these high-profile species, information was gathered in the field for five other species of waterbirds and two other species of mammals: Red-throated Loon (*G. stellata*), Pacific Loon (*G. pacifica*), Greater White-fronted Goose (*Anser albifrons*), Canada Goose (*B. canadensis*), King Eider (*S. fischeri*), red fox (*Vulpes vulpes*), and muskoxen (*Ovibos moschatus*). These species also are relatively common in the region. Additional information on grizzly (brown) bears (*Ursos arctos*), polar bears (*U. maritimus*), and moose (*Alces alces*), was extracted from the literature.

The goal of the Colville River Delta Wildlife Study was to investigate the use of selected areas of the delta by these birds and mammals during June-September 1992. Four specific objectives were identified:

1. describe the distribution and abundance of selected avian species during the nesting, brood-rearing, and fall-staging seasons;

2. describe the distribution and abundance of caribou during the calving and post-calving seasons;

3. locate and determine the status of arctic fox dens;

4. synthesize existing information from the literature on the use of the delta by waterbird and mammal species.

We hired technicians from the village of Nuiqsut, located near the inland apex of the delta, to assist in accomplishing these objectives. Their navigational skills and knowledge of the delta were invaluable to the project.

PREVIOUS WILDLIFE STUDIES

Early biological studies in the vicinity of the Colville Delta consisted solely of aerial surveys for waterfowl (Griffin 1948; Nelson 1949, 1950, 1951; Hansen 1957). A waterfowl nesting and banding study in 1949 was the first ground-based effort to study wildlife on the delta (Nelson 1949). The Colville Delta also was included in a state-wide inventory of Brant in 1960 (Shepherd 1961) and in regional aerial surveys for swans and geese on the Arctic Slope of Alaska in 1966 (King 1973). Information on the distribution and relative abundance of many species also was recorded during other studies in the region

(e. g., Reed 1956, Kessel and Cade 1958, Hall 1972). Mammals were not a focus of these early investigations on the Colville Delta.

With the discovery and subsequent development of petroleum reservoirs on the Arctic Coastal Plain, wildlife research on the Colville Delta increased during the 1970s. Aerial surveys for Tundra Swans were conducted annually in the Colville Delta from 1971 to 1978 (Welling and Sladen 1978) and intensive aerial surveys of the delta were flown for waterbirds in 1972 (Haddock and Evans 1975). Ground-based studies included a waterbird migration study along the Beaufort Sea coast, including the Colville Delta, during 1977-78 (Richardson and Johnson 1981) and a study of the feeding ecology of Brant in the Colville Delta and Prudhoe Bay areas (Kiera 1979). During this period, arctic foxes were studied on the Colville Delta (Garrott 1980) and regional surveys of the Central Arctic Herd of caribou commenced (Cameron and Whitten 1979).

The Special Studies branch of the U. S. Fish and Wildlife Service (USFWS) conducted field studies on the Colville Delta from 1981 to 1984 to provide information on the species composition, density, and habitat use of birds during breeding, molting, and migration staging periods, and to describe and map vegetation communities (Rothe et al. 1983). Intensive studies of the behavior of Tundra Swans (Hawkins 1986), the breeding biology of Yellow-billed Loons (North 1986), and the distribution and breeding biology of Brant and Greater White-fronted Geese (Simpson et al. 1982, Renken et al. 1983, North et al. 1984) also were conducted during this time. The Alaska Department of Fish and Game (ADFG) and the federal Bureau of Land Management (BLM) conducted the first intensive aerial surveys of the Teshekpuk Caribou herd, which ranges west of the Colville Delta, in 1984 (Silva 1985).

In 1986, the Branch of Wetlands and Marine Ecology of USFWS began a three-year study of the habitat associations of birds on the Arctic Slope of Alaska. Two of the six field camps established for that study were located on the Colville Delta (Nickles et al. 1987, Field et al. 1988). Use of littoral zone habitats by shorebirds in the Colville Delta was studied concurrently (Andres 1989). A five-year study of Tundra Swan behavioral ecology was conducted on the delta in the late 1980s (Earnst 1992).

Most recently, aerial surveys for waterfowl again have dominated avian research in the Colville Delta. Breeding-pair surveys were conducted annually by USFWS along the Arctic Coastal Plain of Alaska, including the Colville Delta, from 1986 to 1990 (Brackney and King 1992). Biannual (spring and fall) Tundra Swan surveys have been flown in the Colville Delta since 1982 by USFWS and ADFG (Campbell and Rothe 1990). Aerial or ground surveys of nesting Brant in the Colville Delta have been conducted annually by USFWS since 1987. A survey of nesting Yellow-billed Loons was conducted in the delta in 1989 in response to concern about the effect of the *Exxon Valdez* oil spill on the breeding population (Wells et al. 1989). In 1991, ARCO Alaska, Inc. contracted ABR to conduct an aerial survey for Tundra Swans and Yellow-billed Loons during brood-rearing in areas around five exploratory well sites on and adjacent to the Colville Delta (Ritchie 1992).

STUDY AREA

In 1992, ARCO Alaska, Inc. delineated several proposed drill sites on and to the east of the Colville Delta. The boundaries of the Colville Delta study area included these proposed drill sites. The study area extended from Kalubik Creek on the east to the Nechelik (western) Channel of the Colville River, and included the entire Colville Delta and a large area of the Arctic Coastal Plain of northern Alaska (Figure 1). As used in this report, the Colville Delta (or the delta), refers to the area between the westernmost and easternmost banks of the distributary channels of the Colville River. The area between Kalubik Creek and the eastern channel of the Colville is referred to as the eastern portion of the study area. The southeastern corner of the study area is dominated by uplands that reach 110 m in elevation. These uplands slope gradually northward into flat, low-lying terrain typical of the outer Arctic Coastal Plain. The landforms and vegetation of the Arctic Coastal Plain have been described in detail by Walker et al. (1980).

The Colville River has two main distributaries: the Nechelik (western) Channel, and the Eastern (main) Channel. These two channels together carry about 90% of the water passing through the delta during spring floods and 99% after those floods (Walker 1983). Several smaller distributaries branch from the Eastern Channel, including the Sakoonang, Tamayayak, and Elaktoveach channels. In addition to river channels, the delta is characterized by numerous lakes and ponds, sandbars, mudflats, sand dunes, and low- and high-center polygons (Walker 1973).

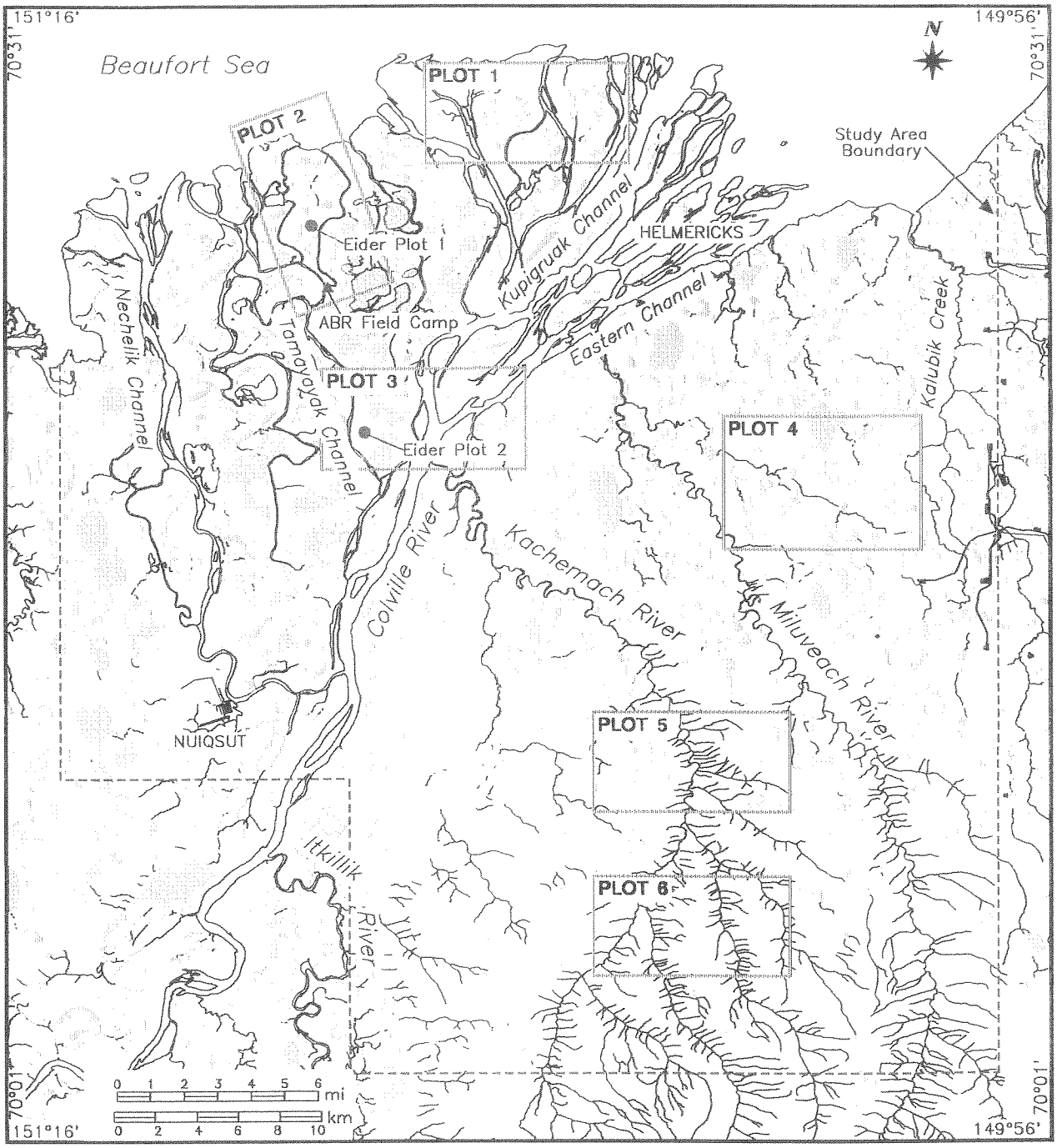

Figure 1. Study area, and locations of Study Plots 1-6 and Eider Plots 1 and 2 for the Colville River Delta Wildlife Study, June-September 1992. The facilities at the eastern edge of the map are the westernmost drill sites of the Kuparuk Oilfield.

The Eastern Channel of the Colville River is deep and flows under ice during winter, whereas the Nechelik and other channels in the delta are shallow and freeze to the bottom. A decrease in river flow during winter results in an intrusion of salt water into the delta; the depth of the river at freeze-up is the main factor influencing the amount of this intrusion (Walker 1973, 1983). The Colville River flows through the zone of continuous permafrost for its entire length. The presence of continuous permafrost combined with freezing of the upper layers of the surface water in winter influences the volume, timing, and character of river flow and erosion within the delta (Walker 1973).

Spring is brief, lasting approximately three weeks in late May and early June, and is characterized by the flooding and breakup of the river. In late-May, water from melting snow flows over and under river ice. Flooding peaks during the first week of June (Walker 1983). Breakup of river ice usually occurs when flood waters are at maximum levels. Water levels decrease in the delta through the summer, with the lowest water levels occurring in September just before freeze-up (Walker 1983).

Lakes are dominant physical features of the Colville Delta. Most of the waterbodies are shallow (e. g., polygon ponds <2 m deep), and therefore thaw by June and freeze to the bottom in winter. Deeper ponds (>2 m deep) with steep, verticle sides are found on the delta, but are uncommon elsewhere on the Arctic Coastal Plain. Lakes larger than 5 ha are common, covering 16% of the deltas surface (Walker 1978). Some of the lakes are deep (up to 10 m) and freeze only in the upper 2 meters. Ice remains on these deep lakes until the first half of July (Walker 1978). Several other types of lakes occur in the delta, including oriented lakes, abandoned-channel lakes, point-bar lakes, perched ponds, and thaw lakes (Walker 1983).

Many of the lakes in the delta are considered "tapped" lakes, in that they are connected to the river by narrow channels. These channels are caused by thermokarst decay of ice wedges between the river and adjacent lakes (Walker 1978). Water levels in tapped lakes usually are lower and fluctuate more dramatically than in untapped lakes (Walker 1978). River sediments raise the bottom of the lake near the channel, exposing previously submerged areas (Walker 1976, 1978). These lake deltas eventually support vegetation. The rate of development of the floristic communities on tapped-lake deltas depends on lake-basin morphology, the rate of sediment deposition, and distance from the coast (Rothe et al. 1983). Because tapped lakes and river channels are the first areas of the delta to become flooded in spring, they constitute important resting habitat for migrating waterfowl in that season (Rothe et al. 1983).

The study area has an arctic maritime climate. Winters last about eight months and are cold and windy. Summers are cool, with temperatures ranging from -10°C in mid-May to 15°C in July and August (Simpson et al. 1982, North 1986). Summer weather is characterized by low precipitation, overcast skies, fog, and persistent winds which come predominantly from the northeast. Westerly winds usually bring storms, which are accompanied by high wind-driven tides and rain (Walker and Morgan 1964, North 1986).

METHODS

Wildlife investigations on the Colville Delta in 1992 consisted of aerial and ground surveys for waterbirds and aerial surveys for mammals. The bird study concentrated on the distribution and abundance of Yellow-billed Loons, Tundra Swans, Brant, and Spectacled Eiders during the nesting and brood-rearing seasons. Although survey techniques were designed primarily to enumerate those species, useful information also was obtained on Red-throated and Pacific loons, Greater White-fronted and Canada geese, and King Eiders. Caribou and arctic fox were the focal species for the mammal study.

Wildlife surveys covered different portions of the overall study area, depending on the species of interest, the season, and the location of proposed drilling activities (Table 1). Within the delta, three 4.8 $\times$ 9.6 km (3 $\times$ 6 mile) study plots (Plots 1-3) were delineated for intensive aerial and ground surveys. In addition, one 6.4 $\times$ 9.6 km (4 $\times$ 6 mile) and two 4.8 $\times$ 9.6 km (3 $\times$ 6 mile) study plots (Plots 4-6) were established in the eastern portion of the study area (east of the delta) for intensive aerial surveys (Figure 1). Portions of Plots 1-3 were not surveyed during ground surveys during the nesting and brood-rearing seasons because of inaccessibility or time constraints. However, the entire area of each study plot was surveyed during aerial surveys.

Highly polygonized wetlands within Plots 1-3 normally were not included in the ground surveys for nesting and brood-rearing waterfowl, because these wetlands were too numerous to survey adequately.

Table 1. Dates and types of wildlife surveys conducted in 1992 on the Colville River Delta.

Species	Survey Type	Season	Dates	Aircraft Used[a]	Transect Width (km)	Transects Spacing (km)	Aircraft Altitude (m)	Area Surveyed[b]
BIRDS								
Loons	Aerial	Nesting	28 Jun	C185	.8	.8	75	Plots 1-3
		Brood-rearing	19 Aug	C185	.8	.8	75	Plots 1-3
Tundra Swans	Aerial	Nesting	18 Jun	C206	2.4	2.4	150-210	CRD
			28 Jun	C185	.8	.8	150	Plots 1-3
		Brood-rearing	17 Aug	C185	.8	.8	150	Plots 1-3
			28 Aug	C206	2.4	2.4	150-210	CRD
		Staging	17 Sep	C206	3.2	3.2	150-210	CRD; Plots 1-3
Brant	Aerial	Nesting	30 Jun	PA18	N/A	N/A	75	Western CRDSA
		Brood-rearing	9 Jul	PA18	.8	.8	75	Coastal CRDSA
			27 Jul	PA18	.8	.8	75	Coastal CRDSA
		Staging	20 Aug	PA18	.8	.8	75	Coastal CRDSA
Eiders	Aerial	Pre-nesting	17-19 Jun	PA18	.8	.8; 3.2	30	Plots 1-6; CRD
	Ground	Nesting	24, 30 Jun	None	N/A	N/A	N/A	Eider Plots 1 and 2
Waterfowl	Ground	Nesting	20 Jun-2 Jul	None	N/A	N/A	N/A	Plots 1-3
		Brood-rearing	18-23 Jul	None	N/A	N/A	N/A	Plots 1-3

Table 1. Continued

Species	Survey Type	Season	Dates	Aircraft Used[a]	Transect Width (km)	Transect Spacing (km)	Aircraft Altitude (m)	Area Surveyed[b]
MAMMALS								
Caribou	Aerial	Calving	4, 16 Jun	C206	.8	1.6	90	CRDSA
		Post-calving	29 Jun, 8, 16, 18, 30 Jul, 18 Aug, 17 Sep	C206	3.2	3.2	90	CRDSA
Arctic Fox	Aerial	Denning	31 Jul	C206	.8	.8	90	Plots 1-3
			16-17 Aug	C206	1.6	1.6	90	CRDSA

[a] C185 = Cessna 185, C206 = Cessna 206, PA18 = Piper Super Cub.
[b] CRD = Colville River delta only; CRDSA = entire Colville River delta study area (includes adjacent area east of the delta).

habitats such as Red-throated Loons and Greater White-fronted Geese, (Bergman and Derksen 1977, Simpson and Pogson 1982, Rothe et al. 1983), were under-surveyed during our nesting and brood-rearing surveys. Exceptions were two 10-ha subplots (Eider Plots 1 and 2, established in wetland habitats in Plots 2 and 3), that were surveyed for nesting eiders. Incidental sightings of birds seen by observers while conducting surveys or in transit to and from the study area were recorded (Appendix A).

Bird habitats cited in this report are from the wetland classification system developed for the Arctic Coastal Plain of Alaska by Bergman et al. (1977). The habitat classification system developed by Murphy et al. (1988) for the Lisburne Development Area (LDA), Alaska is cited parenthetically after Bergman's classification in the text of this report (Table 2). A comparison of the two classification systems can be found in Appendix B.

BIRDS

AERIAL SURVEYS

Surveys in fixed-wing aircraft were flown periodically to locate and enumerate selected waterbird species during the nesting and brood-rearing seasons. The dates of the flights, aircraft used, transect width and spacing, aircraft speed and altitude, and area surveyed depended on the species of interest (Table 1). The aerial survey effort comprised extensive surveys of the Colville Delta, coastal surveys between Kalubik Creek and the Nechelik Channel, and intensive surveys of the study plots. All location data were recorded on U. S. Geological Survey (USGS) 1:63,360-scale quadrangle maps.

Extensive (delta-wide) surveys were flown during nesting and brood-rearing for Tundra Swans and during pre-nesting for eiders. In 1992, these extensive swan surveys were flown by ADFG (with assistance from ABR) and followed tracklines and methodology established earlier by USFWS and ADFG. Extensive aerial surveys of the Colville Delta for Tundra Swans have been flown since 1982 by USFWS and ADFG. Eider surveys of the Colville Delta were flown for the first time in 1992. Delta-wide surveys for pairs of eiders were flown during the pre-nesting season to delineate their distribution on the delta and to locate potential nest sites.

A survey for nesting Brant was flown along the Nechelik Channel in the western delta and was limited to an area where Brant have been known to nest in the past. The Brant colony at the mouth of the Eastern Channel of the Colville River was not included in the aerial survey because it had been surveyed previously from the ground by USFWS (see Ground Surveys below). Brood-rearing surveys for Brant followed procedures described by Stickney et al. (1992). Aerial surveys along the coast from Kalubik Creek to the mouth of the Nechelik Channel were flown for Brant during brood-rearing, and for staging Greater White-fronted and Canada geese, and Brant during fall migration.

Intensive surveys of the study plots were flown to gather additional data on the distribution of nesting and brood-rearing birds in areas of potential development and to augment data collected during the ground surveys. Intensive surveys were conducted in Plots 1-3 for nesting and brood-rearing loons and swans. These intensive surveys for Tundra Swans followed a modification of the standard protocol established by USFWS (1992); survey lines were placed closer together (0.8 km vs 1.6 km) and flight altitude was lower (150 m vs 200 m). Intensive surveys of Plots 1-6 were flown for breeding pairs of eiders.

GROUND SURVEYS

Ground surveys to locate nesting and brood-rearing waterfowl were conducted daily in Plots 1-3 during 20 June-2 July and 18-23 July, respectively. Field crews operated from a base station in Nuiqsut for the nesting surveys, whereas a field camp was established on the Tamayayak channel for the brood surveys (Figure 1). A river boat was used to transport observers to and from the study plots.

During surveys for nesting waterfowl, observers (working in teams of two) walked the perimeters of lakes in each study plot. Areas between lakes were searched when observers moved from one lake complex to another. This lake-edge survey technique has been used in waterbird studies in the Prudhoe Bay area (Johnson et al. 1990, Murphy et al. 1990). Each nest found was numbered and the location was recorded on a 1:1,500-scale color aerial photograph; the nest number, species, clutch size, number of adults present, and comments were recorded on data sheets. Nest markers (1-m pieces of lath) were placed 2-3 m from the nest to facilitate relocation of the nest during subsequent searches.

In addition to lake-edge surveys, searches for nesting eiders were conducted in two smaller subplots (Eider Plots 1 and 2) of approximately 10 ha each. One eider plot was established in each of Plots 2 and

Table 2 Comparison of names used in the wetland classification system developed by Bergman et al. (1977) and Murphy et al. (1988).

Bergman et al. Class	Bergman et al. Name	Murphy et al. Name
I	Flooded Tundra	Wet Meadows-patterned
II	Shallow-*Carex*	Aquatic Sedge
III	Shallow-*Arctophila*	Aquatic Grass
IV	Deep-*Arctophila*	Deep Open Lakes
V	Deep-open	Deep Open Lakes
VI	Basin Complex	Basin Wetland Complex
VII	Beaded Stream	Rivers and Streams
VIII	Coastal Wetland	Halophytic Wet Meadows

3. Observers, spaced approximately 2 m apart, censused these plots by walking systematically through the plot along parallel lines and searching a strip transect approximately 2 m wide. Data were collected in the same way as for lake-edge surveys.

Nest-fate checks and brood-rearing surveys for waterfowl were conducted in Plots 1-3 during 18-23 July. Nests that had been located in June were checked for signs of hatching success or failure (Downing 1980). Lakes in the area of each nest were searched for broods. When a brood was observed, the location, number of adults, and number of young were recorded on a 1:1,500-scale color aerial photograph. Brood sightings were numbered and data were transcribed onto data sheets.

In 1992, USFWS contracted with J. Helmericks to conduct a ground survey of the Brant colony at the mouth of the Eastern Channel of the Colville River. Observers walked through the colony and recorded the number of nests, clutch sizes, and any sign of depredation of eggs or adults. These data were compiled and given to us by USFWS (USFWS 1992).

MAMMAL

CARIBOU

Nine strip-transect surveys (Caughley 1977) were flown in fixed-wing aircraft between early June and mid-September 1992 to evaluate distribution and abundance of caribou in the Colville Delta study area (Table 1). A Piper PA-18 Supercub or a Cessna 206 with two observers (the pilot and one biologist) was flown at a speed of 165-185 km/hr and an altitude of 100 m agl. Surveys covered all or parts of four USGS 1:63,360 scale quadrangle maps: Harrison Bay A-1, A-2, B-1, and B-2. Partial surveys were flown if weather and time constraints did not allow full surveys. Weather conditions and insect activity were noted prior to each flight.

More intensive search effort was employed during calving surveys (4 and 16 June) than during post-calving surveys. To maximize the amount of time observers spent searching during calving surveys, we did not map the exact locations of caribou. During calving season, the snowcover usually is patchy and caribou are well-dispersed in small groups, resulting in poor sightability (Lawhead and Cameron 1988). North-south-oriented transects were spaced 3.2 km

apart, and were divided into segments 4.8 km long, and 0.8 km wide (0.4 km on each side of the airplane). Two observers concentrated on this strip to maximize search intensity. The total number of caribou, the number of calves, and any additional information on the sex and age composition of groups, were summed for each transect segment.

On post-calving surveys, we used 3.2-km-wide, east-west-oriented transects (1.6 km on each side of the airplane) to achieve complete coverage of the area. This broad strip was sufficient for detecting larger groups of caribou, but single animals and smaller groups (e.g., <5) were undersampled. Locations and number of caribou were recorded on the USGS quadrangle maps. Age and sex composition of groups determined when possible; the categories used were male, female, yearling, calf, and mixed.

ARCTIC FOX

Following the survey techniques recommended by Garrott et al. (1983), two fixed-wing aircraft surveys were flown to locate den sites of arctic foxes (Table 1). Both surveys were flown in a Piper PA-18 Supercub at a speed of 165 km/hr and an altitude of 100 m above ground level (agl). The first survey (16-17 July) was a complete survey of the delta, and followed east-west-oriented transects spaced 3.2 km apart and aligned along section lines. The location of sites which appeared to be fox dens (i. e., with burrow larger than those of arctic ground squirrel [*Spermophilus parryii*]) were recorded using a Garmin Global Positioning System (GPS) receiver. Locations are accurate to within 100 m using a single GPS receiver. The latitude and longitude of each site were recorded from the GPS and the location was noted on a USGS 1:63,360-scale map. The second flight (31 July) focused on surveying Plots 1 - 3 and included stops to check den sites on the ground that had been located during the earlier survey. East-west-oriented flightlines 0.8 km apart were followed on the second survey.

In addition to aerial surveys for dens, fox sightings and/or den locations identified during ground surveys for waterfowl nests were recorded on color photocopies of aerial photographs. Den sites that offered a nearby landing area for the supercub were visited to determine the status of the site.

SPECIES ACCOUNTS

YELLOW-BILLED LOON

BACKGROUND

Yellow-billed Loons are uncommon breeders on arctic tundra in Eurasia and North America (Gabrielson and Lincoln 1959). In Alaska, the highest densities of breeding Yellow-billed Loons evidently occur from the Colville Delta west to Meade River (North 1986; Brackney and King 1992). Breeding Yellow-billed Loons are less common east of the Colville Delta, although areas of abundance do occur there (e. g., Sagavanirktok River, R.J. Ritchie, ABR, unpubl. data).

Yellow-billed Loons arrive on the Colville Delta soon after the first open water appears, usually during the last week of May (Rothe et al. 1983, North 1986). Breeding pairs move to territories on untapped lakes and ponds when "moats" of open water form along lake margins (Rothe et al. 1983, North 1986). Nest initiation usually occurs during the second week of June (North 1986).

On the Colville Delta, Yellow-billed Loons nest exclusively along the shoreline of, or on islands in, untapped lakes and ponds (North 1986). Most loon nests have been located on Class IV Deep-*Arctophila* (Deep Open Lakes) and Class V Deep-open (Deep Open Lakes) wetlands (Rothe et al. 1983, North 1986). Most nests are located on small lakes (0.1-10 ha). Large lakes (>100 ha) occasionally are used, but many large lakes are tapped by the river and thus are unsuitable for nesting because of fluctuating water levels. Class VIII Coastal (Halophytic Wet Meadows) wetlands are used infrequently for nesting (North 1986).

After hatching occurs in mid-July, brood-rearing usually occurs on the nesting lake (North 1986). However, some Yellow-billed Loons maintain separate territories for nesting and brood-rearing; loons nesting on extremely small lakes (<0.1 ha) typically move their broods overland to larger lakes (North 1986).

RESULTS AND DISCUSSION

Six Yellow-billed Loon nests were located in Plots 2 and 3 during aerial and ground surveys (Figures 2 and 3); no Yellow-billed Loon nests were found in Plot 1. Four nests had two-egg clutches at the time they were found. One nest had no eggs, but adults were in attendance, and one nest had an unknown number of eggs.

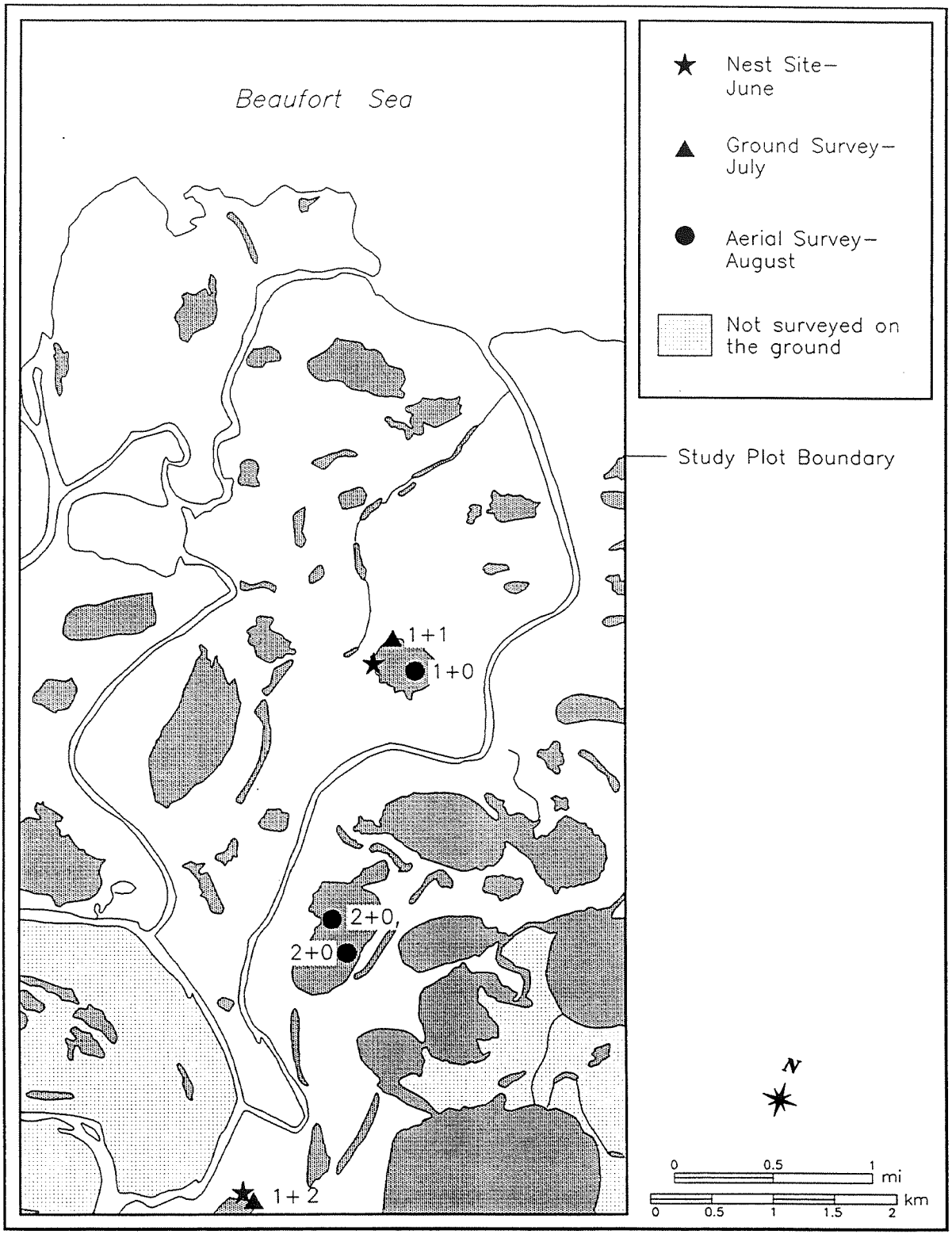

Figure 2. Distribution of Yellow-billed Loon nests and broods (adults + young) in Plot 2, Colville River Delta, Alaska, 1992.

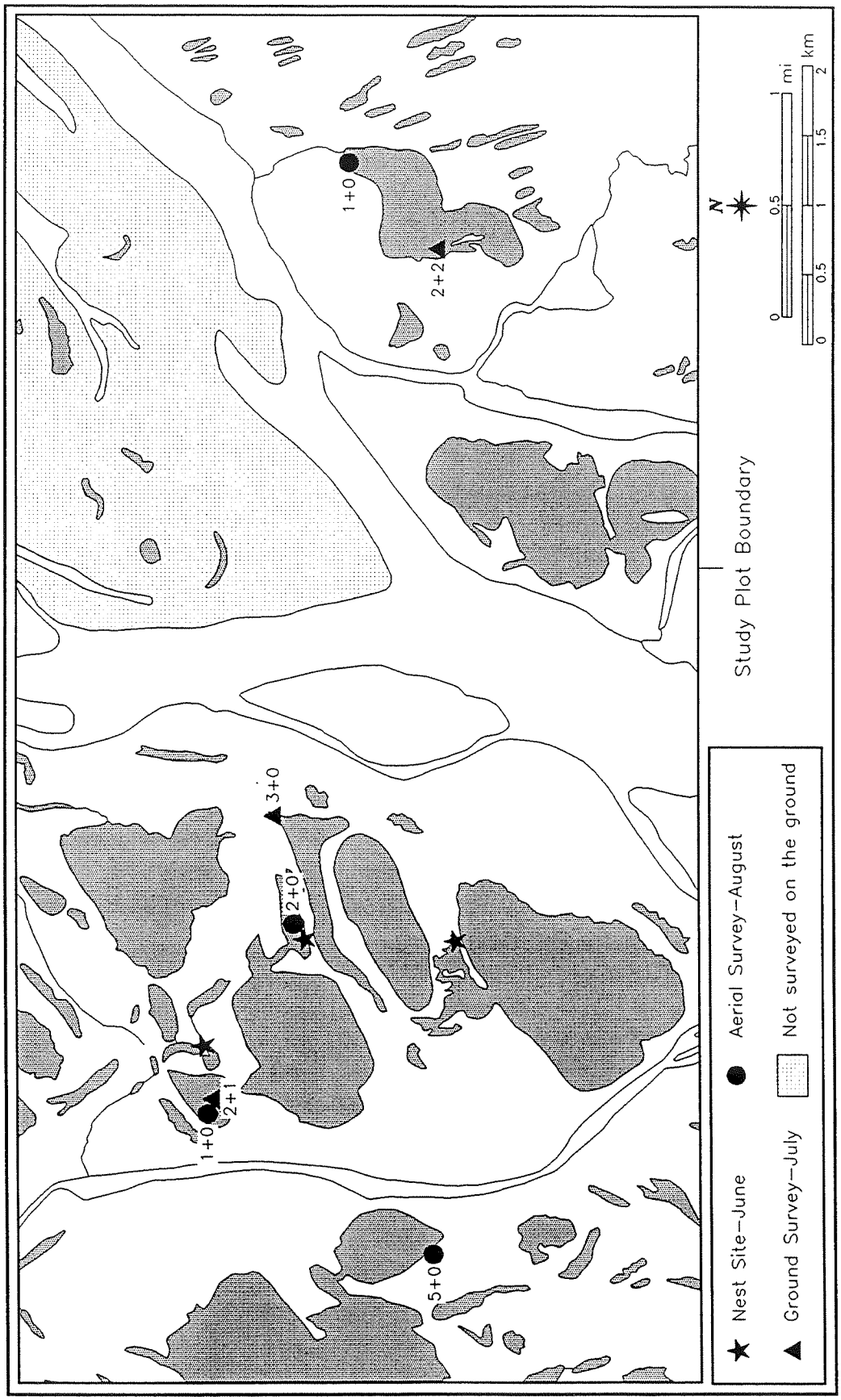

Figure 3. Distribution of Yellow-billed Loon nests and broods (adults + young) in Plot 3, Colville River Delta, Alaska, 1992.

Five of the six Yellow-billed Loon nests were revisited and checked during nest checks. Three nests were considered successful, based on sightings of broods on the nest lakes. The fate of two nests was not determined because no broods were located in the vicinity of the nests. One nest was not relocated. Nesting success of Yellow-billed Loons on the Colville Delta in 1983 and 1984 was high (94%) (North 1986).

Two additional broods were located during brood surveys for which nest sites were not located. Of the five pairs of Yellow-billed Loons with young seen during brood surveys, three pairs had two young and two pairs had one young ($\bar{x}$ = 1.6 young/successful pair). Productivity of Yellow-billed Loons on the Colville Delta during years 1983-84 was 1.38 and 1.18 young/successful pair respectively (North 1986). Flocks of three and five adults were seen without young in Plot 3. Adults not accompanied by young also were recorded in Plots 2 and 3 during aerial surveys (Figures 2 and 3).

Yellow-billed Loons are thought to exhibit fidelity to their nest site and territory (North 1986). Thirty-nine nests were found on the Colville Delta during waterbird studies conducted by USFWS in 1983 and 1984 (North et al. 1983, 1984a, 1984b). Nine of those nest sites were located in Plots 2 and 3. Four of six nests located in 1992 were on the same lakes as nests found in 1983 and 1984. The remaining two nests found in 1992, although not on the same lake, were on the same lake complexes as nests found in 1983 and 1984.

The highest densities of Yellow-billed Loons in the Colville Delta in 1983 and 1984 were on the central delta, along the Tamayayak channel between the Sakoonang and Eastern channels (North 1986). This area is composed of numerous lakes with low-relief shorelines (Walker 1983), which constitute suitable nesting habitat for Yellow-billed Loons (Rothe et al. 1983, North 1986). The only nests found during our study were located in this area, which encompassed the southern portion of Plot 2 and the eastern portion of Plot 3. No nests were found in Plot 1, located in the northern, more marine-influenced portion of the delta. Similarly, Yellow-billed Loon nests were absent from the northern portion of Plot 2 and eastern portion of Plot 3 in 1992. Our survey results are consistent with those of studies conducted in 1983 and 1984 (North et al. 1983, 1984a).

Yellow-billed Loons also occasionally nest in the eastern section of the study area (ABR, unpubl. notes). However, no ground or aerial surveys for loons were undertaken in this area in 1992.

TUNDRA SWAN

BACKGROUND

Tundra Swans are common breeders on the coastal plain of the Beaufort Sea (Gabrielson and Lincoln 1959, Johnson and Herter 1989). Although swans breed in low densities across much of the Arctic Coastal Plain of Alaska, the highest densities of breeding swans are found on major river deltas. The Colville Delta supports densities of breeding Tundra Swans that are three to five times greater than other arctic coastal areas of Alaska (Rothe and Hawkins 1982). Tundra Swans are one of the earliest spring migrants to the Colville Delta. Swans are usually first seen flying over the delta during the third week of May, when snow cover normally exceeds 95% and lakes are still frozen (Hawkins 1986). A rapid influx of swans to the delta coincides with breakup and occurs about 1-2 weeks after initial sightings (Hawkins 1986). The average population of swans on the Colville Delta in June exceeds 200 birds (Campbell and Rothe 1990).

Breeding pairs of Tundra Swans move to their territories upon arrival on the delta. They initially use snow-free areas and open water near the nest site, but shift their activities to deeper wetlands as thaw progresses (Hawkins 1986). Most nests are built near large lakes on ridges of low-center polygons. A combination of large lakes and numerous ponds are important components of swan territories (Hawkins 1986).

Tundra Swans on the Colville Delta initiate nests during the last week of May and first two weeks of June (Hawkins 1983, 1986). After hatching occurs in late June or early July, broods are reared in the nesting territory. Class IV Deep-*Arctophila* (Deep Open Lakes), Class V Deep-open (Deep Open Lakes) wetlands, tapped lakes, brackish wetlands, and shores and bars of river channels are used for brood-rearing (Rothe et al. 1983).

Tundra Swans molt at both coastal and inland sites of the Colville Delta. During the molt, pairs with broods remain on their territories, while failed- and non-breeders use Class IV Deep-*Arctophila* (Deep Open Lakes) and Class V Deep-open (Deep Open Lakes) lakes unoccupied by broods. The August population of swans on the Colville Delta averaged 290 birds, including young-of-the-year, from 1982 to 1989 (Campbell and Rothe 1990). This population count is

somewhat higher than the six-year average of 200 birds calculated from aerial surveys in the 1970s (Welling and Sladen 1978). By early September, over 300 swans use the Eastern Channel and the lower reaches of the Miluveach and Kachemach rivers for staging prior to fall migration (Rothe et al. 1983). Nonbreeding swans depart the delta first in early September, followed by family groups about the third week of September.

RESULTS AND DISCUSSION

Two-hundred eighty-seven Tundra Swans were seen during breeding-pairs surveys of the Colville River delta conducted by ADFG on 18 June 1992 (T. Rothe, ADFG, unpubl. data) (Figure 4). Twenty-three adults were seen attending 19 nests (Figure 5). No nests were found in Plots 1 and 3; one nest was found in Plot 2.

Our intensive aerial and ground surveys during nesting of Plots 1-3 yielded 16 Tundra Swan nests (Figures 6-8). Four nests were located in Plot 1, seven nests in Plot 2, and five nests in Plot 3. One of these nests (in Plot 2) was located during the breeding-pair survey conducted by ADFG.

Of the 16 swan nests located during our aerial and ground surveys of Plots 1-3, five were revisited during nest checks. Four of the five nests were determined to be successful; the success of the other nest was unknown. The remaining 11 nests were not visited during nest checks because they were located in areas not surveyed during ground surveys. Nesting success of Tundra Swans on the Colville Delta ranged from 71% to 82% in 1981 and 1982 (Hawkins 1983).

Aerial surveys during brood-rearing yielded sightings of 26 broods and 65 groups of adults without young (Figures 9 and 10). Mean brood size was 2.4 young/pair in 1992, which was similar to the mean brood size of 2.3 young/pair (range=2.0-2.6 young/pair) during years 1983-89 (Campbell and Rothe 1990). Group sizes of adults without young ranged from 1 to 65. Ground surveys of Plots 1-3 conducted during brood-rearing yielded four swan broods (Figures 6-8). Five Tundra Swan broods were found during intensive aerial surveys of Plots 1-3 conducted about one month after the ground surveys (Figures 6-8).

Nest density of Tundra Swans calculated from the delta-wide aerial survey in June 1992 was 0.04 nests/km^2, slightly lower than the average nest density of 0.06 nests/km^2 (range=0.05-0.10 nests/km^2) during 1983-89 (Campbell and Rothe 1990). The density of nests in Plots 1-3, based on a combination of intensive aerial and ground surveys was considerably higher (0.12 nests/km^2) than the nest density calculated from the delta-wide aerial survey. Nest densities calculated in 1982 and 1983 from intensive ground searches of a 180 km^2 portion of the western and central delta were 0.22 and 0.18 nests/km^2, respectively (Hawkins 1983). Approximately about 50% of the Tundra Swan nests found during intensive ground searches had been previously located during delta-wide aerial surveys in those years (Hawkins 1983).

The density of swans on the Colville Delta based on delta-wide aerial surveys in June and August of 1992 was 0.65 and 0.90 birds/km^2 respectively. Both of these densities were higher than the seven-year (1983-89) average densities of 0.45 birds/km^2 (range=0.36-0.58 birds/km^2) and 0.57 birds/km^2 (range=0.43-0.75 birds/km^2) for these same months (Campbell and Rothe 1990). The eastern population of Tundra Swans, which includes swans nesting on the Colville Delta and other areas of the Arctic Coast, has been increasing since 1986 (Stewart and Bernier 1989, Brackney and King 1992). Delta-wide surveys flown during brood-rearing in August of 1992 yielded 336 adults and 62 young (16% young), considerably lower than the average of 21% young (range=16%-32% young) calculated from brood-rearing surveys conducted during 1983-89 (Campbell and Rothe 1990).

The Colville Delta is a major fall-staging area for Tundra Swans, with over 300 swans using the Eastern Channel annually in September (Rothe et al. 1983). In 1992, swans were absent from the delta when staging surveys were flown on 17 September after an early freeze-up of the river. Fall 1992 was reportedly one of the earliest freeze-ups on record for the Colville River (J. Helmericks, pers. comm.). It is not known if all swans had completed their molt prior to freeze-up.

BRANT

BACKGROUND

Brant are common migrants and localized breeders, nesting in small colonies and at solitary nest sites, along the Beaufort Sea coast (Gabrielson and Lincoln 1959, Johnson and Herter 1989, Ritchie et al. 1991). The Colville Delta supports the largest concentration of nesting Brant along the Arctic Slope of Alaska (Derksen et al. 1981, Simpson et al. 1982, Renken et al. 1983, Rothe et al. 1983). Smaller colonies of Brant are found at Teshekpuk Lake, in the

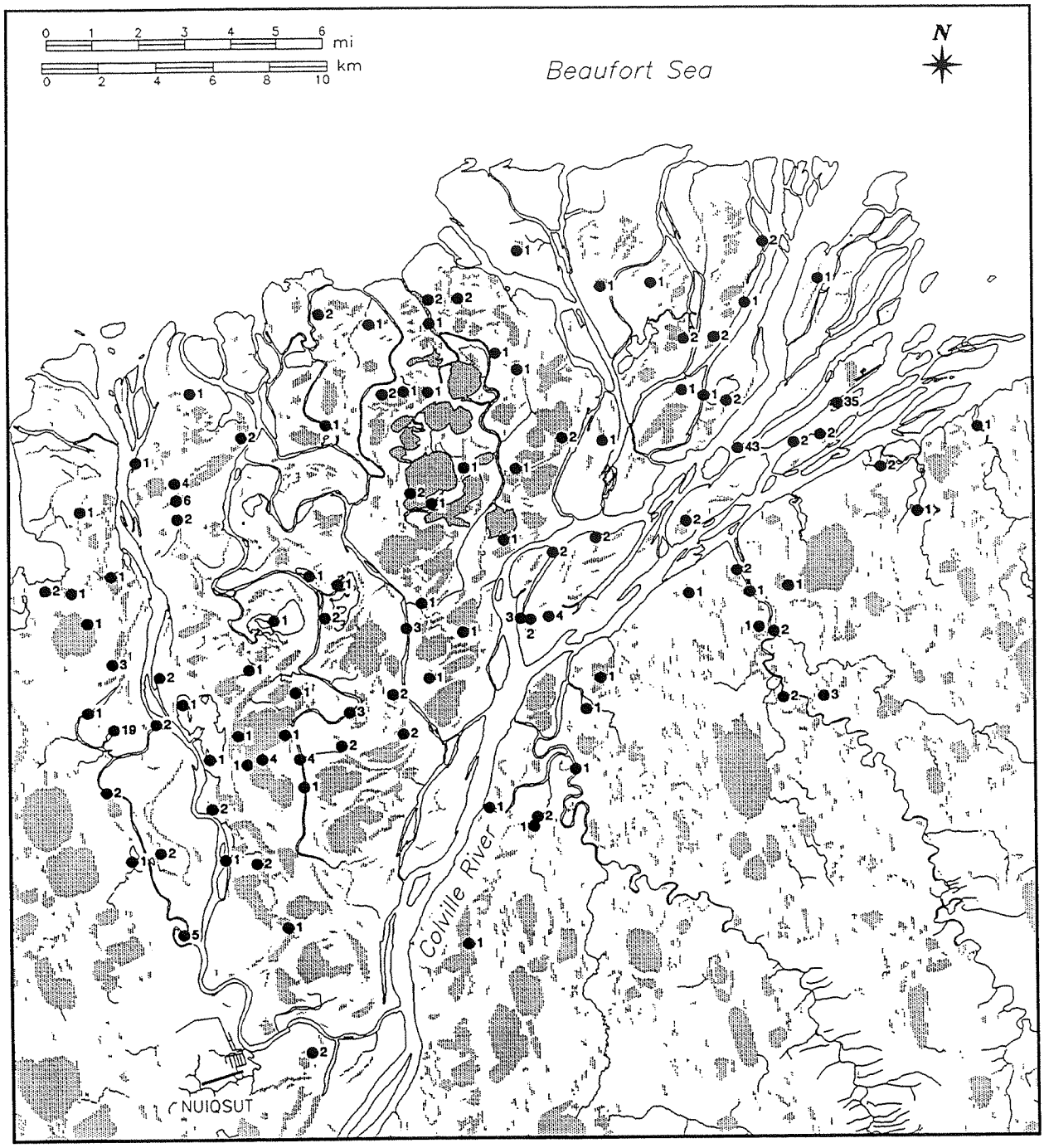

Figure 4. Distribution of Tundra Swans (adults) observed during aerial survey, 18 June 1992, Colville River Delta, Alaska. (Data supplied by ADFG, Anchorage.)

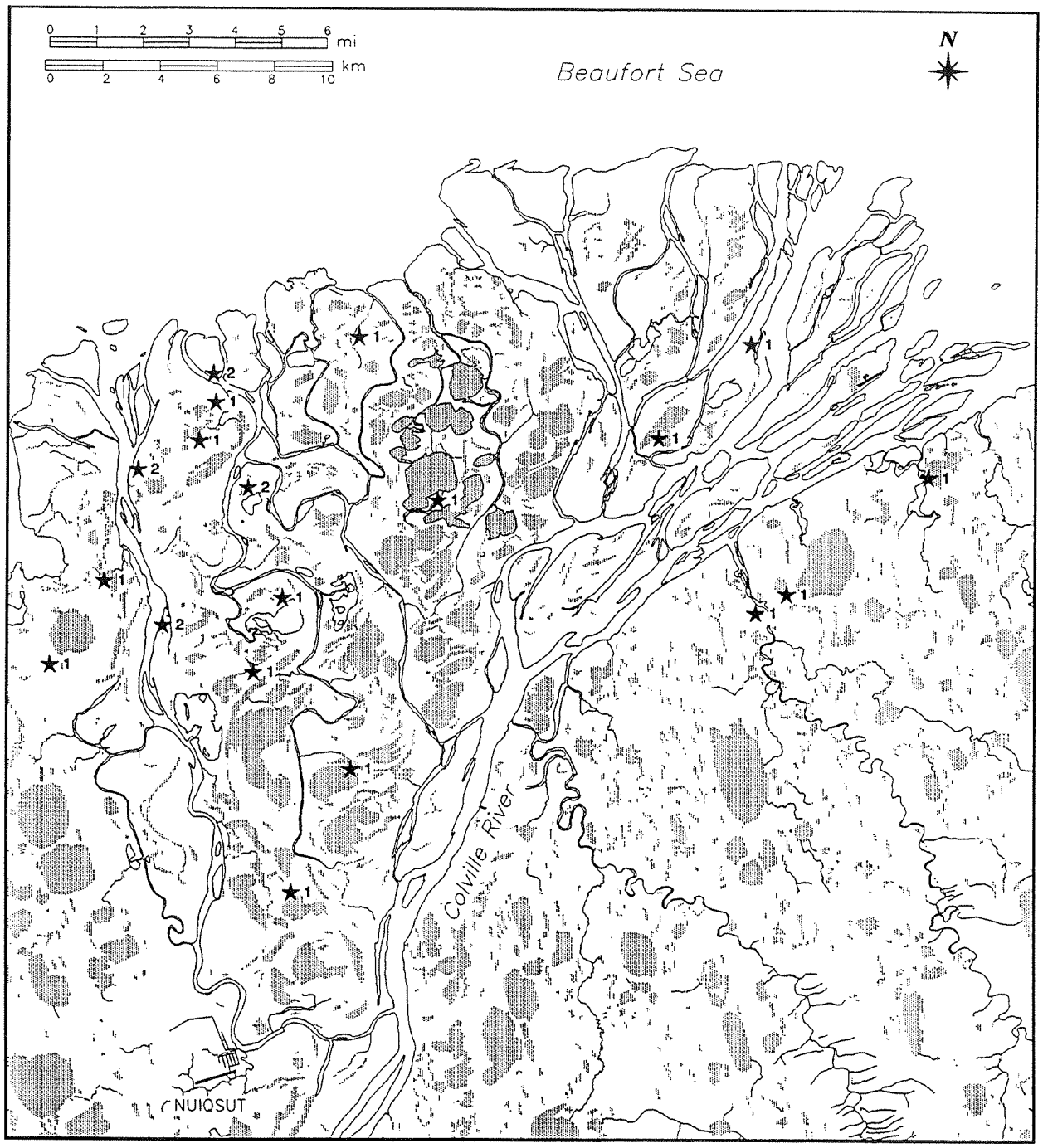

Figure 5. Distribution of Tundra Swan nests and attending adults observed during aerial survey, 18 June 1992, Colville River Delta, Alaska. (Data supplied by ADFG, Anchorage.)

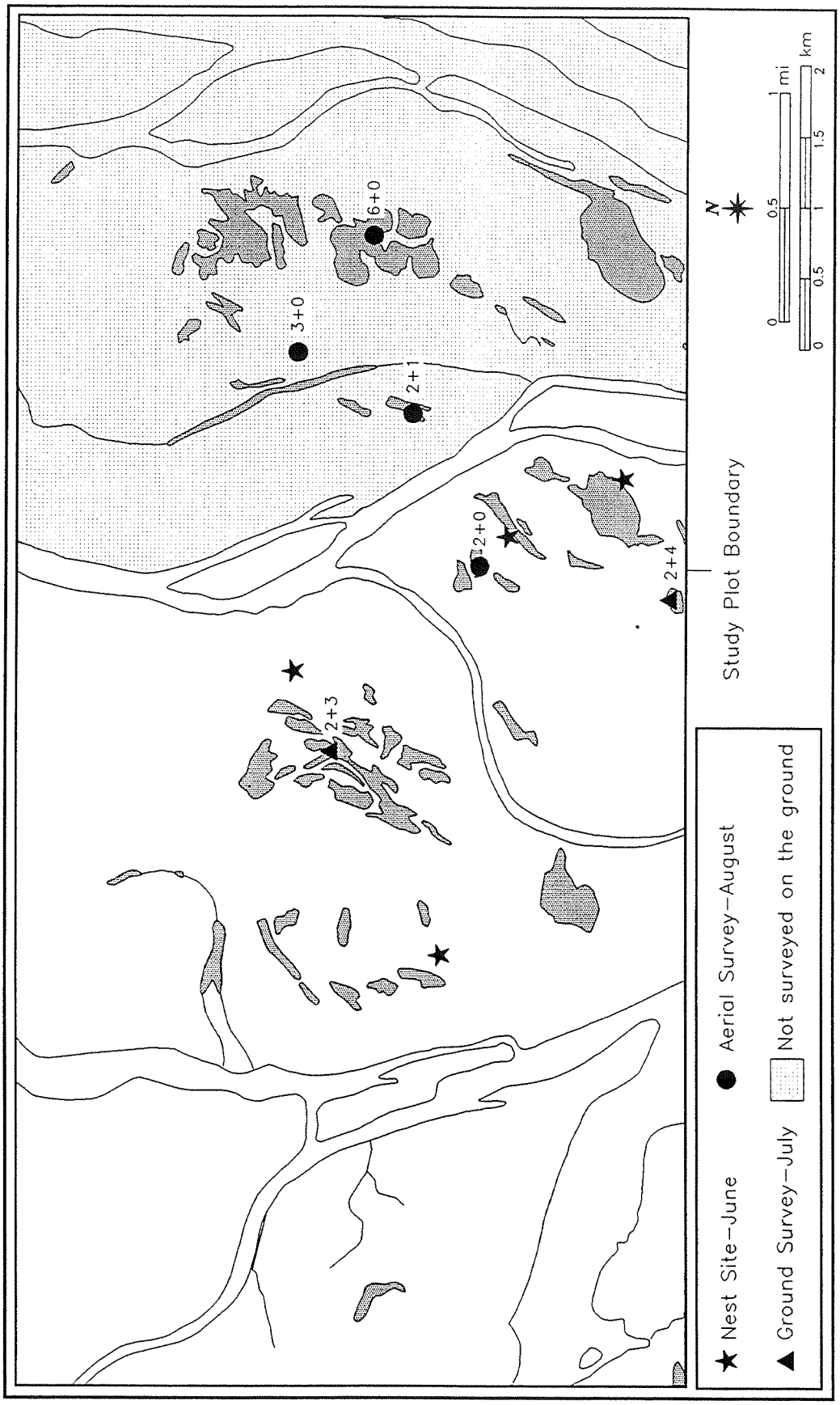

Figure 6. Distribution of Tundra Swan nests and broods (adults + young) in Plot 1, Colville River Delta, Alaska, 1992.

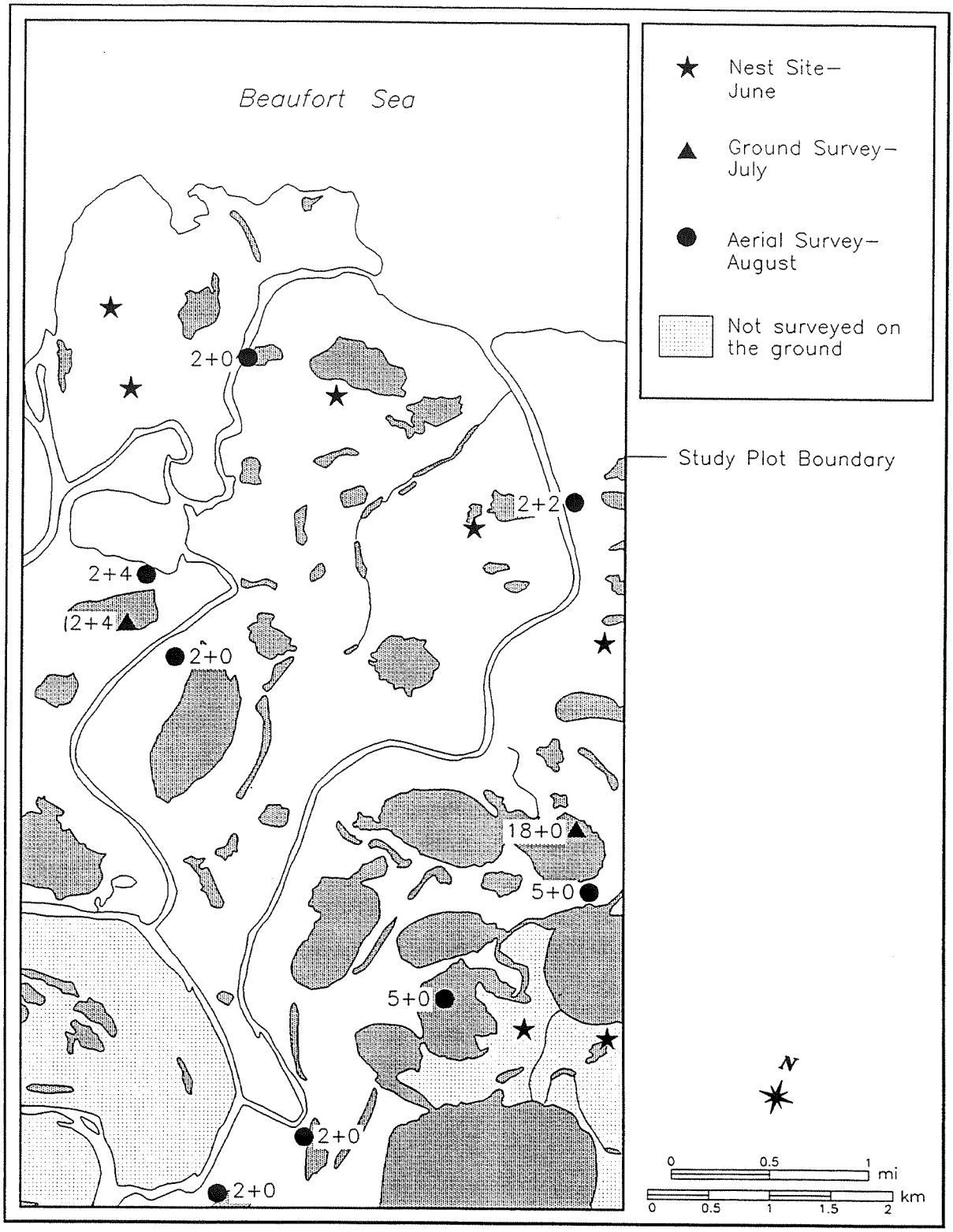

Figure 7. Distribution of Tundra Swan nests and broods (adults + young) in Plot 2, Colville River Delta, Alaska, 1992.

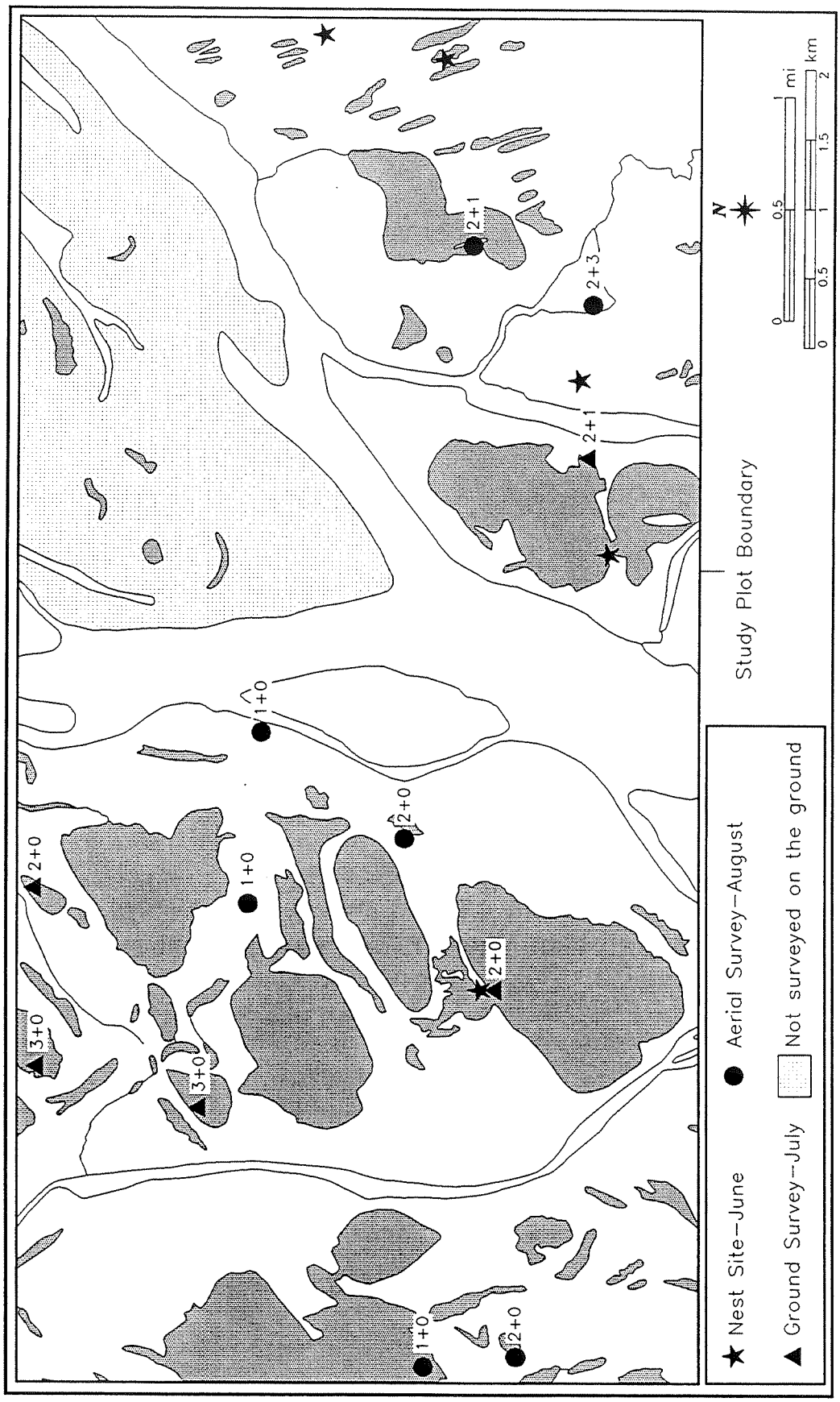

Figure 8. Distribution of Tundra Swan nests and broods (adults + young) in Plot 3, Colville River Delta, Alaska, 1992.

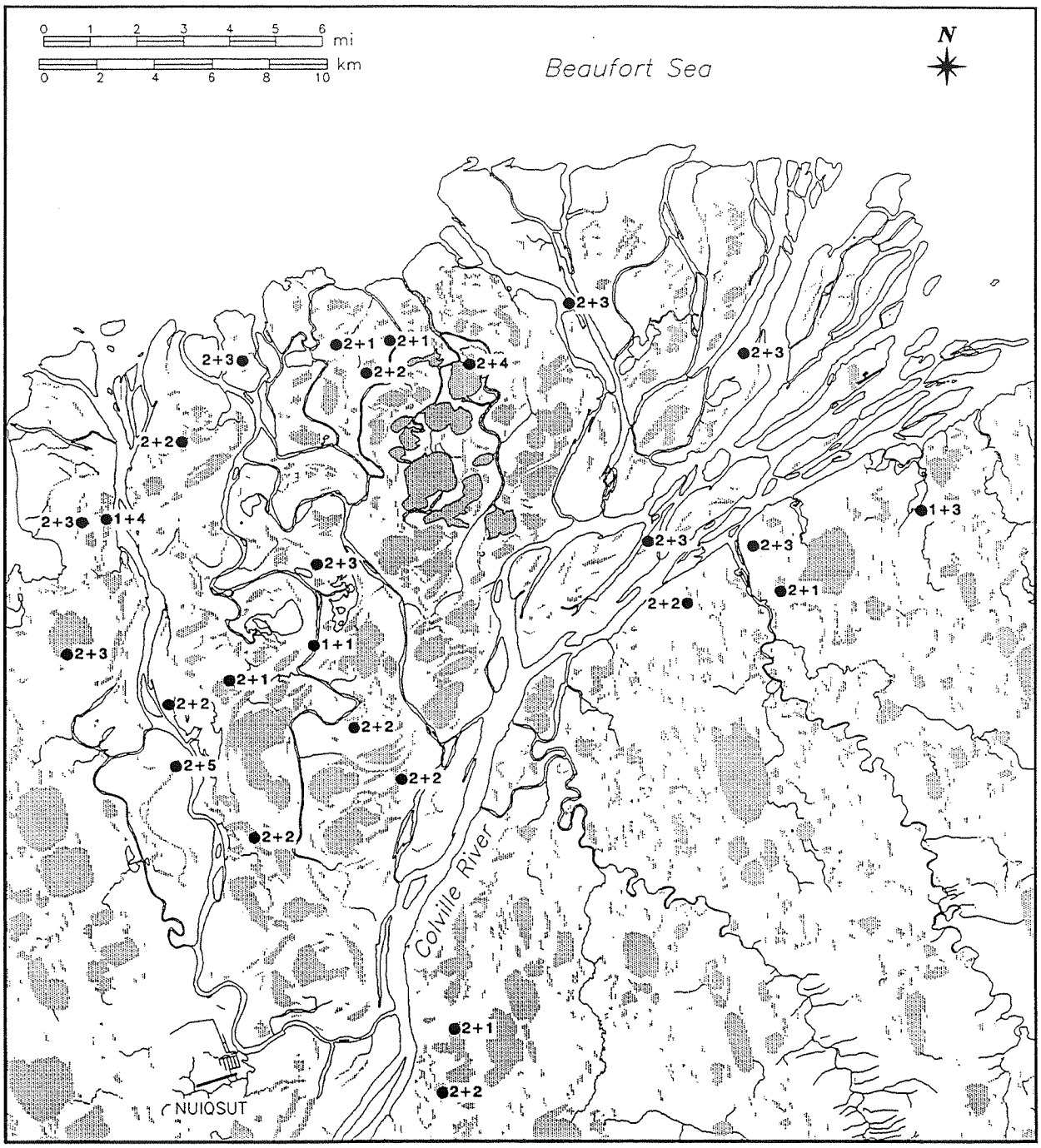

Figure 9. Distribution of Tundra Swan broods (adults + young) observed during aerial survey, 28 August 1992, Colville River Delta, Alaska. (Data supplied by ADFG, Anchorage.)

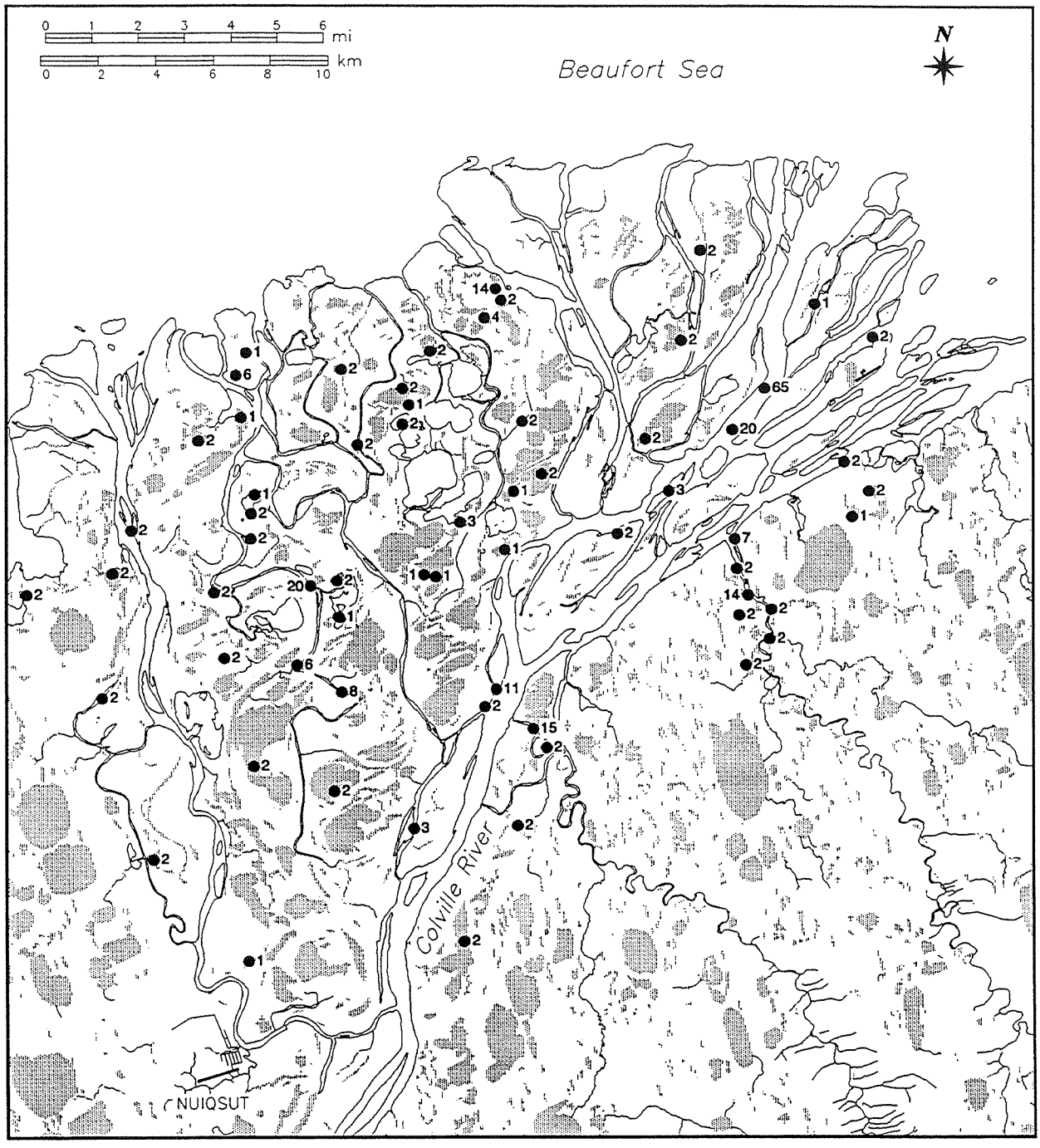

Figure 10. Distribution of Tundra Swans without broods observed during aerial survey, 28 August 1992, Colville River Delta, Alaska. (Data supplied by ADFG, Anchorage.)

Prudhoe Bay and Kuparuk oil fields, and on the Sagavanirktok River delta (Derksen et al. 1981, Ritchie et al. 1991).

The eastward migration of Brant in spring on the Colville Delta peaks during the last half of May and first week of June (Simpson et al. 1982, Renken et al. 1983, North et al. 1984b). Approximately 5000 Brant have been recorded during spring migration on the Colville Delta (Simpson et al. 1982, Renken et al. 1983). The delta is an important stop-over spot for migrating Brant in early spring, providing snow-free areas and open water earlier than surrounding areas (Rothe et al. 1983). Shallow, tapped lakes and river bars on the Colville Delta are important feeding areas for Brant during spring migration (Rothe et al. 1983).

Pairs of Brant arrive on the Colville Delta during late May and early June and nest initiation begins almost immediately (Kiera 1979, Rothe et al. 1983). Nesting may be delayed, however, if flooding or inclement weather occurs (Kiera 1979, Simpson et al. 1982, Renken et al. 1983). Most Brant nests on the Colville Delta are located on ten islands at the mouth of the Eastern Channel (Simpson et al. 1982, Renken et al. 1983, USFWS 1992). In addition, small, isolated groups of nesting Brant are scattered across the northern half of the delta on islands and peninsulas in deep, interconnected Class III Shallow-*Arctophila* (Aquatic Grass) and Class IV Deep-*Arctophila* (Deep Open Lakes) ponds (Rothe et al. 1983). A few small colonies are located near the Nechelik channel approximately 10 to 15 km from the coast, and between the Miluveach and Kalubik creeks (Ritchie et al. 1991).

In the early 1950s, large colonies of nesting Brant were located in the western delta near the Nechelik Channel (J. Helmericks, pers comm.). Brant abandoned the area for unknown reasons and began nesting on Anachlik Island in the eastern delta in the late 1950s and early 1960s. Dune and Whitefront islands, and the mudflats north of Anachlik Island, have supported nesting Brant since the late 1970s. In 1979, Brant began nesting on Char, Brant, and Eskimo islands. Swan, Plover, and Turnstone islands have supported nesting Brant since 1989 (USFWS 1992).

Soon after hatching in early July, most Brant with goslings move from nesting areas and congregate in salt marshes northwest of Anachlik Island, river channels, and on the mainland near Snow Goose Lake east of the river (Rothe et al. 1983, USFWS 1992). Approximately half of the Brant nesting on Anachlik Island usually remain on the island during brood-rearing and molt (USFWS 1992). Brant nesting in the small colonies near the Nechelik channel may use wetlands west of the delta at the mouth of Fish Creek for brood-rearing and molting. Failed and nonbreeding Brant from the Colville Delta probably move to Oliktok Point and Teshekpuk Lake prior to the molt (Derskson et al. 1979, Rothe et al. 1983, Stickney et al. 1992, USFWS 1992).

RESULTS AND DISCUSSION

In 1992, the USFWS contracted with J. Helmericks to conduct surveys of nesting Brant in the eastern Colville Delta. Brant nests (n=713) were counted on ten islands in the delta and on the mainland area around Snow Goose Lake (n=7) from 19 to 22 June (Figure 11). Six of these islands (Dune, Whitefront, North Mud Flats, Turnstone, Plover, and Swan) and Snow Goose Lake on the mainland were surveyed for Brant nests for the first time in many years in 1992. The remaining four islands (Char, Brant, Eskimo, and Anachlik) have been censused almost yearly since the late 1970s (USFWS 1992).

In 1992, most (n=590) (83%) of the island nests were located on Char, Brant, Eskimo, and Anachlik islands (USFWS 1992). Nest counts for these four islands during 1988-91 ranged from 297 nests in 1989 to 450 nests in 1991 (Table 3). Average clutch size (3.7 eggs/nest) for Brant nests on these four islands, and the entire colony, in 1992 was similar to the average clutch sizes calculated for 1988-90 (Table 3).

An additional 19 Brant nests were located during our aerial and ground surveys of the Colville Delta (Figure 11). The aerial surveys did not include the main nesting colony at the mouth of the Eastern Channel; the ground surveys only included Plots 1-3. Brant are known to nest in small, scattered colonies, as well as singly, along the Arctic Slope. In the Prudhoe Bay region, for example, approximately 47% of the Brant nest in small colonies (<5 nests) (Ritchie et al. 1991).

Predation by arctic foxes and a brown bear accounted for significant nest losses (eggs and adults) in the main Brant colony on the eastern Colville Delta in 1992 (USFWS 1992). Snowy Owls (*Nyctea scandiaca*), Golden Eagles (*Aquila chrysaetos*), Glaucous Gulls (*Larus hyperboreus*), and jeagers (*Stercorarius* spp.) also were observed preying on eggs and adults. Of the 713 nests at the main colony, 153 (21%) were destroyed prior to the nest survey, evidently by a brown bear that was seen on Char Island on 26 June (USFWS 1992).

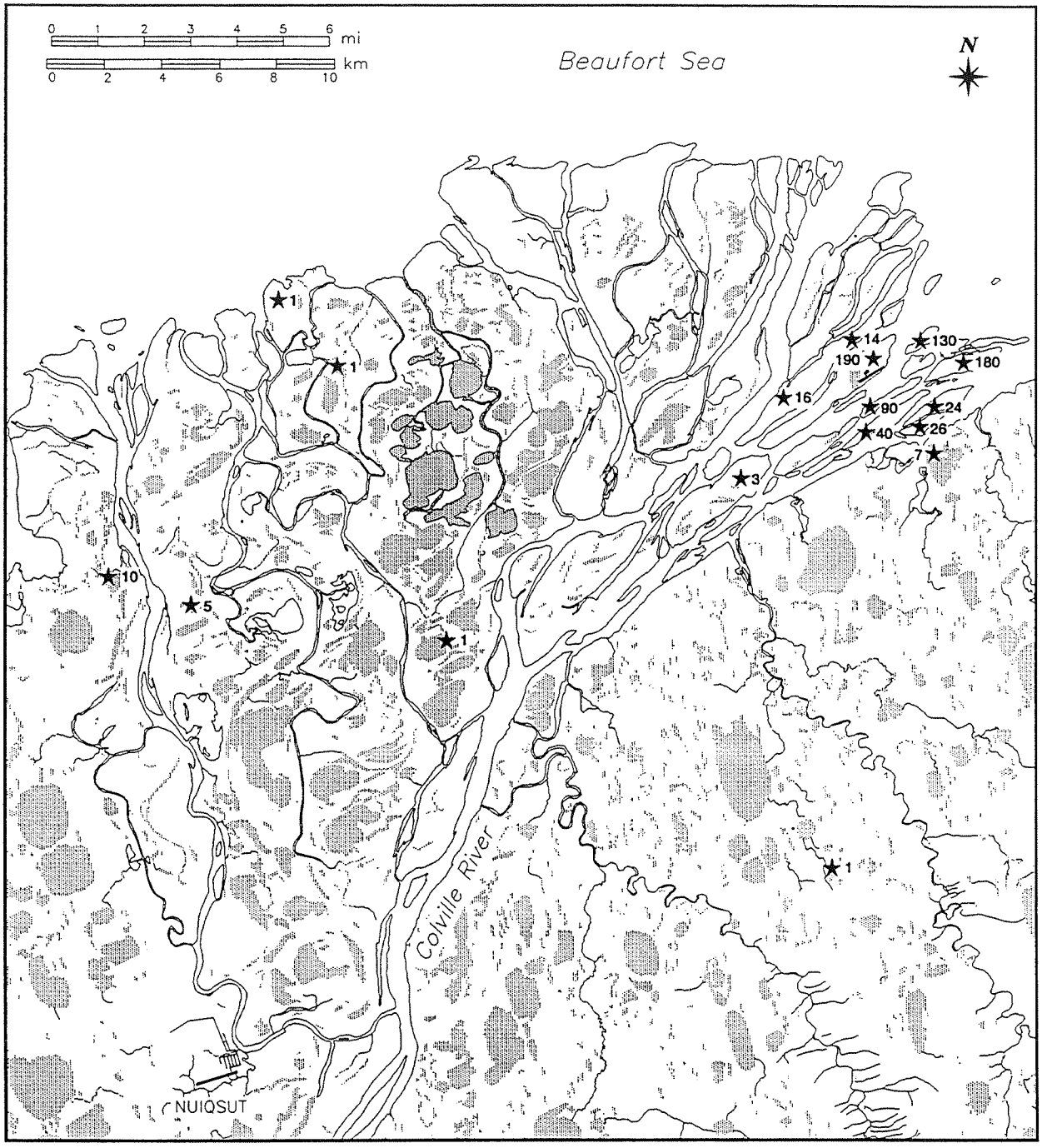

Figure 11. Distribution of Brant nests observed during aerial and ground surveys, June 1992, Colville River Delta, Alaska. Some data provided by USFWS (1992).

Table 3. Number of nests and average clutch size for Brant nesting on the eastern Colville River Delta, Alaska, 1988-92 (Bayha et al.1992, USFWS 1992).

Year	Char	Brant	Eskimo	Anachlik	White-front	North Mud Flats	Turnstone	Plover	Dune	Swan	Snow-Goose Lake	Total Nests	Average Clutch Size
1988	113	157	78	67	NS	NS	NS	NS	NS	NS	NS	415	3.7
1989	59	110	67	61	NS	NS	NS	NS	NS	NS	NS	297	3.7
1990	130	107	87	109	NS	NS	NS	NS	NS	NS	NS	433	4.0
1991	N/A	N/A	N/A	N/A	NS	NS	NS	NS	NS	NS	NS	450	N/A
1992[a]	130	180	90	190	16	14	26	24	3	40	7	720	3.7

NS = Not surveyed.

NA = Data not summarized by individual island; no clutch size data collected.

[a] Average clutch size in 1992 for Char, Brant, Eskimo, Anachlik islands was 3.7 eggs/nest, the same as for the entire colony.

In 1992, some Brant broods moved from the islands to salt marshes northwest of the colony during brood-rearing; other broods moved east across the river to the mainland. Counts of brood-rearing Brant on Anachlik Island conducted on 13 and 22 July yielded 65 goslings in 20 broods, and 50 goslings in 14 broods, respectively (USFWS 1992). It is not known if these counts were of Brant that remained on Anachlik Island throughout brood-rearing, or if some of these broods subsequently departed for other brood-rearing areas.

Aerial surveys during brood-rearing conducted on 9 July along the outer Colville Delta (within 5 km of the coast, excluding the unvegetated mudflats) did not include the Brant nesting colony on the Eastern Channel. Four groups of Brant were seen during this survey, but only two contained goslings (n=10) (Figure 12). No Brant were seen on the outer delta during an aerial survey conducted on 27 July.

The fall migration of Brant along the Arctic Coast of Alaska usually begins in mid- to late August (Johnson and Herter 1989). An aerial survey to locate staging geese was flown on 20 August and included the coastal area from Kalubik Creek to the mouth of the Nechelik Channel (Figures 13 and 14). Five groups (n=208 birds) of Brant were seen; all were within 2-3 km of the coast. Sightings of large flocks of Canada and Greater White-fronted geese also were recorded during the survey. In northern Alaska, Brant and other geese stop-over at major river deltas, such as the Canning and Sagavanirktok, to rest and feed during fall migration (Johnson and Richardson 1981).

SPECTACLED EIDER

BACKGROUND

The Spectacled Eider is considered an uncommon breeding bird of arctic Alaska. Its breeding range extends from Baird Inlet on the Yukon-Kuskokwim delta north and east along the Arctic Coast of Alaska (Gabrielson and Lincoln 1959, Dau and Kistchinski 1977). Spectacled Eiders were considered locally common visitors and uncommon nesters on the Colville Delta in studies conducted during the 1980s (Simpson et al. 1982, Renken et al. 1983, Rothe et al. 1983, North et al. 1984, Nickles et al. 1987, Gerhardt et al. 1988).

Spectacled Eiders first arrive on the Colville Delta from wintering grounds during the late May and early June, with peak migration occurring between 1 and 10 June (Simpson et al. 1982, Renken et al. 1983, Rothe et al. 1983, North et al. 1984b, Nickles et al. 1987, Gerhardt et al. 1988). Mixed flocks of Spectacled and King Eiders occasionally are seen on the delta in early June (Rothe et al. 1983, this study). These flocks disperse into small groups and breeding pairs by mid-June (Rothe et al. 1983).

Spectacled Eiders prefer to nest coastally on islands in, or along shorelines of lakes (Bergman et al. 1977, Derksen et al. 1981, Lehnhausen and Quinlan 1981, Rothe et al. 1983). In the Colville Delta, Spectacled Eider nests have been found on polygon ridges in Class II Shallow-*Carex* (Aquatic Sedge) and on low, wet shorelines of Class III Shallow-*Arctophila* (Aquatic Grass) wetlands (Rothe et al. 1983, North 1990). Nests also have been found near Class IV Deep-*Arctophila* (Deep Open Lakes) and Class V Deep-open (Deep Open Lakes) lakes at Storkerson Point (Bergman et al. 1977) and in the National Petroleum Reserve-Alaska (NPR-A) (Derksen et al. 1981, North 1990). In the Prudhoe Bay region, nests have been found in wet, non-patterned tundra (Troy 1990).

Spectacled Eiders in arctic Alaska usually initiate nests during the second week of June (Gabrielson and Lincoln 1959). Dates of first nests found on the Colville Delta range from 8 to 24 June (Simpson et al. 1982, Renken et al. 1983, North et al. 1984b, Nickles et al. 1987, Gerhardt et al. 1988). Mid-June dates of nest initiation also were recorded for the Prudhoe Bay region (Troy 1988).

Hatching dates of Spectacled Eiders on the Arctic Coast of Alaska have not been well documented. Broods were first seen in the Colville Delta in early August in 1983 and 1984 and on 13 and 22 July in 1986 and 1987, respectively (Renken et al. 1983, North et al. 1984b, Nickles et al. 1987, Gerhardt et al. 1988).

Based on a limited amount of information, brood-rearing by Spectacled Eiders usually occurs on Class II Shallow-*Carex* (Aquatic Sedge) wetlands (Derksen et al. 1981, North 1990). In the NPR-A, Spectacled Eider broods were seen most often on Class II Shallow-*Carex* (Aquatic Sedge) (56%) and Class V Deep-open (Deep Open Lakes) (22%) lakes (Derksen et al. 1981). On the Colville Delta, Spectacled Eider broods also have been observed on Class II Shallow-*Carex* (Aquatic Sedge) lakes (North 1990). Occasionally broods are accompanied by small groups of failed or nonbreeding females (Derksen et al. 1981). Small flocks (2-7 birds) of failed or nonbreeding females have been seen in river channels, Class V Deep-open (Deep Open Lakes) lakes, and in

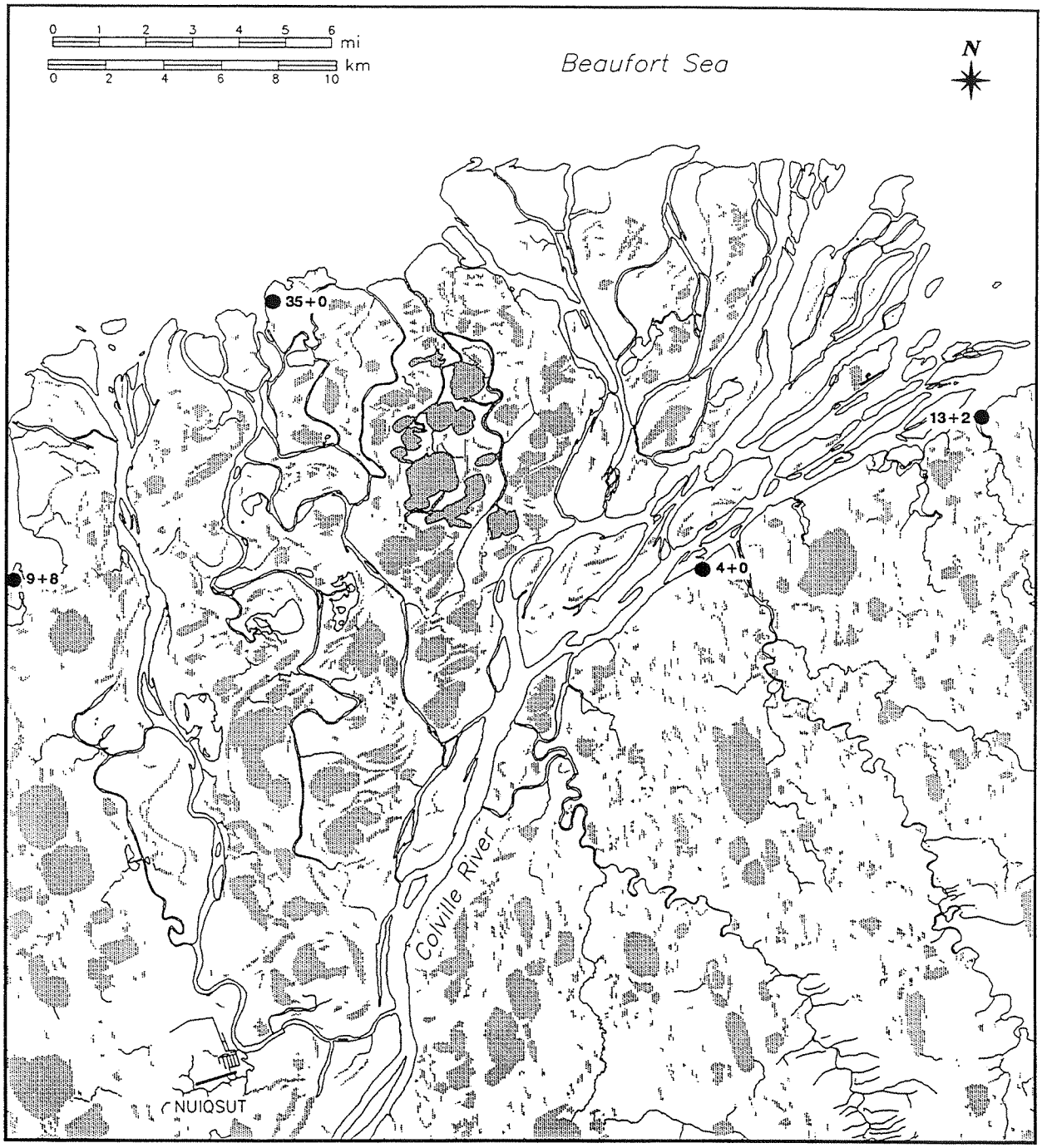

Figure 12. Distribution of Brant (adults + young) observed during aerial survey, 27 July 1992, Colville River Delta, Alaska, 1992.

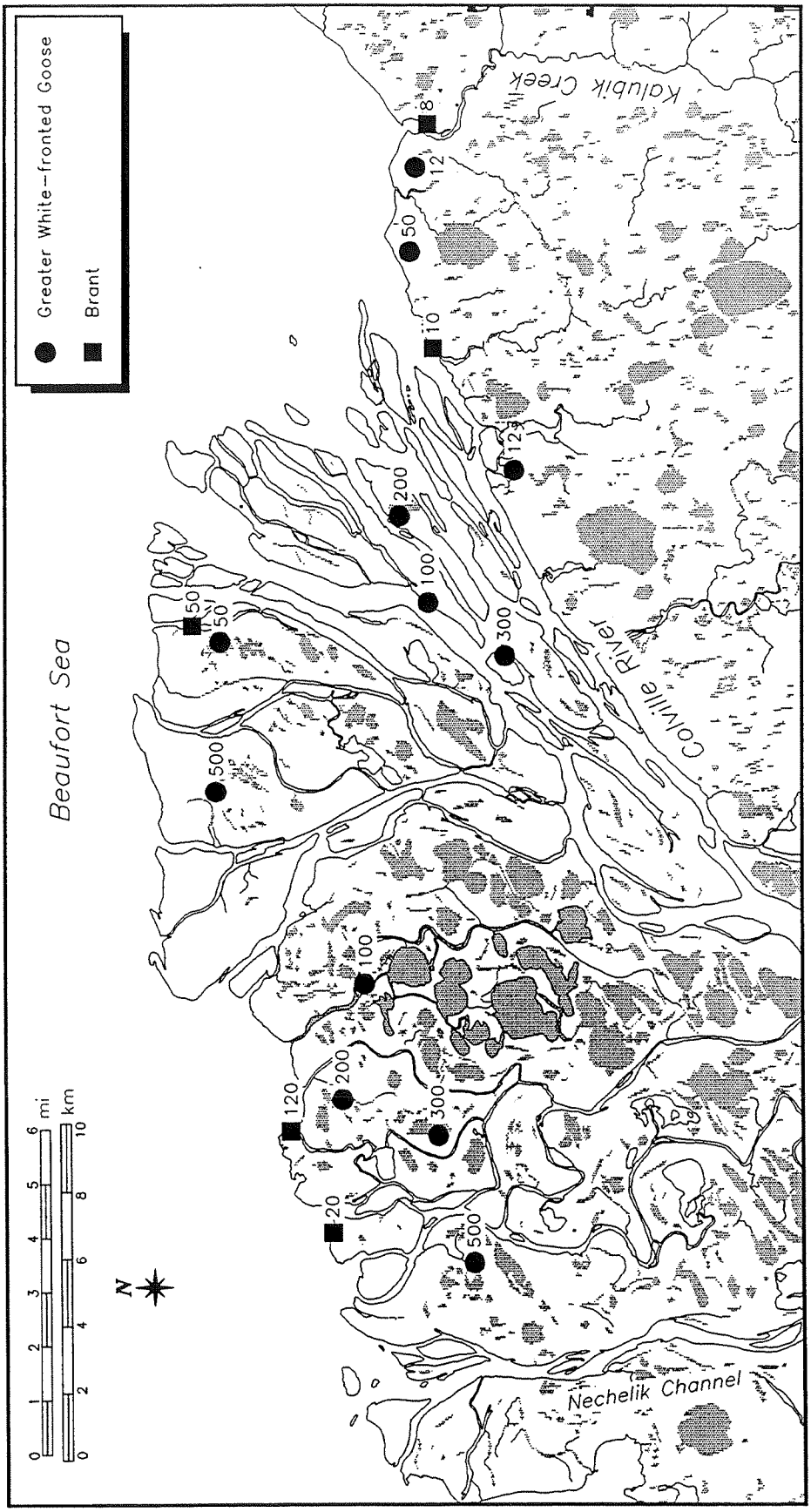

Figure 13. Distribution and numbers of Brant and Greater White-fronted Geese observed during aerial survey, 20 August 1992, Colville River Delta, Alaska.

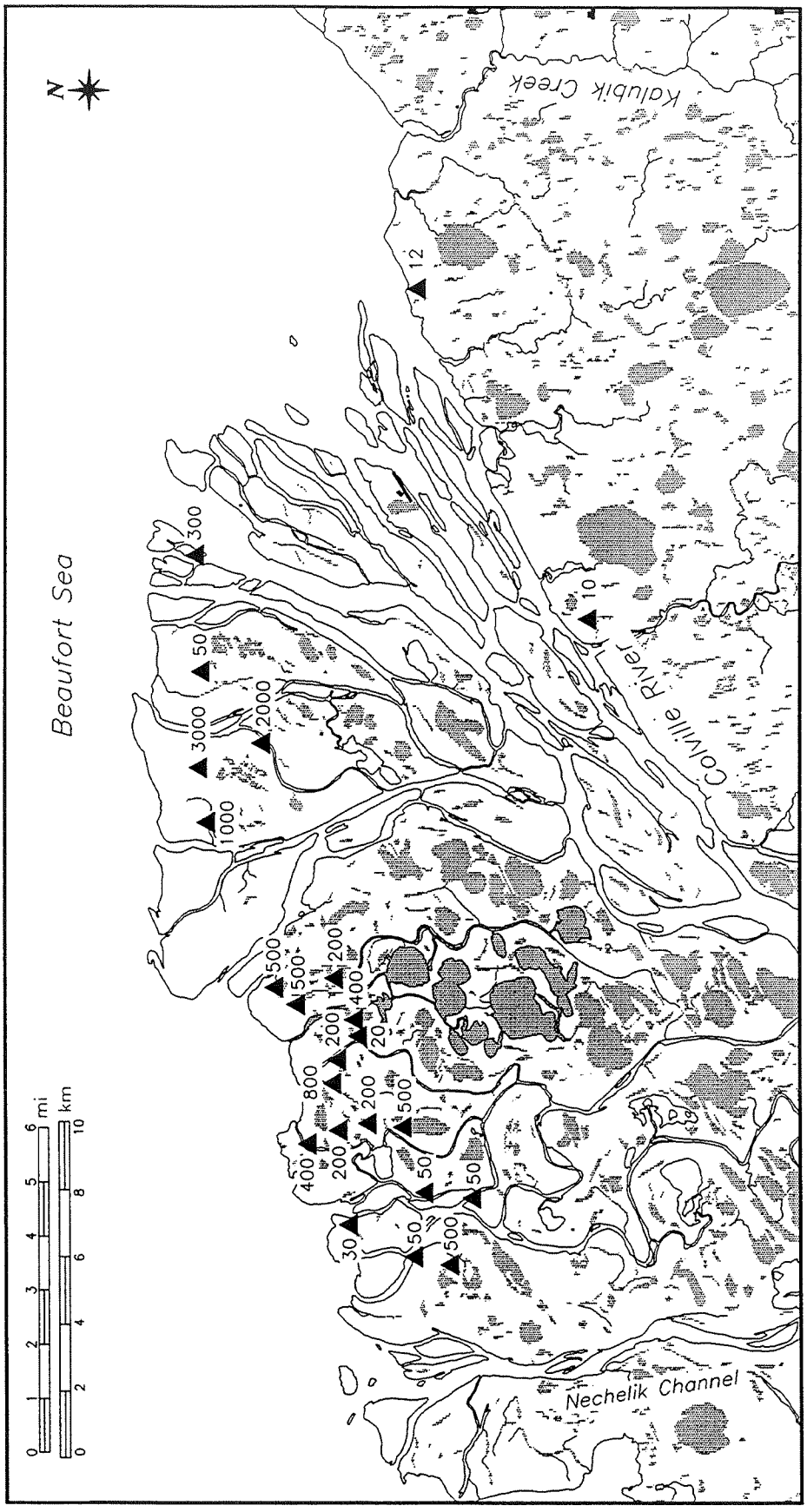

Figure 14. Distribution and numbers of Canada Geese observed during aerial survey, 20 August 1992, Colville River Delta, Alaska.

brackish wetlands on the Colville Delta in late July and August (Rothe et al. 1983).

Male Spectacled Eiders usually remain on the breeding grounds for only two to four weeks, departing prior to hatch and molt (Gabrielson and Lincoln 1959). Departure dates of males on the Colville Delta and NPR-A ranged from 25 June to 11 July (Derksen et al. 1981, Rothe et al. 1983, Nickles et al. 1987, Gerhardt et al. 1988). The destination of male eiders after departing the breeding grounds is unknown.

The fall migration of Spectacled Eiders from the Arctic Coast has not been well documented. Spectacled Eiders have been recorded on the Colville River delta as late as 21 August (Renken et al. 1983, North et al. 1984b). Spectacled Eiders migrating past Icy Cape in 1980 were last observed on 24 August (Lehnhausen and Quinlan 1981).

Over the last 20 years, the breeding population of Spectacled Eiders in the Yukon-Kuskokwim delta has declined by approximately 90% (Kertell 1991). As a result of this decline, the USFWS was petitioned in December 1990 to add the Spectacled Eider to the endangered species list. In May 1992, the USFWS issued a preliminary decision to list the Spectacled Eider on the endangered species list and opened the decision for public comment; a final decision should be announced by early 1993.

RESULTS AND DISCUSSION

Three pairs of Spectacled Eiders were located during aerial surveys of Plots 1-4 conducted on 17 and 18 June. One pair each was found in Plots 1, 3, and 4 (Figures 15-18). In addition, two female eiders, for which species could not be determined, were seen in Plot 4. No eiders were seen in study Plots 5 and 6.

No isolated pairs of Spectacled Eiders were seen during an aerial survey of the entire delta on 19 June. However, a mixed flock of approximately 80 King and Spectacled eiders was seen on the Eastern Channel near its confluence with the Miluveach River (Figure 19). This flock comprised about 40 male King Eiders, 15 male Spectacled Eiders, and 25 females not identified to species. Eiders reportedly congregate in this area each year during the second week of June, remain for about two weeks, and then depart by the end of June (J. Helmericks, pers. comm.).

One Spectacled Eider nest, with three eggs, was found during the nest search of Eider Plot 1 (Figure 16). This nest, when revisited during brood-rearing surveys, was intact but contained no eggs or shell pieces and no broods were seen in the area. No other Spectacled Eider nests were found during the nest search of Eider Plot 2 or during lake-edge nest searches of Plots 1-3. Spectacled Eider broods were not seen in Plots 1-3 during brood-rearing surveys. Four Spectacled Eider nests, each with four eggs, were found during surveys for nesting Brant in the eastern delta conducted from 19 to 22 June. Two nests were located on Anachlik Island, one nest on Swan Island, and one nest on the mainland near Snow Goose Lake (USFWS 1992). The fate of these nests is unknown.

In 1992, the density of Spectacled Eiders (male and female) was 0.04 birds/km^2 in those plots located on the delta (Plots 1-3), based on aerial survey data. No comparable aerial surveys of the delta have been conducted previously for Spectacled Eiders. Therefore it was not possible to determine whether this density was similar to that of previous years.

The low density of Spectacled Eider pairs on the Colville Delta in 1992 may reflect the reported decline in Spectacled Eiders throughout much of their range. However, sampling schedules may have influenced these density estimates. Male Spectacled Eiders are thought to depart from nesting areas on the delta in late June (Rothe et al. 1983), but the aerial survey was not conducted until the third week of June 1992, and it is not known if some male eiders had already left the area by the time the survey was conducted.

The low number of Spectacled Eider nests found on the Colville Delta in 1992 may not be unusual, however. In studies conducted between 1981 and 1987, only 11 Spectacled Eider nests and nine broods were found on the Colville Delta (Simpson et al. 1982, Renken et al. 1983, Rothe et al. 1983, North et al. 1984b, Nickles et al. 1987, Gerhardt et al. 1988). In several of those years (1981-1983, 1987), only one nest was found. Most of these nests were discovered opportunistically, however, usually during searches for other species of birds. No systematic searches for Spectacled Eiders were conducted during these studies.

OTHER BIRDS

PACIFIC LOON

Pacific Loons nest on the arctic tundra and in the northern boreal forest of North America and Siberia (Petersen 1979). Pacific Loons are the most common loon on the Colville Delta, reaching densities of 1.09 birds/km2 which is similar to densities reported for other areas of the Arctic Coast of Alaska (Rothe et al. 1983, Derksen et al. 1979, McDonald and Kenyon 1979).

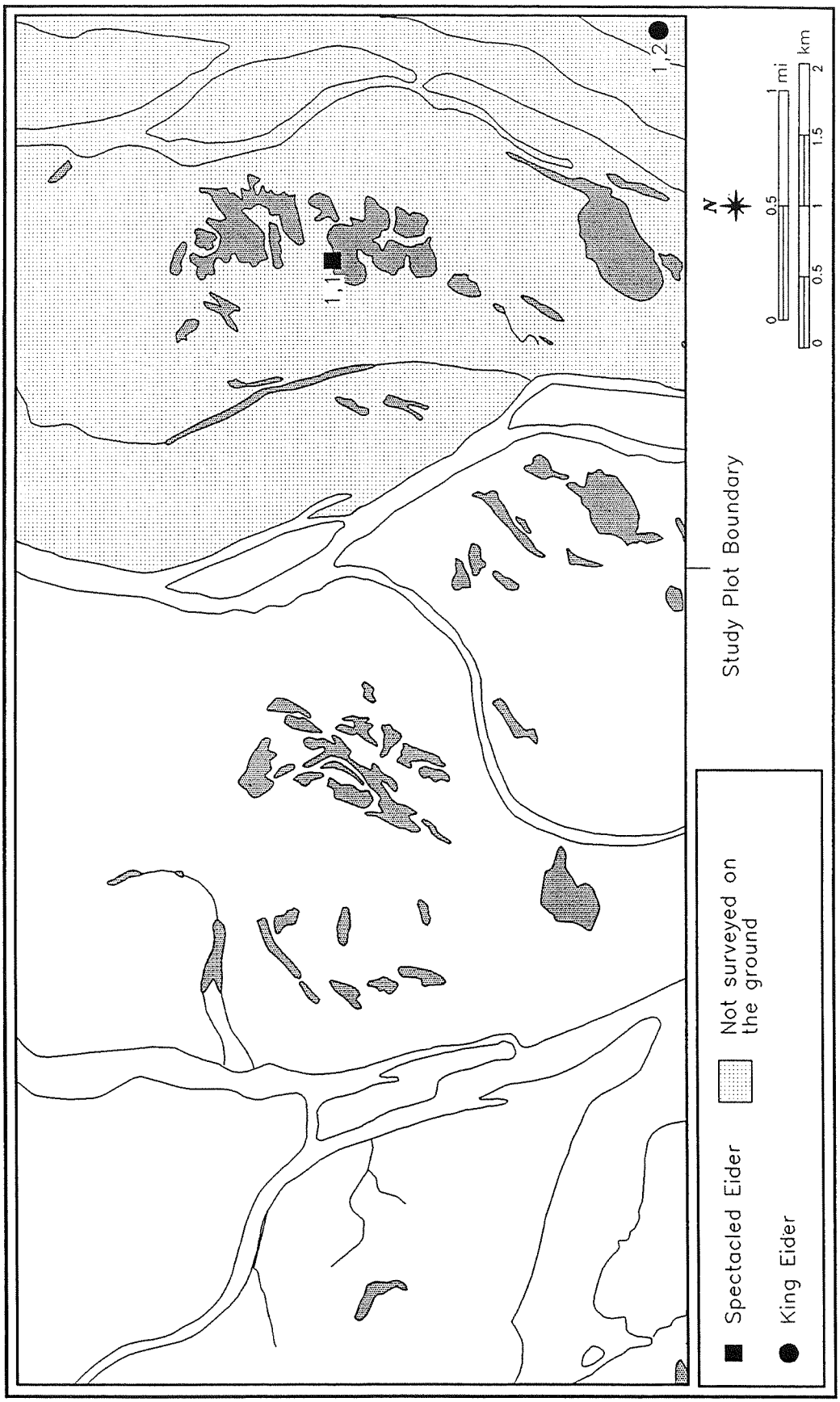

Figure 15. Distribution of Spectacled and King eiders (males and females) in Plot 1 observed during aerial survey, 17 June 1992, Colville River Delta, Alaska.

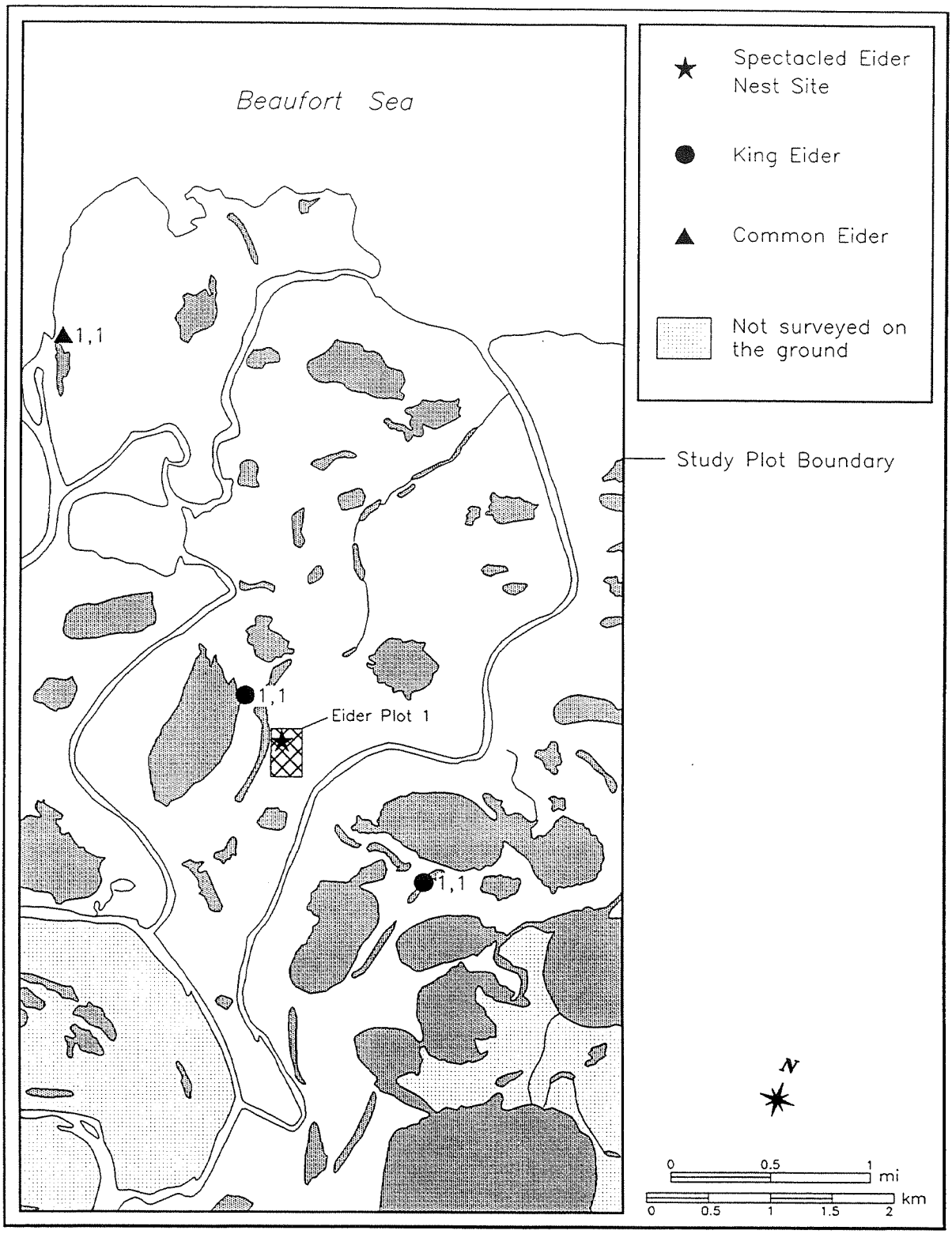

Figure 16. Distribution of Spectacled, King, and Common eiders (males and females) in Plot 2 observed during aerial survey, 17 June 1992, and Spectacled Eider nest site found during ground survey, June 1992, Colville River Delta, Alaska.

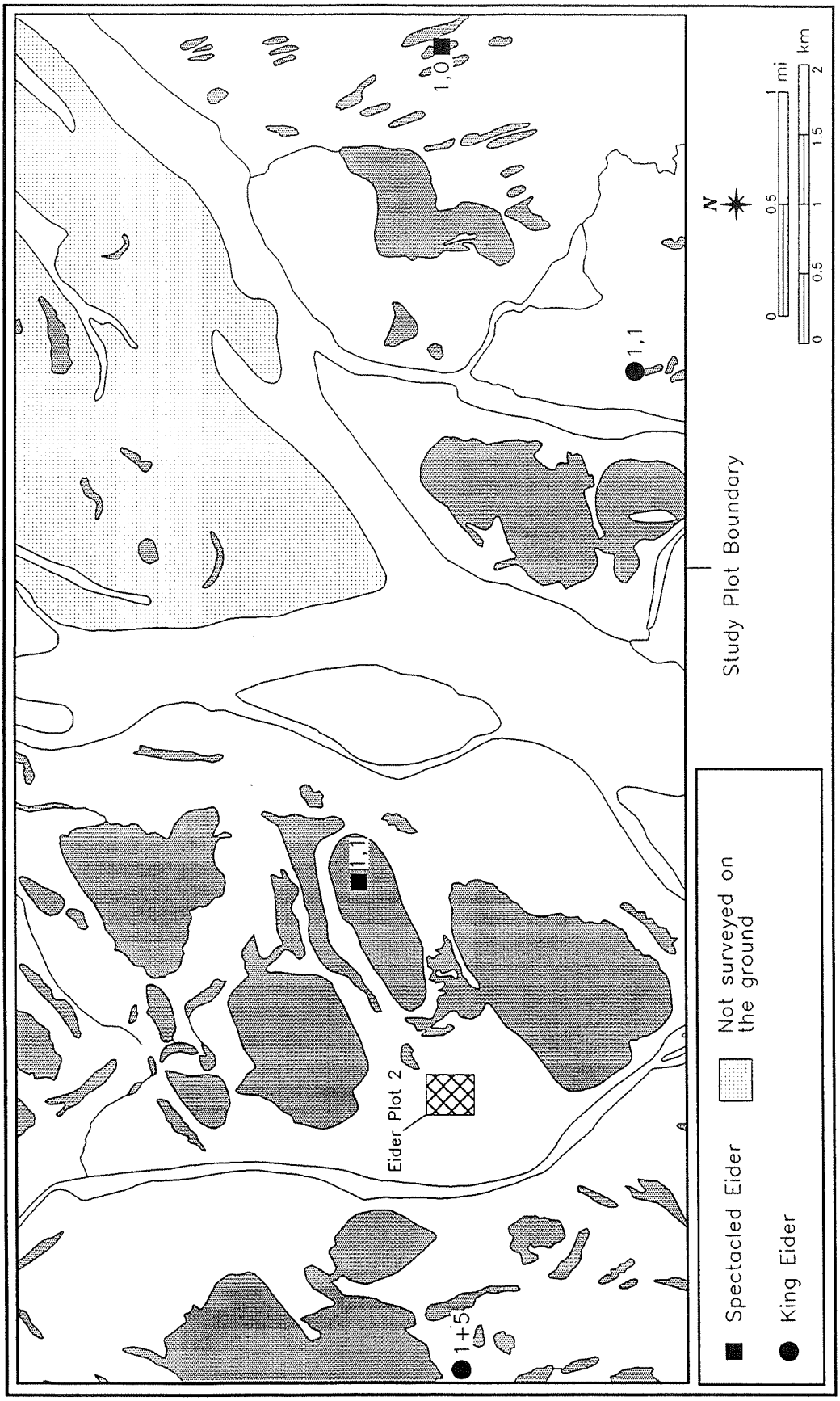

Figure 17. Distribution of Spectacled and King eiders (males and females) in Plot 3 observed during aerial survey, 17 June 1992, and King Eider brood (females + young) seen during ground survey, July 1992, Colville River Delta, Alaska.

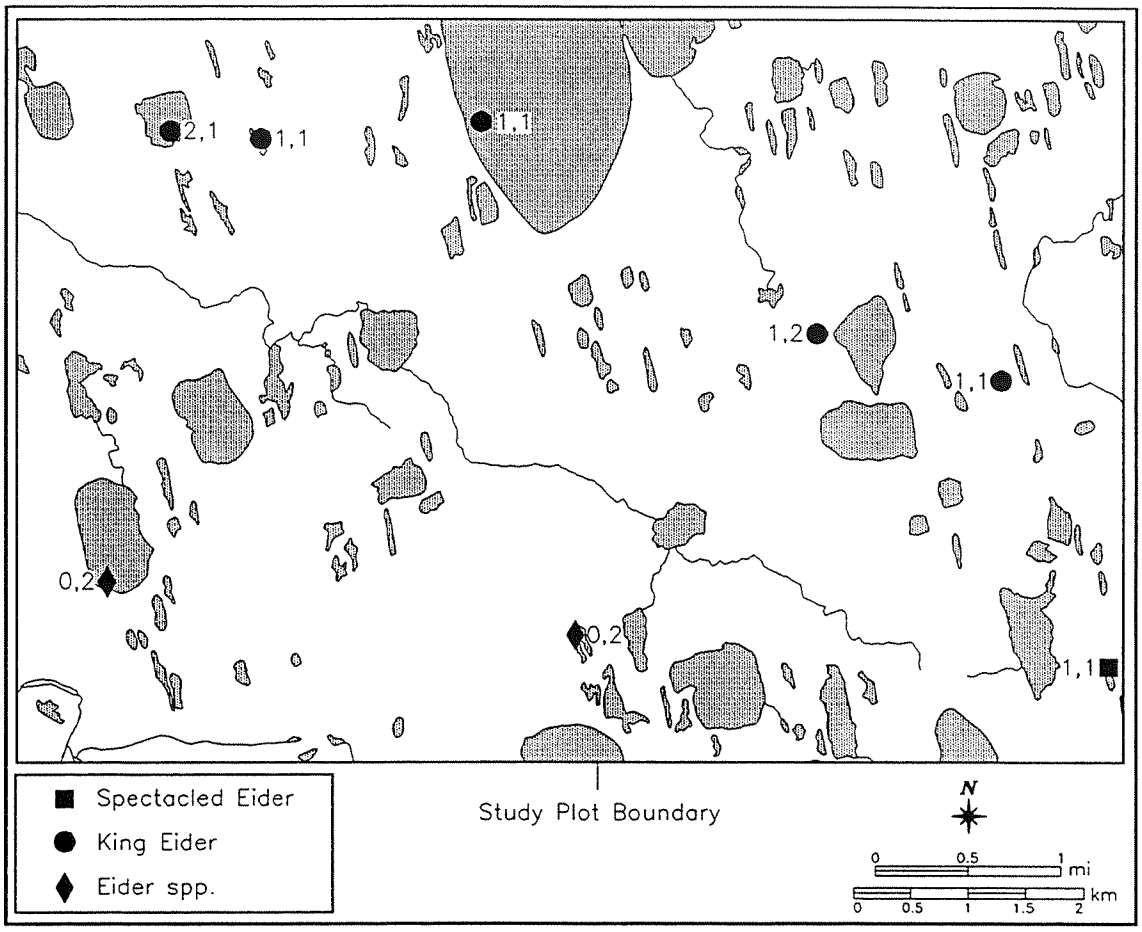

Figure 18. Distribution of Spectacled and King Eiders and eiders of undetermined species (males and females) in Plot 4 observed during aerial survey, 19 June 1992, Colville River Delta, Alaska.

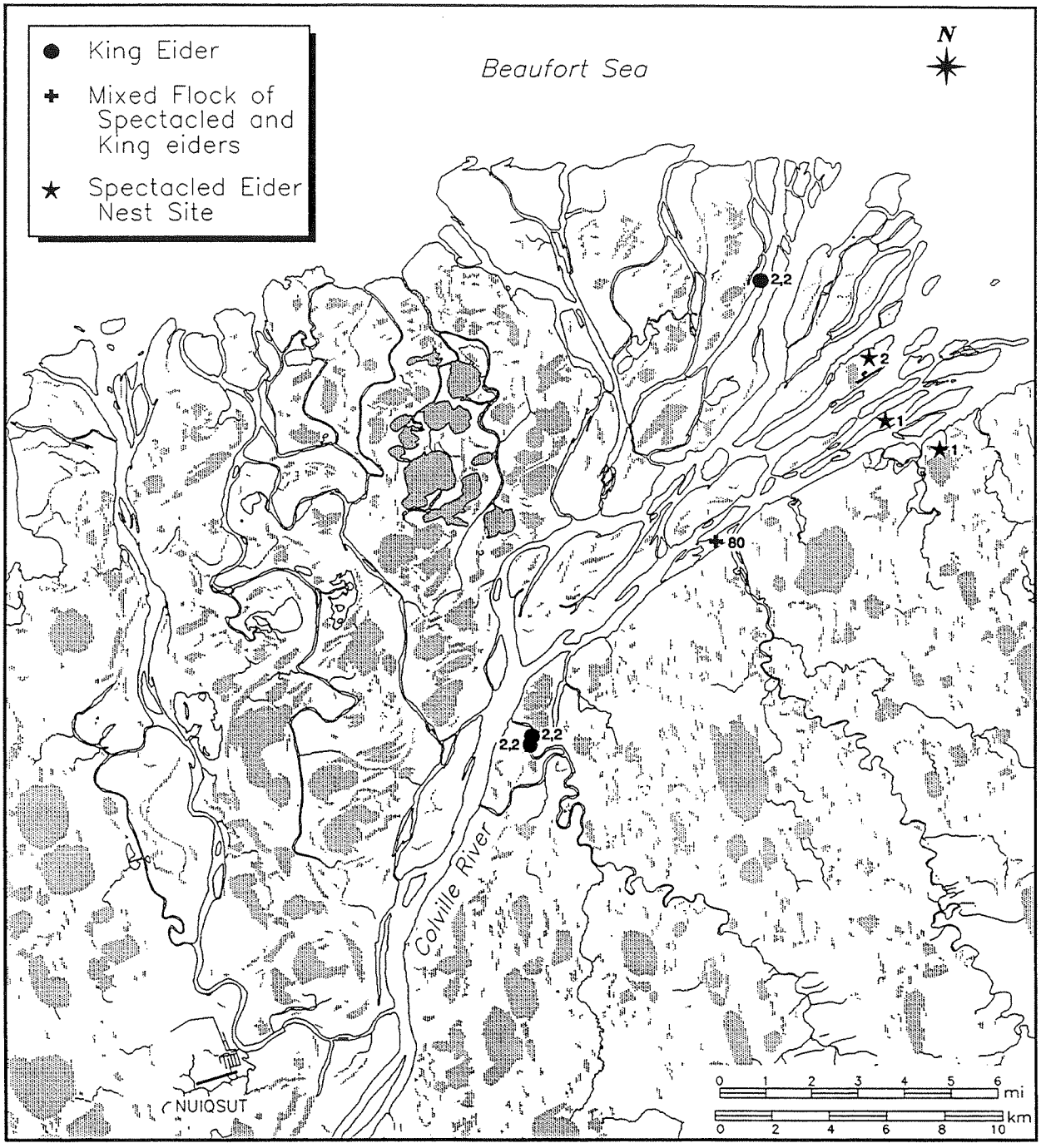

Figure 19. Distribution of Spectacled and King eiders (males and females, or adults) observed during aerial survey, 18 June 1992, and approximate locations of Spectacled Eider nests located during surveys for nesting Brant 19 to 22 June 1992, Colville River Delta, Alaska. Spectacled Eider nest data provided by USFWS (1992).

Pacific Loons arrive on the delta with the first occurrence of open water in rivers and tapped lakes, usually during the last week of May (North 1986). Breeding territories are established in untapped wetlands as thaw progresses and nests are initiated within 7-11 days, usually during the second or third week of June (Bergman and Derksen 1977, North 1986). Hatching of Pacific Loon nests occurs during the first or second week of July on the Colville Delta and hatching success is high (Bergman and Derksen 1977, Rothe et al. 1983).

Pacific Loons nest on the delta on a wider variety of wetland habitats than do Yellow-billed Loons (North 1986). Class III Shallow-*Arctophila* (Aquatic Grass), Class IV Deep-*Arctophila* (Deep Open Lakes), Class V Deep-open (Deep Open Lakes), and Class VIII Brackish (Halophytic Wet Meadows) wetlands are used by nesting and brood-rearing Pacific Loons, although highest densities are found on Class IV Deep-*Arctophila* (Deep Open Lakes) wetlands (North 1986). Pacific Loons are the only loon species to consistently use lakes and ponds within Class VIII Brackish (Halophytic Wet Meadows) wetlands on the Colville Delta (North 1986). Pacific Loons occasionally move broods overland from nesting lakes to nearby brood-rearing lakes, presumably because forage is more available there (Bergman and Derksen 1977, North 1986).

Fifteen Pacific Loon nests were found during aerial and ground surveys of Plots 1-3. Five nests were located in Plot 1, six nests in Plot 2, and four nests in Plot 3 (Figure 20). Five nests had two-egg clutches, and three nests had one-egg clutches at the time they were discovered; seven nests had clutches of unknown size. Eleven of 15 nests were revisited during nest checks in Plots 1-3. Four nests could not be relocated or were in areas not surveyed on the ground. Broods were seen near six of the nest sites, indicating success of those nests. One nest appeared to have been depredated, and the fate of four nests was unknown, because no evidence of predation was present at the nest and no broods were seen in the area. An additional six broods were located during brood-rearing surveys in areas where nest sites had not been previously found.

Twelve broods ($\bar{x}$= 1.3 young/brood) of Pacific Loons were located during ground surveys of Plots 1-3. In addition, two pairs of loons exhibited defensive behaviors toward observers, as though chicks were present, although none were seen. Six Pacific Loon broods were seen during an aerial brood-rearing survey of Plots 1-3 conducted about three weeks after the ground surveys. It is not known if these broods previously were seen during ground surveys. Three flocks, totaling 14 birds, four pairs, and a single loon also were seen during this aerial survey.

Islands are thought to be important components of the nesting habitats of Pacific Loons because they provide protection from terrestrial predators, such as arctic foxes (Bergman and Derksen 1977). Of the 15 nests located during aerial and ground surveys of Plots 1-3, eight (53%) were on islands in Plots 1 and 2; islands were not used in Plot 3. On the Colville Delta, Pacific Loon broods occupied lakes and ponds within Class VIII Brackish (Haolphytic Wet Meadows) wetlands more often than either Yellow-billed or Red-throated loons (North 1986). In 1992, Pacific Loons were the only loons found nesting in Plot 1, the most marine-affected plot.

RED-THROATED LOON

Red-throated Loons are common nesting birds on arctic tundra areas along the Beaufort Sea coast of Alaska and Canada (Pitelka 1974). Densities of Red-throated Loons during the breeding season near Prudhoe Bay averaged 1.1 birds/km^2 over a three-year period (Troy 1985a, 1985b). On the Colville Delta, the mean density of Red-throated Loons during the breeding season was estimated at 0.53 birds/km^2 in 1981 (Rothe et al. 1983).

Unlike Yellow-billed and Pacific loons, Red-throated Loons do not arrive on the Colville Delta until their nesting ponds begin to thaw, usually during the first half of June (Rothe et al. 1983, North et al., 1984b). Nest initiation occurs within two weeks of territory establishment (Bergman and Derksen 1977, North 1986). Hatching on the Colville Delta occurs in mid- to late July and hatching success is usually high (Bergman and Derksen 1977, Rothe et al. 1983, North et al. 1984b). Brood-rearing occurs on the natal pond (Bergman and Derksen 1977, North et al. 1984a).

Four Red-throated Loon nests were found during aerial and ground surveys of Plots 1-3 (Figure 20). One nest was found in Plot 2 and three nests in Plot 3; no nests were found in Plot 1. Three nests had two-egg clutches and one nest had a clutch of unknown size. Three nests were revisited during nest checks of Plots 1-3; one nest was not found. One of the three nests was considered successful, based on the presence of a brood on the nest lake. The other two nests had no broods nearby and were considered unsuccessful. An additional two broods were located for which nests

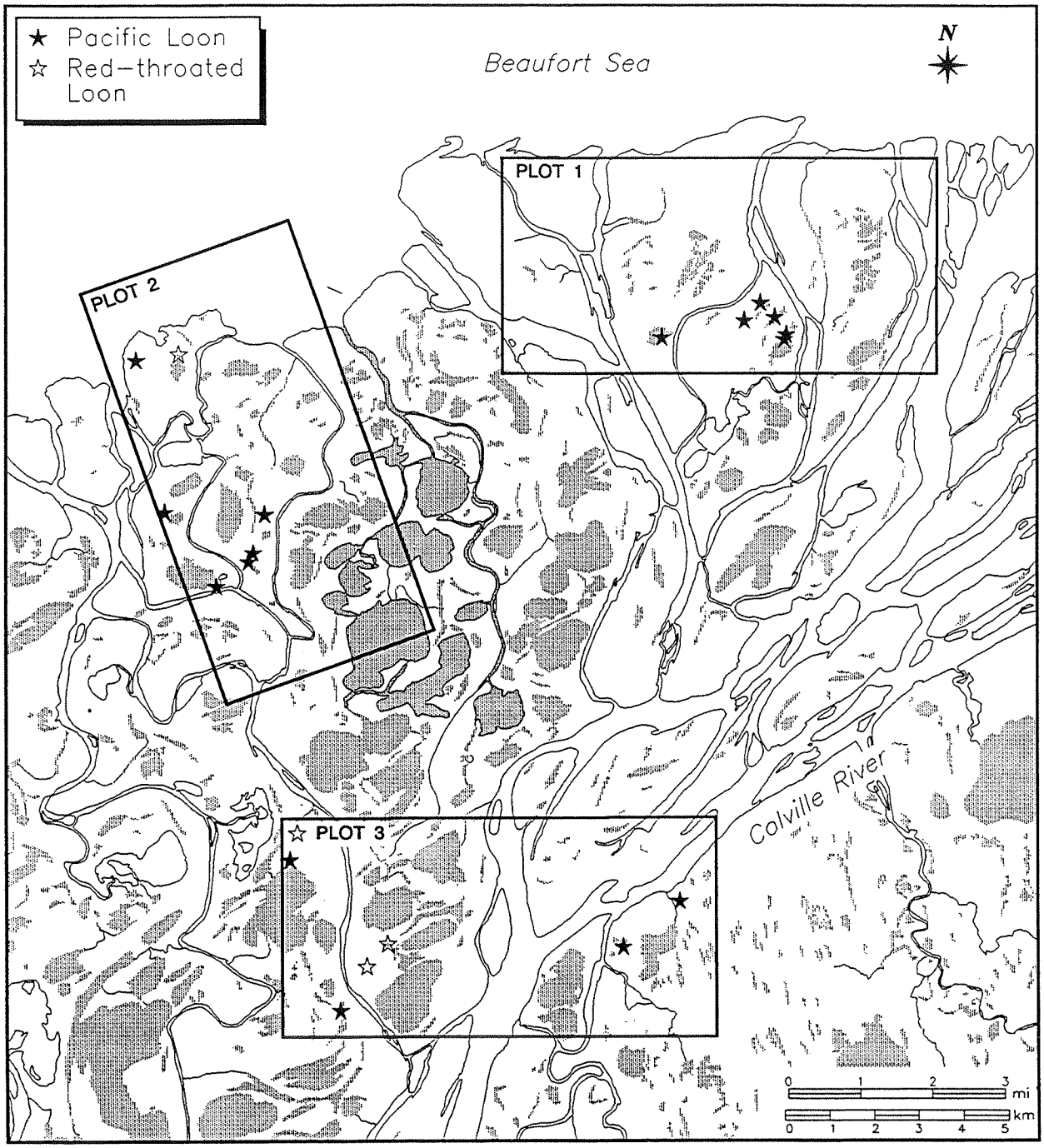

Figure 20. Distribution of Pacific and Red-throated loon nests in Plots 1-3, June 1992, Colville River Delta, Alaska.

had not been previously found.

Three pairs of Red-throated Loons, each with two young, were found during ground surveys of Plots 1-3 conducted in June. Eight pairs, two single adults, and three flocks of Red-throated Loons were seen during an aerial survey conducted about three weeks after the ground survey; no young were seen with any of these adult loons.

The distribution of nesting Red-throated Loons on the Colville Delta differs considerably from the distribution of either nesting Yellow-billed or Pacific loons (North 1986). Red-throated Loons usually nest on ponds of less than 0.5 ha in untapped, Class II Shallow-*Carex* (Aquatic Sedge) and Class III Shallow-*Arctophila* (Aquatic Grass) wetlands; Yellow-billed and Pacific loons nest on deeper, larger ponds and lakes usually in wetlands of Class III Shallow-*Arctophila* (Aquatic Grass) or greater (North 1986). Although relatively few Red-throated Loon nests were found on the Colville Delta in 1992, all were located on the edge of small ponds in highly polygonized, shallow wetlands.

The survey techniques we used for conducting the nesting and brood-rearing ground surveys undoubtedly accounted for the low number of Red-throated Loon nests and broods we found on the delta in 1992. We did not survey the preferred nesting habitat (small ponds within Class II Shallow-*Carex* [Aquatic Sedge] and Class III *Shallow-Arctophila* [Aquatic Grass] wetlands) of Red-throated Loons as intensively as Class IV Deep-*Arctophila* (Deep Open Lakes) and Class V Deep-open (Deep Open Lakes) wetlands, which contained larger, more discrete lakes.

GREATER WHITE-FRONTED GOOSE

Greater White-fronted Geese are a common breeding bird along the Arctic Coast of North America. In Alaska, they breed from Bristol Bay north and east along the coast to the Alaska-Yukon border (Gabrielson and Lincoln 1959), with the highest nesting densities occurring within 30 km of the coast (King 1970). The Colville Delta is a regionally important area for nesting Greater White-fronted Geese, with mean densities of 6.28 birds/km^2 during June and nest densities of 1.8 nests/km^2 (Simpson and Pogson 1982, Simpson 1983). These densities are among the highest recorded for Greater White-fronted Geese on the Arctic Coast (Simpson and Pogson 1982, Rothe et al. 1983, Simpson 1983).

Intensive searches for Greater White-fronted Goose nests were not conducted on the Colville Delta in 1992, however, their nests were located incidentally during nest searches for Yellow-billed Loons, Tundra Swans, and Spectacled Eiders. Thirty nests were found during nest surveys on the delta in 1992, most (76%) on polygon ridges within 3 m of water. In 1982, 87% of the Greater White-fronted Goose nests were located on polygon ridges within 2.5 m of water (Simpson and Pogson 1982). The mean clutch size of Greater White-fronted geese was 4.0 eggs/nest in 1992, which was similar to the mean of 4.2 eggs/nest recorded in 1982 and 1983 (Simpson and Pogson 1982, Simpson 1983).

On the Colville Delta, Greater White-fronted Geese use sedge-willow tundra and Class I Flooded tundra (Wet Meadows-patterned) and Class II Shallow-*Carex* (Aquatic Sedge) wetlands for nesting and feeding. Brood-rearing and molting geese use Class IV Deep-*Arctophila* (Aquatic Grass) and Class V Deep-open (Deep Open Lakes) wetlands and rivers (Simpson and Pogson 1982, Rothe et al. 1983). Brackish salt marshes and mudflats on the outer delta reportedly were not used by white-fronts during the early 1980s (Simpson and Pogson 1982, Rothe et al. 1983), however, approximately 150 molting white-fronts were observed in salt-marsh habitats at the edge of the mudflats in Plot 2 during brood-rearing searches in July 1992. In addition, 12 groups (n=2324 birds) of white-fronts were seen during an aerial survey of coastal portions of the delta in late August 1992 (Figure 13).

CANADA GOOSE

Canada Geese are common breeding birds and migrants on the Arctic Coast of Alaska (Gabrielson and Lincoln 1959). While several hundred Canada Geese nest along the banks and bluffs of the upper Colville River (Kessel and Cade 1958), they have not been reported nesting on the Colville Delta or in the NPR-A (Derksen 1981, Simpson et al. 1982, Renken et al. 1983, Rothe et al. 1983, North et al. 1984b). Fifty to 100 geese nest on islands in coastal wetlands of the Prudhoe Bay area (Troy 1985a, 1985b, Murphy et al. 1990) and they also regularly nest on the Arctic Coastal Plain east of the Kuparuk River (Ritchie et al. 1991).

Migrations of failed and non-breeding Canada Geese to primary molting areas such as Teshekpuk Lake and the Prudhoe Bay-Sagavanirktok River delta region occurs in late June and early July (Derksen 1981, Troy 1985a). The Colville Delta has not been identified as an important molting or brood-rearing

area for Canada Geese, and no Canada Geese were seen on the delta during aerial surveys in late July.

Although the Colville Delta is not an important area for Canada Geese during nesting, brood-rearing, and molting, it may be important during fall migration. Nearly 11,000 Canada Geese in 23 groups were seen on the delta during aerial surveys conducted in late August 1992 (Figure 14). During Fall, geese migrating along the Beaufort Sea coast stop to rest and feed in major river deltas such as the Canning and Sagavanirktok (Johnson and Richardson 1981, Garner and Reynolds 1986). The Colville Delta also appears to be an important fall-staging area along the Beaufort Sea coast for migrating geese.

KING EIDER

King Eiders are considered abundant in the Beaufort Sea area (Gabrielson and Lincoln 1959, Johnson and Herter 1989). In Alaska, they breed from the Bering Sea north and east along the coast to the Alaska-Canada border (Gabrielson and Lincoln 1959, Derksen et al. 1981). Off the coast at Barrow, King Eiders are the most abundant duck observed in spring and during molt (summer) migration (Johnson 1971, Woodby and Divoky 1982). They also are the most abundant species during molt migrations near Oliktok Point (Johnson and Richardson 1982). The highest densities of nesting King Eiders in Alaska are found in the Prudhoe Bay region, east of the Colville Delta (Derksen et al. 1981, Troy 1988). Low densities of nesting King Eiders are found in the Arctic National Wildlife Refuge (Garner and Reynolds 1986), on the Colville Delta (Rothe et al. 1983), and in coastal areas of the NPR-A (Derksen et al. 1981).

Nine pairs and small groups of King Eiders were seen during aerial surveys of Plots 1-6 conducted from 17-19 June; one sighting each in Plots 1 and 3, two sightings in Plot 2, and five sightings in Plot 4 (Figures 15-18); no eiders were seen in Plots 5 and 6. An additional four pairs, and a mixed flock of King and Spectacled eiders, were seen during aerial surveys of the entire delta (Figure 19). No King Eider nests were found during nest searches of Plots 1-3. One brood with five goslings was seen in Plot 3 during brood-rearing searches (Figure 17).

Five King Eider nests were located during surveys for nesting Brant on the eastern Colville Delta conducted from 19 to 22 June. One nest was found on Brant Island, one nest on White-front Island, and three nests on the mainland near Snow Goose Lake (USFWS 1992). One nest was destroyed prior to being discovered. Of the remaining four nests, three nests had three-egg clutches, and one nest had one-egg clutch. The fate of these four nests is unknown (USFWS 1992).

The Colville River delta is not considered to be a primary nesting area for King Eiders. King Eiders were listed as common visitors and uncommon nesters on the delta during studies conducted in the early 1980s (Simpson et al. 1982, Renken et al. 1983, North et al. 1984b, Nickles et al. 1987). King Eiders similarly were uncommon nesters at Barrow and at coastal sites on the NPR-A (Derksen et al. 1981). High densities of nesting King Eiders were found at Storkerson Point (Bergman et al. 1977, Derksen et al. 1981) and in Prudhoe Bay (Troy 1988).

CARIBOU

BACKGROUND

The Colville Delta lies at the western edge of the summer range of the Central Arctic Herd (CAH) of caribou, and at the far eastern periphery of the summer range of the Teshekpuk Lake Herd (TLH). The CAH generally ranges between the Colville and Itkillik rivers on the west and the Canning and Tamayariak rivers on the east (Cameron and Whitten 1979, Lawhead and Curatolo 1984, Shideler 1986). The distribution of caribou within this range varies seasonally, with the majority of the herd being near the coast in summer and near the Brooks Range in winter (Cameron and Whitten 1979, Carruthers et al. 1987). The TLH calves and summers in a core area around Teshekpuk Lake, about 80 km to the west of the Nechelik Channel (Silva 1985), but may disperse widely in winter (Carroll 1992).

Systematic surveys of caribou in the past generally have not included the Colville Delta. Except for two years in the early 1980's, calving surveys of the CAH by ADFG routinely have ended at the east bank of the Colville River (Whitten and Cameron 1985, Lawhead and Cameron 1988). U. S. Bureau of Land Management (BLM) surveys of the TLH routinely stopped at the west bank of the Nechelik Channel (Reynolds 1982). Cameron et al. (1989) documented that during westerly winds CAH caribou have used the Colville River delta for insect relief; the frequency of use of the delta by radio-collared CAH caribou increased during the late 1980's (R. Cameron, ADFG, unpubl. data). A 1992 location of a radio-collared TLH caribou by satellite telemetry indicated that some TLH animals may occasionally use the delta during periods of mosquito harassment (G. Carroll,

ADFG, pers. comm.). The extent of contact and exchange of individuals between these two herds has not been quantified.

The current size of the CAH is estimated at 19,000 caribou (R. Cameron, ADFG, pers. comm.); results of a 1992 aerial photo-census will be available early in 1993. The herd increased during the 1970's and 1980's, but growth is thought to have stabilized or to be declining (Valkenburg 1990).

Pregnant cows of the CAH disperse widely across the coastal plain during calving season, which begins in late May; peak calving occurs in the first week of June (Whitten and Cameron 1985, Lawhead and Cameron 1988). The Kuparuk and Milne Point oilfields have received relatively high use by calving cows in recent years (Whitten and Cameron 1985, Lawhead and Cameron 1988). Following calving, caribou of the CAH remain within 30 km of the coast throughout the mosquito season (late June through July) (Lawhead and Curatolo 1984).

Caribou movements during mid-summer are influenced predominantly by mosquito and oestrid flies (*Hypoderma tarandi* and *Cephenemyia trompe*) (White et al. 1975, Roby 1978). Typically, by the beginning of July, mosquitoes emerge in numbers near the coast and persist to the end of the month. Mosquito activity is lowest at the coast due to low ambient air temperature and elevated wind speeds near the Beaufort Sea (White et al. 1975, Dau 1986). Caribou normally move to the coast in response to mosquito harassment. Mosquito-harassed caribou will move coastward, and upwind, but only as far as is necessary to reach insect-free habitat (Lawhead and Curatolo 1984, Dau 1986). With the cessation of insect harassment due to low temperatures or windy weather, CAH caribou move inland to the south or southwest (White et al. 1975, Lawhead and Curatolo 1984).

Oestrid fly harassment of caribou typically lasts from mid-July well into August (Dau 1986). Fly-harassed caribou use unvegetated and elevated sites as relief habitat, such as pingos, mud flats, river bars and roads. By the beginning of August, CAH caribou begin to disperse southward after mosquito harassment abates and coastal habitat becomes less important (Lawhead and Curatolo 1984, Dau 1986). This inland dispersal continues through September.

In October, the sexes (which are usually segregated) mix for the rut in the southern portion of the CAH's range (Roby 1978). Caribou winter (November-April) in relatively small groups in the foothills and valleys of the northern Brooks Range. A few hundred caribou overwinter on the coastal plain (Carruthers et al. 1987).

The TLH has increased steadily in population size, growing from 2000 animals in 1976 to 16,600 in 1989 (Carroll 1992). Although some of this increase can be attributed to the implementation of better census methods, the TLH is probably undergoing growth similar to that recently documented in the Western Arctic and Central Arctic herds (Silva 1985, Carroll 1992).

Little information is available on the seasonal movements of the TLH. Since 1981, calving (late May to mid-June) has occurred in the area north and east of Teshekpuk Lake, approximately 80 km to the west of the Colville Delta (Reynolds 1982). Like caribou of the CAH, the TLH caribou seek relief from mosquitoes in windblown, sparsely vegetated areas, such as spits, river deltas, and beaches along the coastline of the Beaufort Sea, between late June and July.

RESULTS AND DISCUSSION

Nine aerial surveys were conducted between 4 June and 17 September 1992 to characterize the seasonal use and distribution of caribou in the study area. The total numbers observed ranged from 72 to 3363 among surveys (Table 4). Surveys 1 and 2 (4 and 16 June) coincided with the peak and end of the calving season. Surveys 3 - 7 (29 June; 8, 16, 18, and 30 July) were conducted during the period in which insect harassment exerts a strong effect on caribou movements. Surveys 8 and 9 (18 August; 17 September) were conducted after insect harassment had declined for the season (although oestrid flies normally remain active until at least mid-August).

Calving Season

Snow cover was less than 20% on the first survey (4 June), making caribou relatively easy to see (greater snow cover results in lower sightability [Lawhead and Cameron 1988]). Eighty-three caribou were observed; 61 (73%) were cows or calves (15.1 calves:100 cows). Most caribou were observed along the upper Miluveach and Kachemach rivers and the greatest concentration of calves also was along the Miluveach River and in the area between the Miluveach and Kachemach rivers (Figures 21 and 22). No caribou were seen on the Colville Delta.

Snow cover was less than 5% for the survey on 16 June. Of the 453 animals observed, 378 (83%) were cows or calves (69.5 calves:100 cows); the

Table 4. Caribou survey results, June-September 1992, Colville River Delta, Alaska.

Season	Date	Total caribou observed	Largest group	Comments
Calving	4-June-92	83	17	Largest group count per 4.8 km segment; 15.1 calves:100 cows
	16-June-92	456	39	Largest group count per 4.8 km segment; 69.5 calves:100 cows
Insect	29-June-92	1146	250	
	8-Jul-92	98	65	Partial Survey
	16-Jul-92	2943	1700	
	18-Jul-92	3363	1500	Partial survey
	30-Jul-92	679	220	
Post-insect	18-Aug-92	72	25	
Freeze-up	17-Sep-92	331	37	Partial survey

overall ratio for the CAH in 1992 was 73 calves:100 cows (R. Cameron, ADFG, pers. comm.). In general, the caribou were more widely dispersed than in the previous calving survey. Caribou were distributed throughout the eastern half of our study area (Figures 23 and 24). The largest concentrations occurred along the Miluveach River, and no caribou were observed in the delta.

Cameron and Whitten (1985) reported a small number of caribou and calves on transects covering the Colville River Delta in 1981-82. Less than 5% of the calves were observed within 8 km of the coast; the majority of total caribou and calves were distributed in an upland area to the south, 32-40 km from the coast. They attributed the low level of calving in the delta to flooding along the river.

Calving surveys of the CAH in 1987 resulted in estimates of 75-78 calves:100 cows for the area between the Colville and Canning rivers (Lawhead and Cameron 1988). Annual surveys resulted in ratios of 56-91 calves:100 cows in the period 1978-1986 for the concentration area in the Kuparuk Oilfield (between Oliktok Point and the Kuparuk River) (Lawhead and Cameron 1988). The area between the Colville River and the western edge of the Kuparuk Oilfield has become increasingly important for calving by the western segment of the CAH since about 1987 (R. Cameron, ADFG, pers. comm.).

Insect Season

Approximately 1150 caribou were observed on the first survey during the insect season. Mosquito harassment at Nuiqsut was severe on 29 June. Most of the large groups (60-250 animals) totalling about 800 caribou (about 70% of the total observed) were congregated between the mouths of the Miluveach and Kachemach rivers (Figure 25). No caribou were seen south of these aggregations. Scattered animals were distributed to the north in an east-west band across the delta. The caribou observed had reached relief habitat, for they did not appear to be harassed by insects (i.e., most were walking or grazing). Only one large group of about 100 was seen running (to the northeast), 10 km south of the coast.

Approximately 100 caribou were observed during the survey on 8 July. Two groups (65 at the mouth of Kalubik Creek and 10 at Tolaktovut Point) accounted for most of the observed animals (Figure 26). The remaining caribou were spread across the northern portion of the survey area.

On the morning of 8 July, approximately 6000 caribou were concentrated between the mouth of

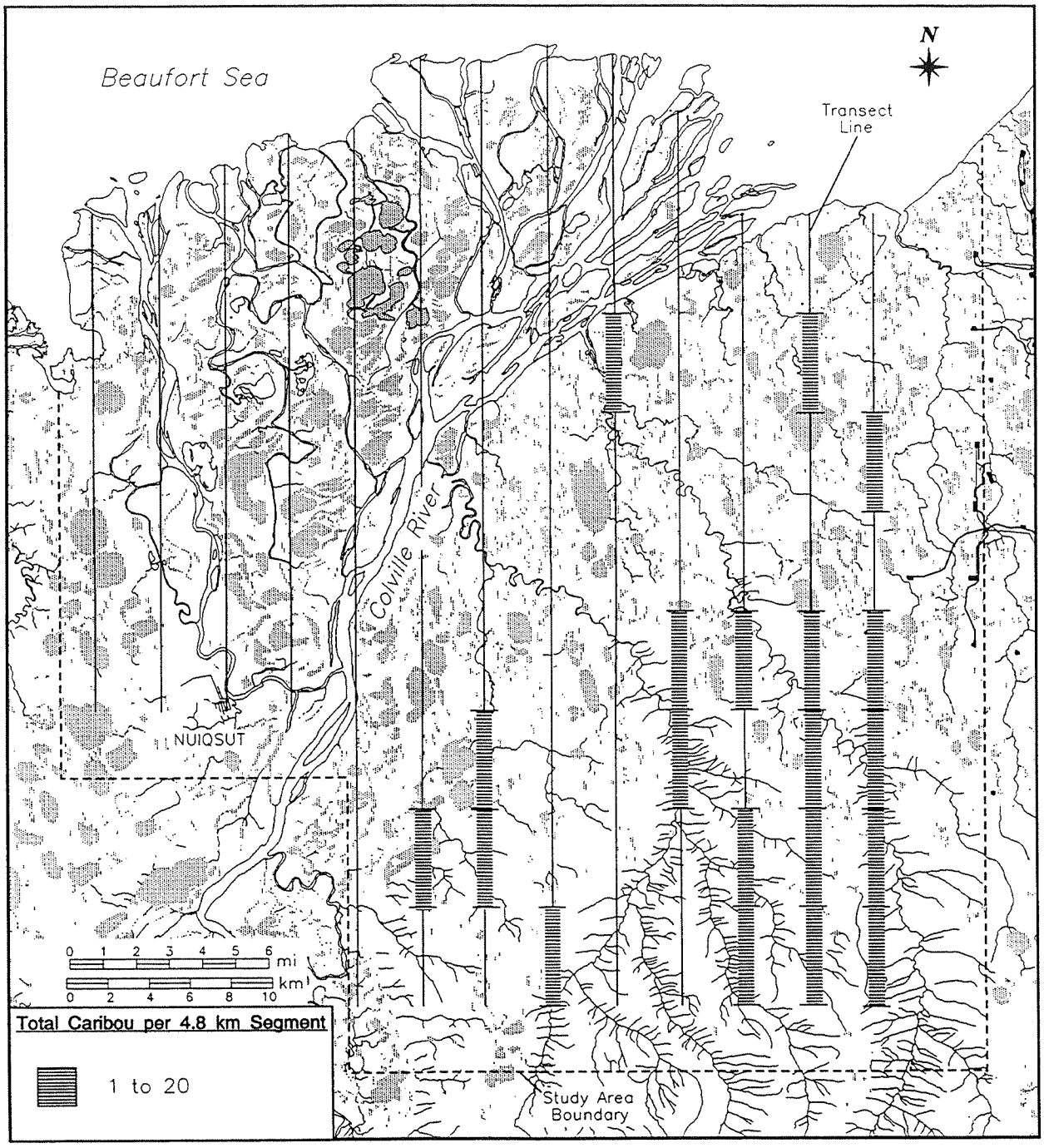

Figure 21. Distribution and density of total caribou in the Colville River Delta study area, Alaska, 4 June 1992.

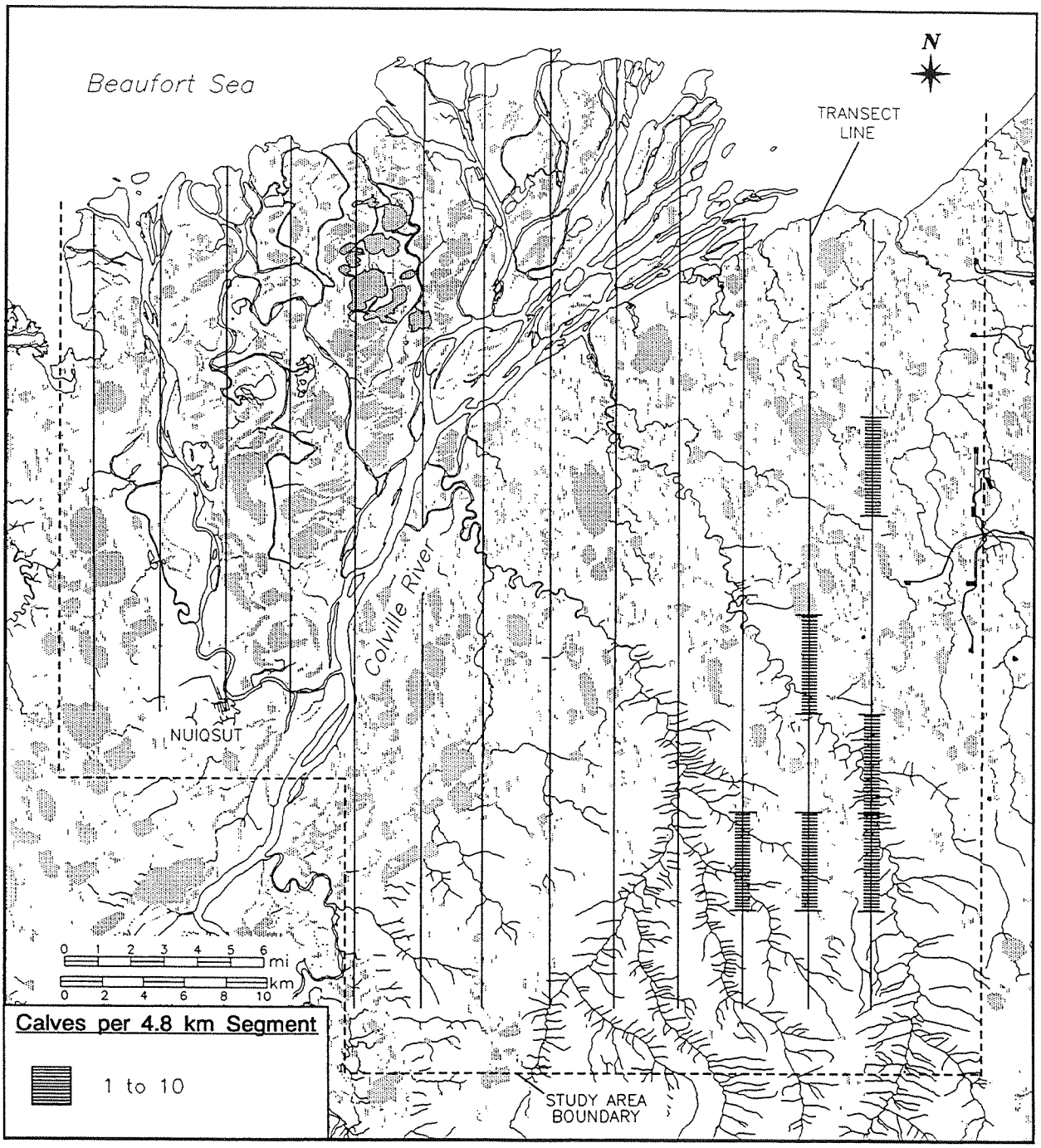

Figure 22. Distribution and density of caribou calves in the Colville River Delta study area, Alaska, 4 June 1992.

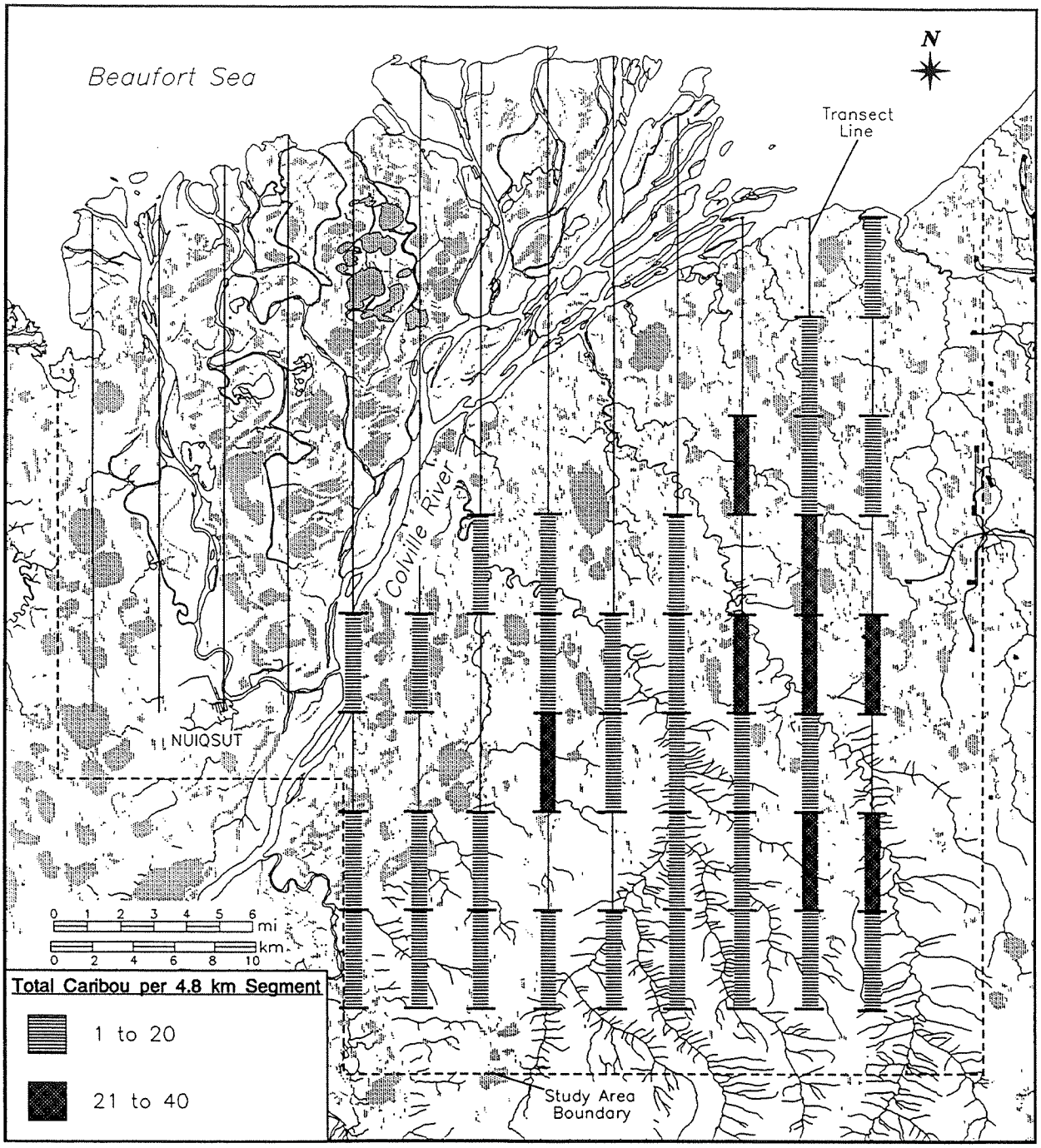

Figure 23. Distribution and density of total caribou in the Colville River Delta study area, Alaska, 16 June 1992.

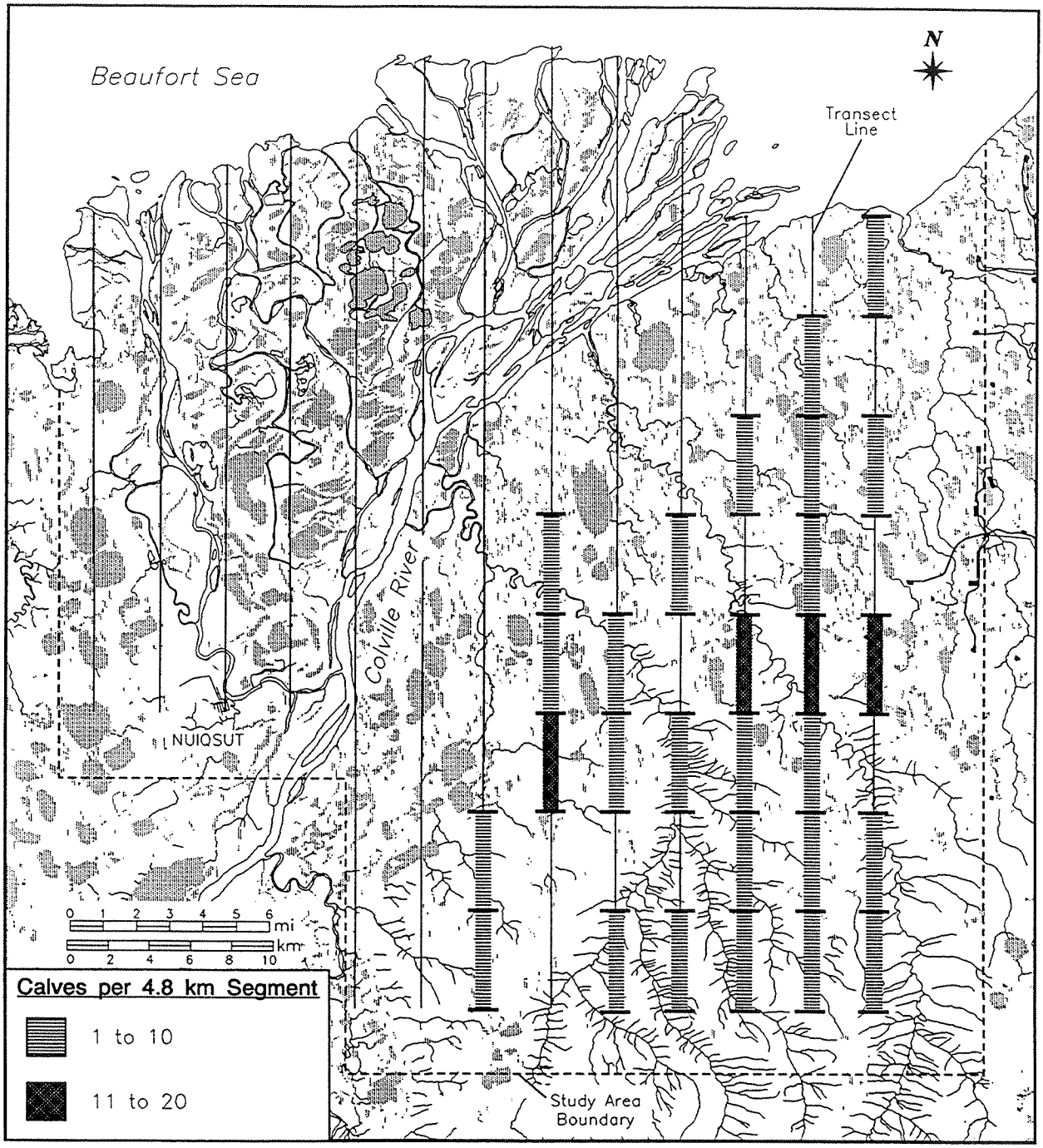

Figure 24. Distribution and density of caribou calves in the Colville River Delta study area, Alaska, 16 June 1992.

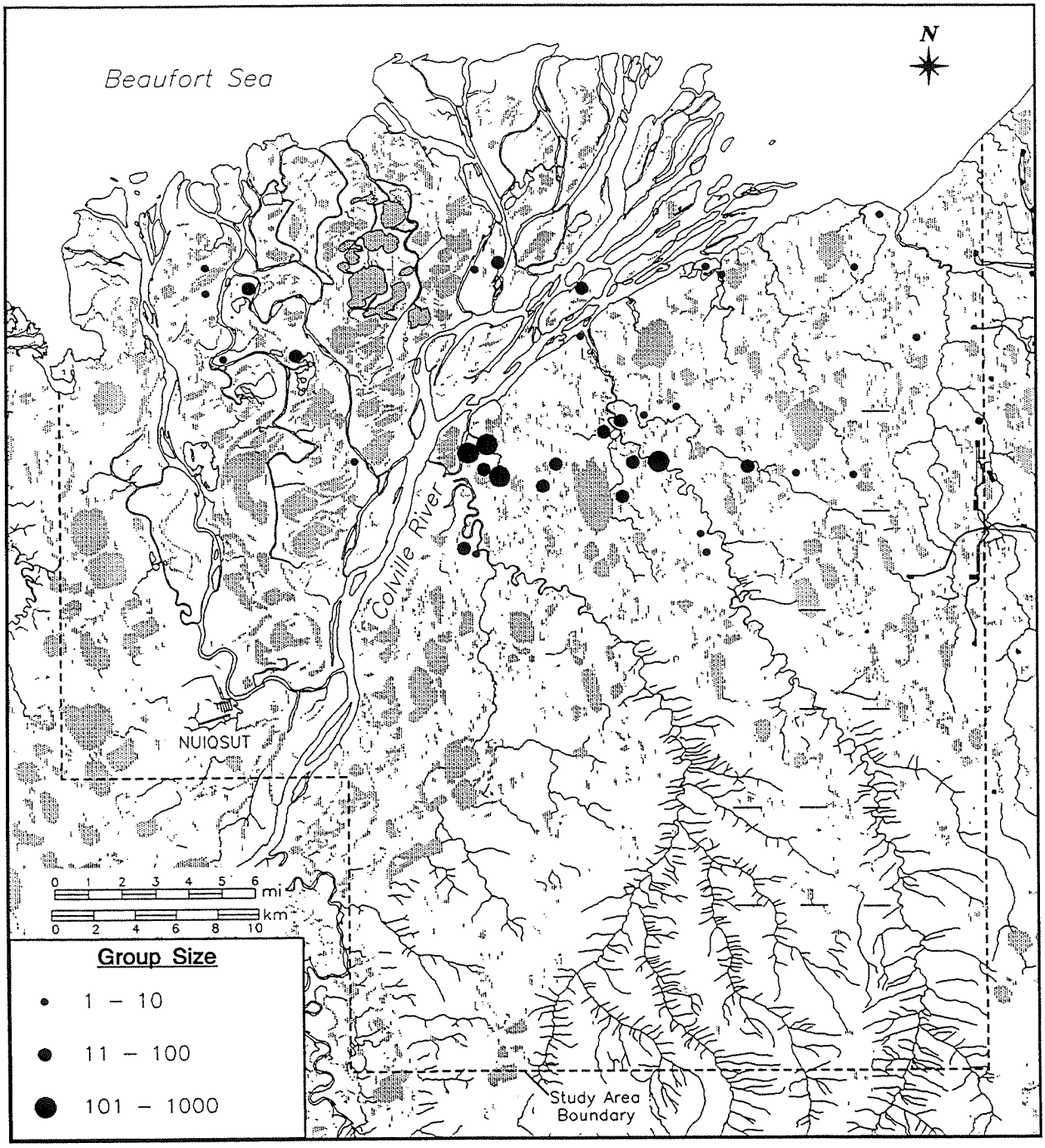

Figure 25. Distribution and group sizes of caribou in the Colville River Delta study area, Alaska, 29 June 1992.

Kalubik Creek and Oliktok Point in the Kuparuk Oilfield outside of the Colville study area. These animals subsequently moved away from the study area in an easterly direction. Mosquito harassment was severe that morning, but had decreased by the time our survey was flown (2026 h) (B. Lawhead, ABR, pers. comm.). By the evening of 8 July, approximately 7000 caribou were concentrated between the Milne Point road and the Kuparuk River, approximately 35 km east of the Colville River.

Approximately 2950 caribou were recorded on our survey on 16 July. The majority of these caribou (2300) were observed in four groups on the west bank of the Nechelik Channel (Figure 27). The animals in those groups were agitated (i.e., running continually). Mosquito harassment was severe at Nuiqsut on the morning of our survey on 16 July and the agitation of the caribou may have been caused by mosquito harassment. Another large group of caribou (350 animals) was seen in Plot 2. Other caribou were widely dispersed in small groups across the north-central portion of the delta.

On 18 July, a partial survey consisting only of the four northernmost east-west transects was conducted during severe insect harrassment. More than 3300 caribou were observed in five groups at the mouth of the Kupigruak Channel, on the east side of the delta (Figure 28). These may have been the same animals as those seen on 16 July at the western edge of the study area (approximately 32 km to the west). With a northeasterly wind and mosquito harassment on the intervening day (D. Flint, ABR, pers. comm.) that contingent of animals probably had moved northeast.

An unknown number of TLH caribou evidently came onto the delta on 18 July, judging from the location of a radio-collared caribou from the TLH in the delta just east of the Nechelik Channel (G. Carroll, ADFG, pers. comm.). That animal was part of a much larger group that apparently had moved to seek relief from mosquito harassment. Movement data for that collared animal before and after 18 July were unavailable for review. This location provides the first evidence we are aware of that TLH caribou at least occasionally occur on the Colville Delta during the insect season.

Six hundred seventy-nine caribou were recorded on 30 July, of which 569 caribou (85%) were east of the Colville Delta (Figure 29). The groups were small in size and widely dispersed; animals were not harassed by insects, as they were either lying down or grazing. Caribou were observed distributed evenly over the eastern half of the survey area, ranging from 5 km south of the coast to 56 km inland. The two largest aggregations (220 and 90 caribou) were observed near Plots 5 and 6.

Dispersal/Pre-rut

On 18 August, caribou were widely scattered in small groups, the largest of which contained 25 animals (Figure 30). Locations on that date extended from the coast to 42 km inland, across the entire study area.

Poor weather hampered our survey on 17 September. The outer delta from the coast to 23 km inland was covered, as well as Plots 5 and 6 farther south. The area was completely covered by snow and all water bodies, including the Colville River, were entirely covered by a thin layer of ice. The caribou seen were east of the Colville River (Figure 31), where 138 caribou were found in small, widely dispersed groups between Kalubik Creek and the Miluveach River, up to 13 km inland. Most of the groups near the coast were dominated by cows and calves. Another 193 caribou, were observed in, or adjacent to, Plots 5 and 6. Those groups were small and densely distributed, and bulls were more abundant than in the groups seen farther to the north.

ARCTIC FOX

BACKGROUND

Arctic foxes occur across the Arctic Coastal Plain of Alaska (Chesemore 1967). Their distribution reflects adaptations to arctic tundra conditions and competition with the red fox (Chesemore 1975).

Arctic fox movements in northern Alaska are characterized by two distinct phases. In fall and early winter, probably triggered by food scarcity, arctic foxes move to the coast and onto the sea ice. While on sea ice, foxes often follow polar bears and feed on the marine mammal carrion left over from bear kills (Chesemore 1975). The winter diet of arctic foxes remaining on land is dominated by brown lemmings (*Lemmus sibiricus*) and collared lemmings (*Dicrostonyx torquatus*) (Chesemore 1975). In spring, foxes return to land to occupy den sites for the summer. Litters are whelped during May or June. Arctic foxes feed primarily on lemmings, birds, and eggs during summer (Chesemore 1968; Fine 1980).

The mechanism involved in regulating fox numbers is not known. Fine (1980) suggested that arctic fox productivity generally reflects the status of the small mammal populations in a local area.

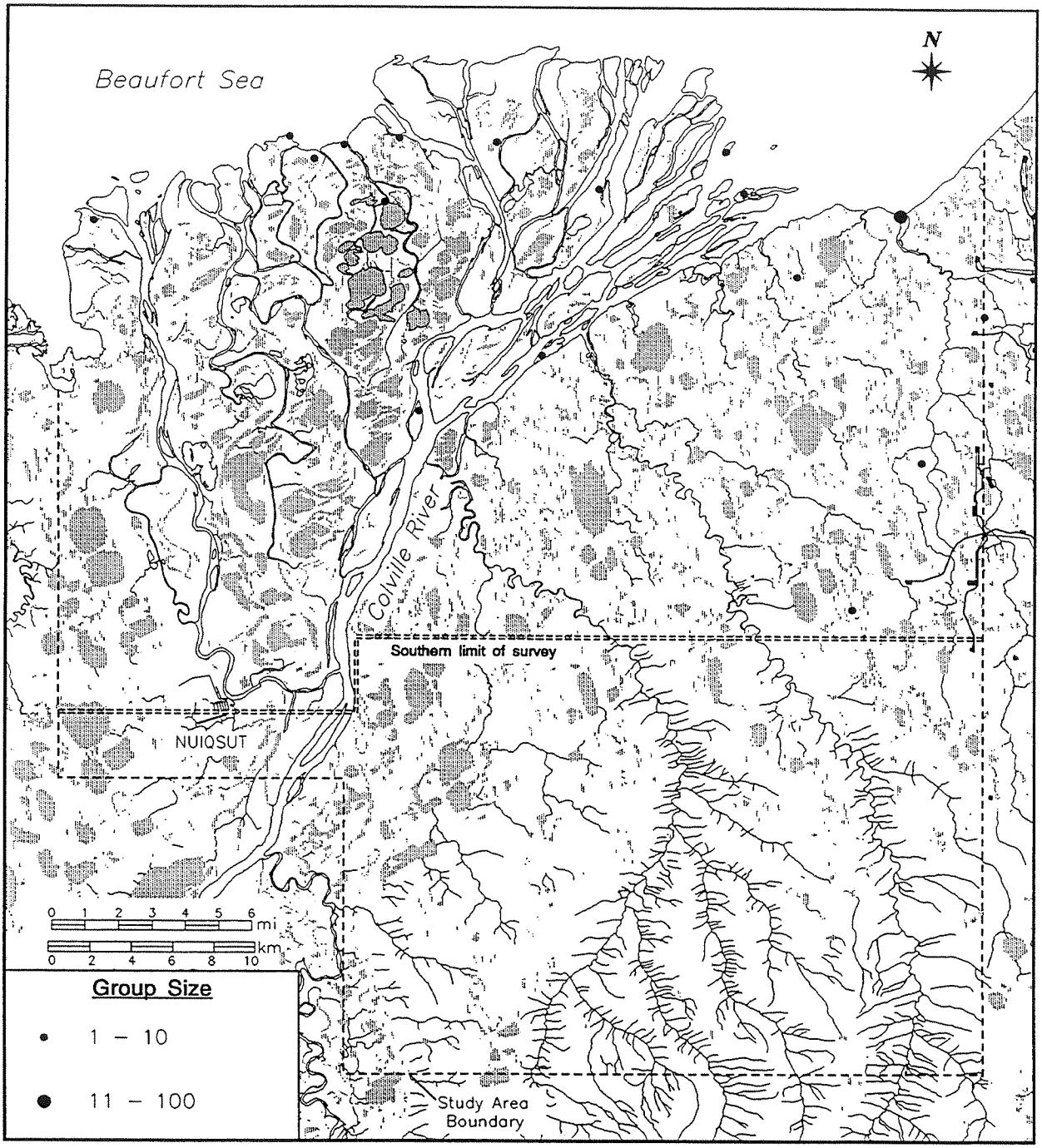

Figure 26. Distribution and group sizes of caribou in the Colville River Delta study area, Alaska, 8 July 1992.

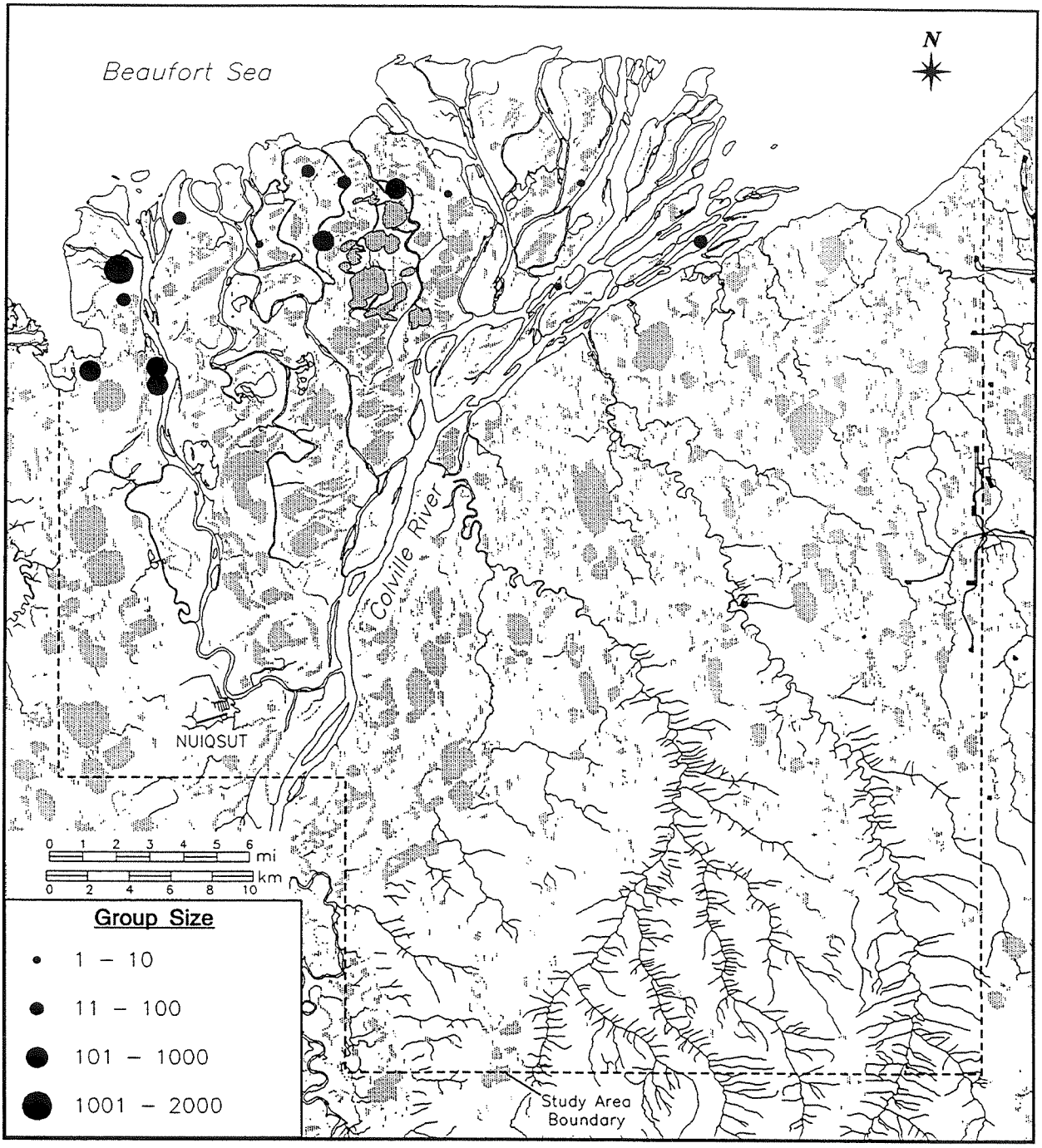

Figure 27. Distribution and group sizes of caribou in the Colville River Delta suty area, Alaska, 16 July 1992.

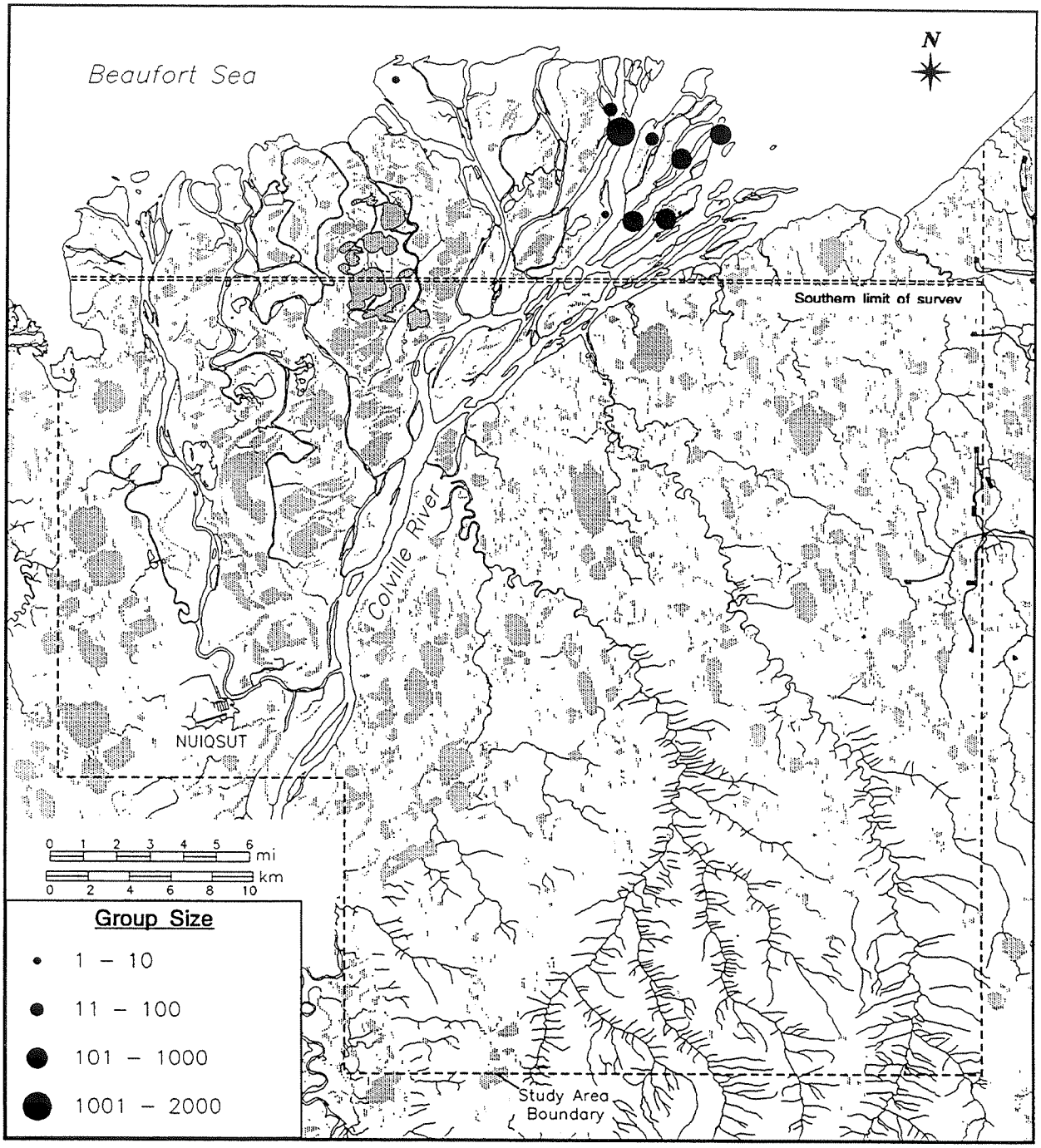

Figure 28. Distribution and group sizes of caribou in the Colville River Delta study area, Alaska, 18 July 1992.

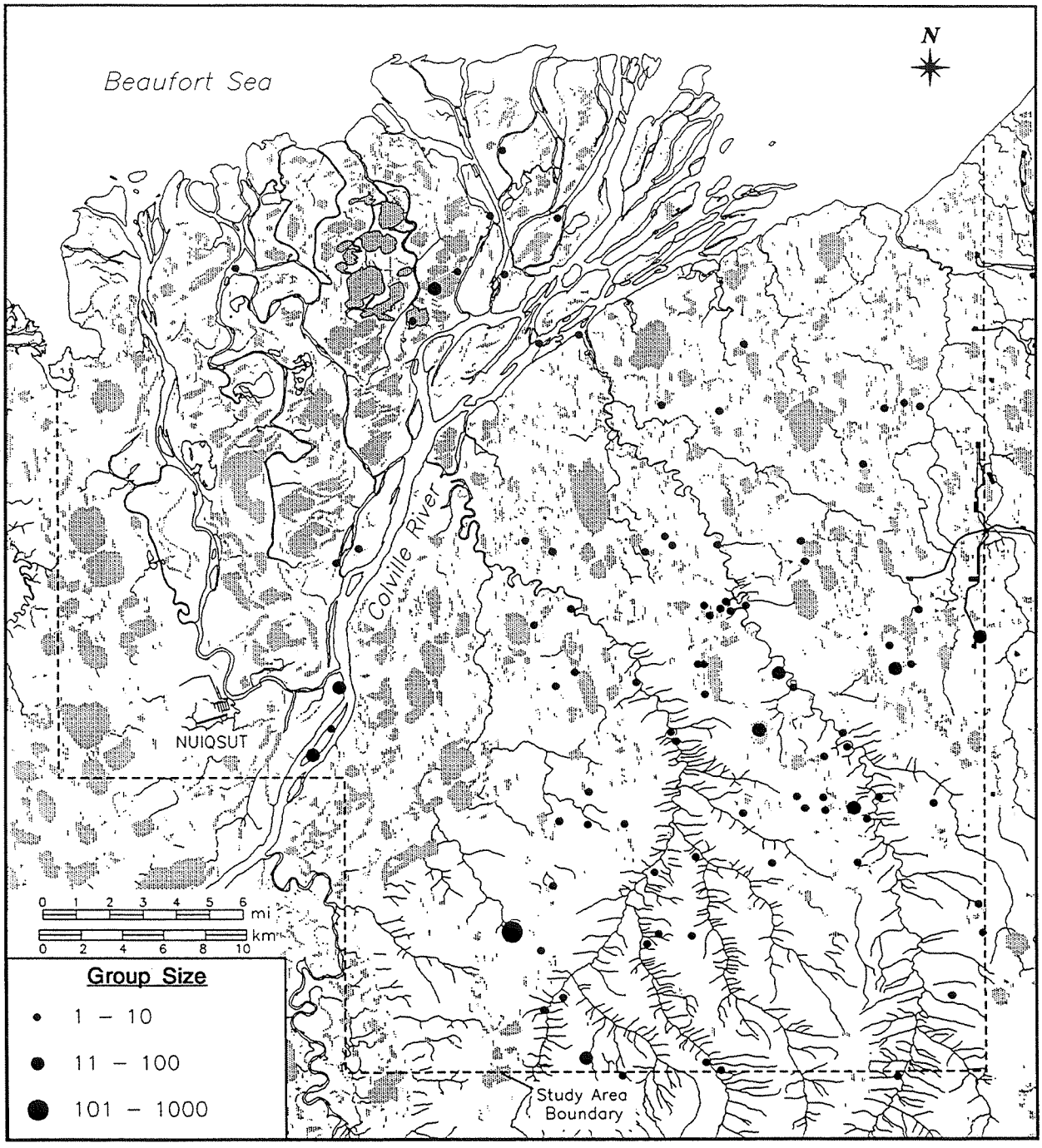

Figure 29. Distribution and group sizes of caribou in the Colville River Delta study area, Alaska, 30 July 1992.

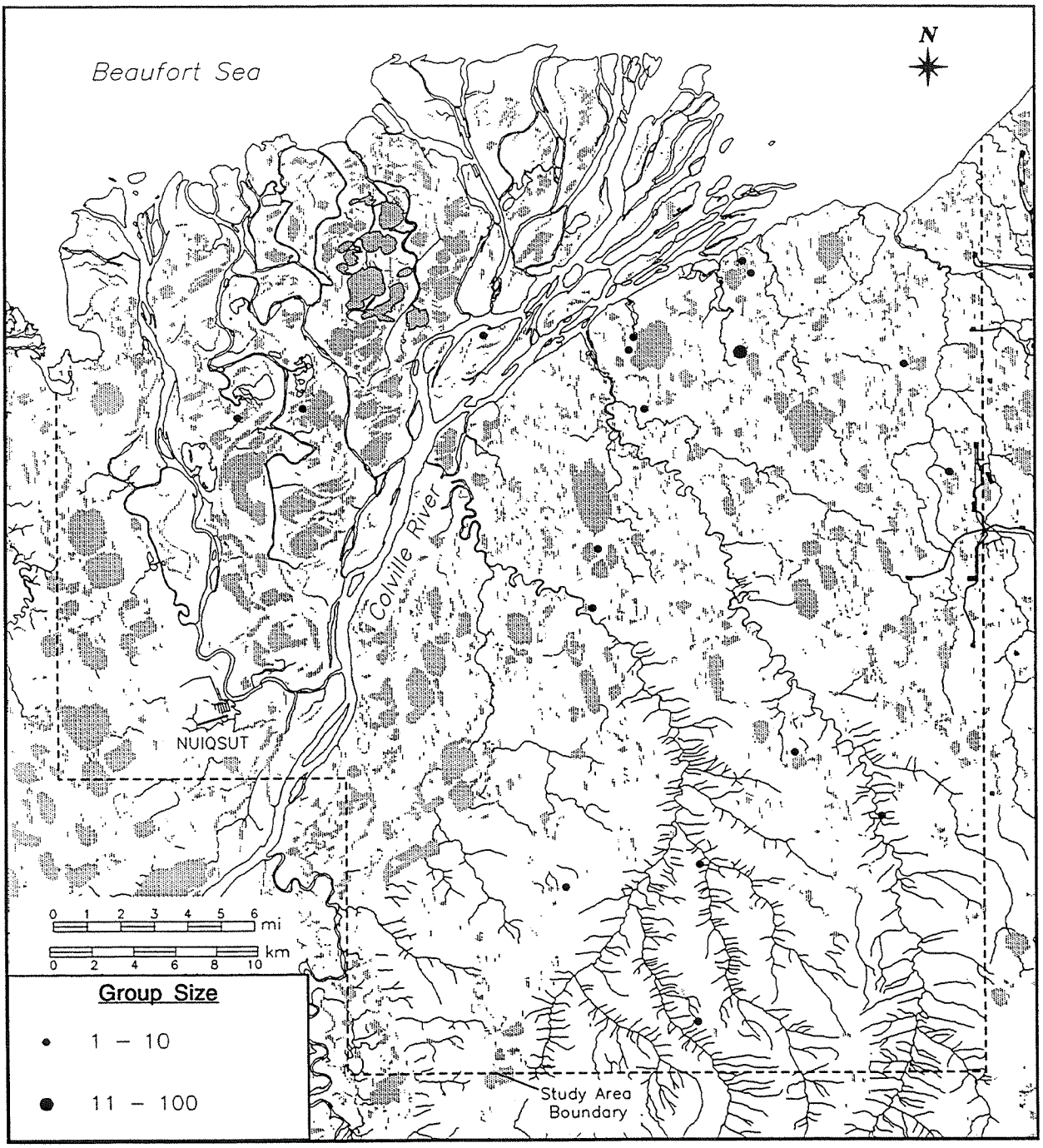

Figure 30. Distribution and group sizes of caribou in the Colville River Delta study area, Alaska, 18 August 1992.

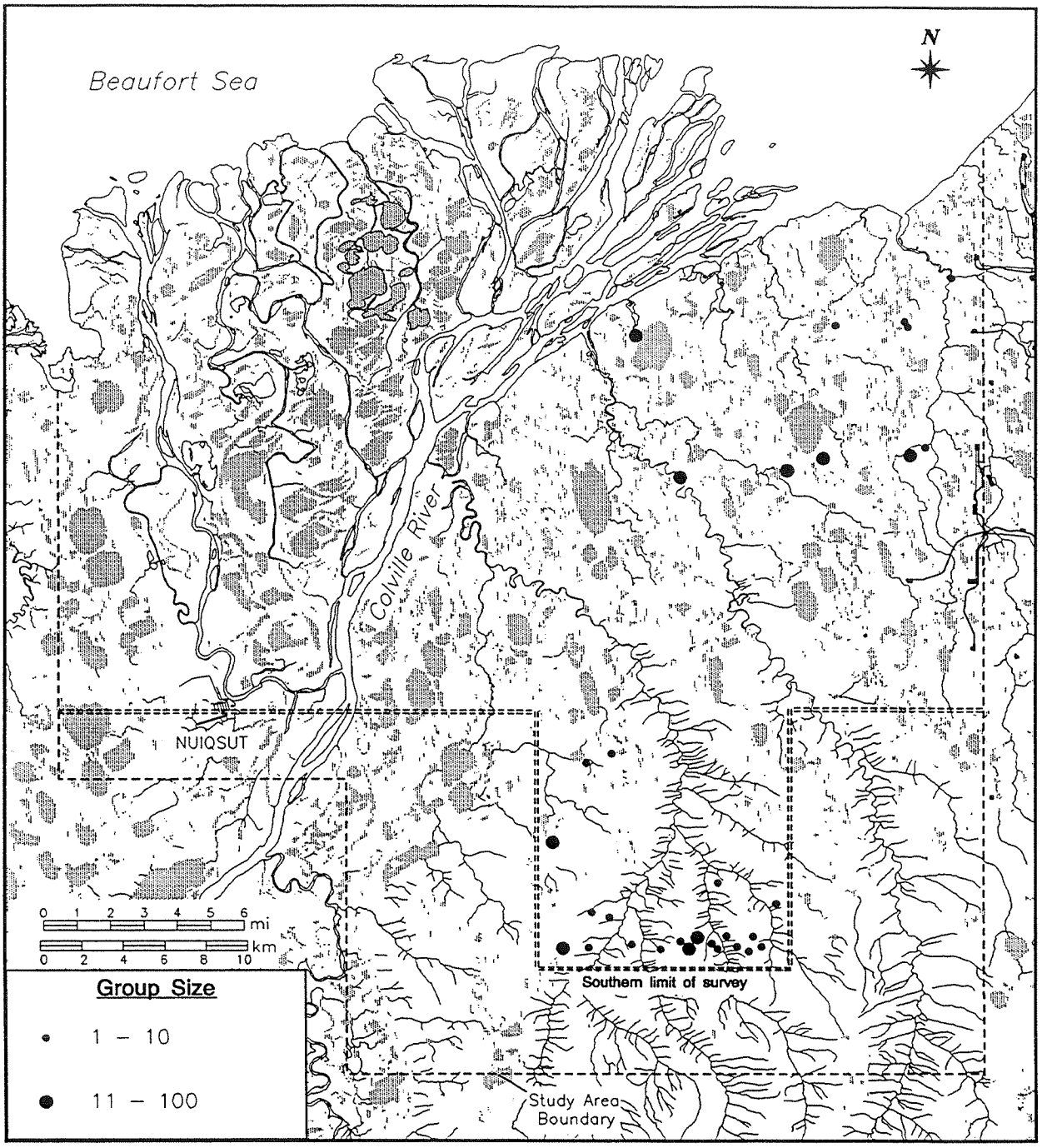

Figure 31. Distribution and group sizes of caribou in the Colville River Delta study area, Alaska, 17 September 1992.

Chesemore (1975) noted an approximate 4-year cycle of arctic fox numbers, which was usually highly correlated with the population of lemmings.

Oil development has provided artificial denning sites for arctic fox pairs. Both a culvert and an underground utility corridor have been documented as denning sites in the Prudhoe Bay oilfield (Eberhardt et al. 1983a). Seven of eight secondary dens found in 1992 at Prudhoe Bay were in artificial sites, such as, culverts, utilidors, crawl spaces and burrows in gravel road beds (R. Burgess, ABR, pers. comm.). Pups were probably moved to these secondary dens to take advantage of the readily available food source associated with oilfield camps.

Garrott and Eberhardt co-authored several papers on arctic fox biology stemming from their complementary field work in the Colville Delta and the Prudhoe Bay area, respectively. In addition, various USFWS avian research projects (Markon et al. 1980; Renken et al. 1983; North et al. 1984) have contributed incidental observations on arctic fox numbers, movements, and den sites on the Colville Delta.

RESULTS AND DISCUSSION

Only one active den in the western section of Plot 3, was found on the Colville Delta in 1992 (Figure 32). The den, which was situated on a low mound between small ponds, was occupied by two adults and at least two kits. On 23 July, the foxes were absent, but the area surrounding the den burrows was littered with numerous signs of activity: fox scats, a strong urine scent, several clumps of gray fur, and waterfowl remains. Garrott et al. (1984) reported den site characteristics were similar in both the Prudhoe Bay and Colville River study areas: banks of streams and lakes were preferred sites in both areas, and low mounds and ridges were alternative sites. Pingos were selected as den sites in the Prudhoe area but accounted for only a small percentage of the known sites in the Colville area. Most of the fox dens found in 1992 in the Prudhoe area by a team led by R. Burgess (ABR, pers. comm.) were located in low mounds or pingos.

Six additional, potential den sites were located during our aerial surveys. Ground inspection of site 1 indicated that it was an old, inactive den. The status of the five remaining possible den locations was not confirmed because of their remote locations and a lack of aircraft landing areas.

B. Lawhead (ABR, pers. comm) observed an arctic fox den (site 8) on a streambank just south of pad 2M in the Kuparuk Oilfield. This fox den was active in both 1984 and 1987, the only two years Lawhead was able to make observations.

Markon et al. (1982) found six active dens in the Colville Delta during summer 1981, but did not supply locations in their report. Dr. R. Garrott (Univ. of Wisconsin, pers. comm.) provided eight positive locations, and one possible location, of fox dens that he encountered during his arctic fox research in the Colville Delta in the late 1970s (Figure 32, Table 5). He believes an additional eight or nine sites were active in our study area during his tenure on the delta, for a total of 16-17 dens. We received these locations from Dr. Garrott after our fieldwork was completed, and were not able to verify their current status. One of his sites corresponds to ABR Site 1, described above. Two of his other sites were in Plot 2. We camped in that plot for five days and intensively searched the area twice for waterfowl nests and broods from late June to mid-July and no foxes or fox dens were observed. However, we did note one set of fox tracks along the west bank of the Tamayayak Channel near our camp. Another den site that Garrott identified was located just north of Kachemach Mound near our Plot 3. An adult arctic fox was observed approximately 3.2 km north of this site on June 23. However, we did not identify any possible den locations in this area nor did we visit the area on foot. Three of Garrott's sites were east of the Colville River in the area between the Miluveach River and Kalubik Creek. We did not identify any den sites in this area.

The number of active dens and fox sightings we recorded in 1992 was low. These low numbers may be explained by low-intensity survey coverage late in the season. (Earlier surveys at greater intensity of coverage should reveal more dens.) In addition, the low numbers observed may reflect lower densities of foxes compared with areas such as the Prudhoe Bay oilfield. Research conducted by Garrott (1980) in the Colville River delta and by Eberhardt et al. (1983a) in the Prudhoe Bay area demonstrated that conditions were more favorable for foxes in the Prudhoe Bay study area as indicated by greater den density (1 den/12 km^2 vs. 1 den/ 34 km^2), greater juvenile occupancy of dens in a low lemming year (18% vs. 6%), and a higher percentage of dens of recent origin (33% vs.11%) in the Prudhoe Bay area compared to the Colville River delta area. The greater abundance of arctic foxes in the Prudhoe Bay area also was reflected in the number of foxes captured during fox studies on the North Slope: out of 193 foxes tagged

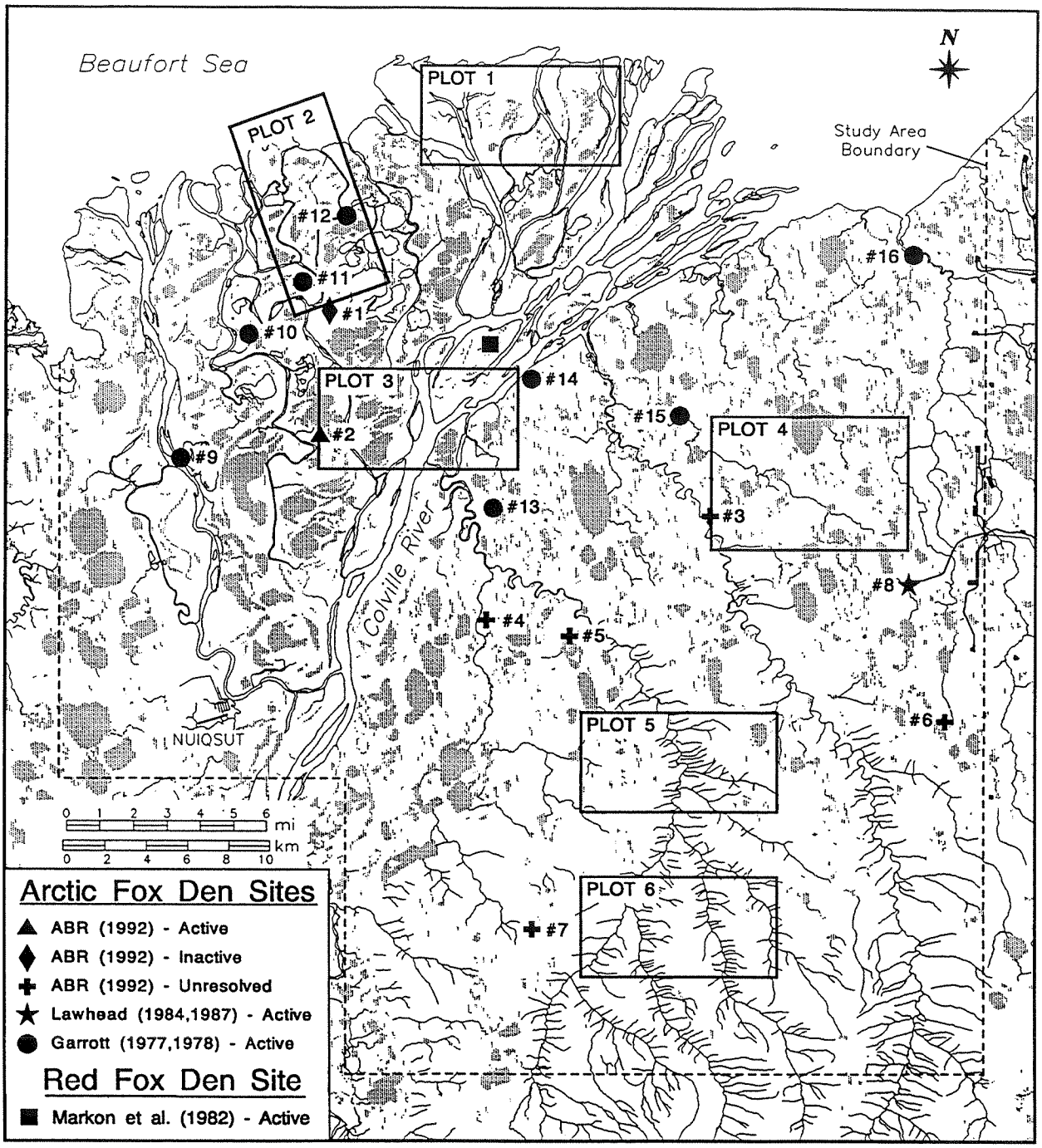

Figure 32. Distribution of fox den sites, Colville River Delta study area, Alaska, June-August 1992.

Table 5. Arctic fox den location and status, Colville River Delta, Alaska.

Den Site Number	Status[a]	Land Form	Source[b]
1	Old, inactive den site; active late 1970s	Stabilized dune	ABR
2	Active den; 2 adults, at least 2 young	Low mound	ABR
3	Unresolved	Bank of oxbow lake (Miluveach River)	ABR
4	Unresolved	Pingo near lake	ABR
5	Unresolved	Pingo near lake	ABR
6	Unresolved	Stabilized dune	ABR
7	Unresolved	Pingo	ABR
8	Active in 1984 & 1987	Bank of stream	Lawhead
9	Active during late 1970s	Bank of Nanuk Lake	Garrott
10	Active during late 1970s	Stabilized dune	Garrott
11	Active during late 1970s	Extensive dunes	Garrott
12	Active during late 1970s	Bank of lake	Garrott
13	Active during late 1970s	Kachemach Mound (pingo)	Garrott
14	Active during late 1970s	Pikonik Mound (pingo)	Garrott
15	Active during late 1970s	Pingo	Garrott
16	Active during late 1970s (near mouth)	West bank of Kalubik Cr.	Garrott

[a] Unresolved = not accessible by Supercub.
[b] ABR = 1992 surveys; Lawhead 1984, 1987 (unpubl. data); Garrott = 1977-78 investigations (Garrott 1980)

for a dispersal study, 164 (85% of total) were from the Prudhoe Bay area, 16 (8%) were from the Colville Delta area, and 13 (7%) were from the vicinity of Franklin Bluffs, south of the Prudhoe area (Eberhardt and Hanson 1978). In addition, although production of young decreased in both areas during a lemming low, the decrease was less pronounced at Prudhoe Bay. The availability of artificial food sources in the Prudhoe Bay oilfield was cited as the most probable reason for these differences between the two areas (Eberhardt et al. 1983a).

In 1992, arctic foxes were also abundant in the Prudhoe Bay area and regularly observed (R. Burgess, ABR, pers. comm.). A team of biologists conducting an ongoing fox study captured 157 foxes at 49 active natal dens on the Arctic Coastal Plain, between Milne Point and the Shaviovik River. Of that total, 147 (94%) animals were captured at 33 (67%) dens in the Prudhoe Bay oilfield area. Although the higher numbers captured in the Prudhoe Bay area may have been due partly to ease of access to dens because of the road system, the population of arctic foxes in the oil field did appear to be greater than in adjacent undeveloped areas.

OTHER MAMMALS

MUSKOXEN

Except for dispersing individuals, muskoxen are relatively sedentary ungulates, exhibiting seasonal movements of generally less than 80 km (Lent 1978). River drainages are used preferentially by muskoxen throughout the year (Jingfors 1980, Robus 1981, O'Brien 1988,). Willow thickets, sedges, grasses and forbs are preferred forage plants (Jingfors 1980; Robus 1981). During winter and calving (late April through May), muskoxen prefer exposed vegetation on windblown areas, such as ridges (Garner and Reynolds 1986, Jingfors 1980). Muskoxen are polygamous, with males defending harems during the rut (early July through September) (Lent 1978).

The Arctic Slope of Alaska provides excellent habitat for muskoxen (Jingfors 1980, O'Brien 1988). Muskoxen were re-introduced in ANWR in 1969 and 1970 (Burris and McKnight 1973) and northwestern Alaska (in the Seward Peninsula and near Cape Thompson) in the 1970s (Smith 1989a). Transplanted muskoxen populations in those regions are thriving and expanding their range (Reynolds 1989, Smith 1989a, Larsen 1989, Golden 1990). The Colville Delta is located about halfway between the ANWR and Cape Thompson herds. Dispersing muskoxen from those expanding populations are expected to eventually reach the Colville Delta area from either the east or the west.

Smith (1989b) suggested that far-ranging, migratory bulls pioneer new areas and may precede the arrival of cows and subadults by several years. Garner (1986) noted movements of bulls up to 290 km from ANWR and Reynolds (1989) noted observations of muskoxen 397 and 298 km southwest of ANWR. Muskoxen have been regularly recorded on the Sagavanirktok River since the mid-1980s (ABR, unpubl. notes), presumably having originated from the ANWR herd. Also, in the summer of 1992, biologists with the North Slope Borough reported two bull muskoxen on the Ikpikpuk River and four bull muskoxen on the Meade River; those animals were believed to have dispersed eastward from the Cape Thompson herd (G. Carroll, ADFG, pers. comm.). Dispersing animals from the northwestern herds have been reported over 320 km east of the release site (Smith 1989a).

We did not observe muskoxen during aerial surveys of the Colville River Delta study area in 1992, although they recently were recorded south of the delta. A herd of 13 muskoxen overwintered approximately 64 km southeast of the village of Nuiqsut in 1988-89 (Golden 1990), the first time a mixed-sex group is known to have overwintered in this area. On 26 July 1992, ABR personnel working on a different project observed a group of 14 muskoxen about 2 km south of the mouth of the Itkillik River (8 km southeast of Nuiqsut) (Figure 33). Muskoxen have been observed in previous years on the Itkillik River (ABR, unpubl. notes).

Muskoxen have been observed on deltas along the Arctic Ocean in ANWR, perhaps to fill a dietary salt need (Garner and Reynolds 1986) or to escape insect harassment (Reynolds et al. 1986). A group of muskoxen was observed on the Sagavanirktok River delta in 1992 (C. Herlugson, BP Exploration, pers. comm.). Therefore, it is possible that pioneering bulls from the Itkillik group seen in 1992, or others, may move farther north and west into the Colville River Delta study area.

In 1988, BLM proposed a plan to transplant muskoxen in the Oolamnagavik River region of the North Slope, approximately 240 km southwest of the Colville Delta (BLM 1988). The plan was opposed by residents of Nuiqsut, because of concerns that an established muskoxen herd would displace caribou and attract hunting from nonresidents under a lottery system for permits, similar to permit hunts conducted

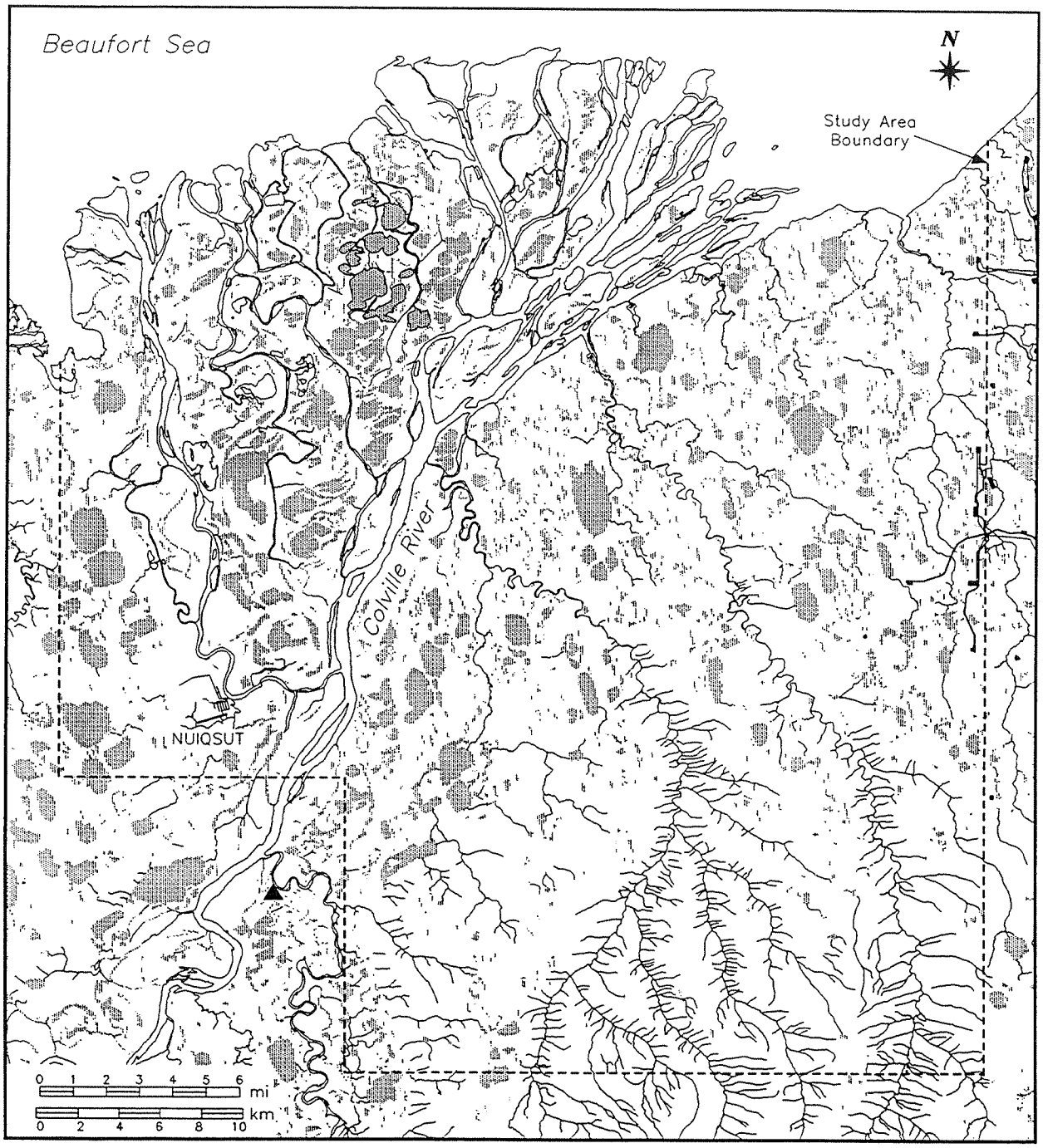

Figure 33. Location of muskoxen group observed on 26 July 1992, Colville River Delta study area, Alaska.

out of Kaktovik. The BLM plan eventually was dropped.

RED FOX

Red foxes are found throughout northern Alaska (Bee and Hall 1956). Although they are more common in the foothills and mountains of the Brooks Range, they also occur in the tundra habitat of the Arctic Coastal Plain and along the coast of the Beaufort Sea (ADFG 1978). Riparian habitats are preferred on the coastal plain, where the ranges of the red and the arctic fox overlap in this region of Alaska. Red foxes are superior competitors and predators of arctic foxes in regions where their ranges overlap (Chesemore 1975, West and Rudd 1983, Hersteinsson and Macdonald 1992).

Red foxes were observed on three occasions in the Colville River Delta study area. On 21 July, an adult red fox was seen on the west bank of the Tamayayak Channel, about 2.4 km north of Plot 3. On 23 July an adult red fox was encountered in the northwest corner of Plot 3, again on the west bank of the Tamayayak Channel. During an aerial survey for caribou on 17 September a red fox was observed in a dune system about 0.8 km north of the northeast corner of Plot 3, in the same area where Markon et al. (1982) reported an active red fox den in the summer of 1981 (Fig. 32).

POLAR BEAR

In Alaska, polar bears commonly inhabit a 300-km-wide strip of sea ice in the Beaufort and Chukchi Seas, extending from the Canadian border to the Bering Strait (Amstrup 1988). Polar bear distribution in Alaska largely is dictated by the availability of seals (DeMaster et al. 1980), particularly ringed seals (*Phoca hispida)* and bearded seals (*Erignathus barbatus*) (Amstrup 1988).

Female polar bears enter dens in late November, bear young in late December-early January, and family groups emerge in late March or early April (Amstrup 1988). About half the dens in the Beaufort Sea region of Alaska are located on land (S. Amstrup, USFWS, pers. comm.). Amstrup (1989) stated that suitable denning habitat for polar bears depends primarily on the amount and variety of topographic relief. Topography and weather conditions (snowfall, wind, ambient temperatures) combine to form snowdrifts that will not melt during denning (Lentfer and Hensel 1977). The Colville Delta has been described as good habitat and the Miluveach River as adequate habitat for polar bear dens (Amstrup 1989). No maternity dens have been located in these areas in recent years, although polar bears are seen periodically on the Colville River (S. Amstrup, USFWS, pers. comm.). R. Shideler (ADFG, pers. comm.) reported a polar bear den on lower Kalubik Creek, at the eastern edge of our study area, in the winter of 1991- 92.

GRIZZLY BEAR

Grizzly (brown) bears are common residents of the foothills and mountains of the Brooks Range. Grizzlies regularly visit the Arctic Coastal Plain in small numbers, especially during caribou calving season (mid-May to early June), although they are more abundant in ANWR than in the area of the Colville Delta and oilfields to the east. Grizzly bears have become regular visitors in the oilfields on the central coastal plain (Shideler and Hechtel 1991).

In spring 1990, ADFG initiated a study aimed at reducing conflicts between humans and grizzly bears in the oilfields on the Arctic Slope. The study was undertaken in response to a local increase of grizzly bears in the oilfield, due to a rich food source provided by garbage from field camps (Shideler and Hechtel 1991). Nine grizzly bears were radio-collared in the summers of 1991 and 1992 (R. Shideler, ADFG, pers. comm.). Three of these bears (1 female, 2 males) were located subsequently in the Colville Delta during summer 1992. A young male was the most frequent visitor to the delta, but all three bears were located along or near the Colville River throughout the summer.

One grizzly bear was observed during summer field work in 1992 by ABR personnel. This bear was sighted on the Kachemach River, about 20 km from the mouth. A young 4-year old male grizzly bear was shot and killed outside of the village of Nuiqsut in October 1992. This bear had spent most of the summer in the Deadhorse area (R. Shideler, ADFG, pers. comm.). In summer 1992 a grizzly bear destroyed the majority of nests in a large brant colony at the mouth of the Eastern Channel (USFWS 1992). It is unknown if this bear was collared.

In the winter of 1990-91, bears dispersed widely and denned up to 75 km from Deadhorse. In the winter of 1991-92, all of the radio-collared bears denned within 35 km of Deadhorse. In general, the delta, especially the lower delta, probably is not good denning habitat for grizzlies, due to flooding and overflow (R. Shideler, ADFG, pers. comm.).

MOOSE

Moose have occurred in arctic Alaska since at least the late 1800s. Before 1920, most animals probably immigrated from the south. Between 1920 and 1960, breeding populations became established in the region (Coady 1980). General cessation of hunting pressure in northern Alaska and growth of moose populations to the south during that time were the main factors effecting moose dispersal to, and general population increase in, northern Alaska (Coady 1980). The predator control program operated by the federal government in the late 1940s and 1950s also has been cited as a factor contributing to the increase of the moose population in northern Alaska (Machida 1990).

No moose were observed on the Colville Delta during field work in the summer of 1992. Moose occasionally disperse to the Beaufort Sea coast in summer, but occupation of coastal areas is apparently limited to the summer months. Moose are occasionally seen in the western Kuparuk Oilfield (S. Murphy, ABR, pers. comm.). Distribution in the winter is restricted almost entirely to thin strips of riparian shrub habitat (Coady 1977; Machida 1990). The density of moose in winter along the main channel of the Colville River from Umiat to the Nechelik Channel and then north to the coast was described as "moderate" (0.25-1.0 moose/mi^2) by Coady (1977).

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Appendix A. Common and scientific names of birds seen during the Colville River Delta Wildlife Study, June-August 1992.

Red-throated Loon	*Gavia stellata*
Pacific Loon	*Gavia pacifica*
Yellow-billed Loon	*Gavia adamsii*
Tundra Swan	*Cygnus columbianus*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Brant	*Branta bernicla*
Canada Goose	*Branta canadensis*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
American Wigeon	*Anas americana*
Greater Scaup	*Aythya marila*
Common Eider	*Somateria mollissima*
King Eider	*Somateria spectabilis*
Spectacled Eider	*Somateria fischeri*
Oldsquaw	*Clangula hyemalis*
Black Scoter	*Melanitta nigra*
Surf Scoter	*Melanitta perspicillata*
Red-breasted Merganser	*Mergus serrator*
Northern Harrier	*Circus cyaneus*
Golden Eagle	*Aquila chrysaetos*
Peregrine Falcon	*Falco peregrinus*
Willow Ptarmigan	*Lagopus lagopus*
Sandhill Crane	*Grus canadensis*
Black-bellied Plover	*Pluvialis squatarola*
Lesser Golden-Plover	*Pluvialis dominica*
Bar-tailed Godwit	*Limosa lapponica*
Ruddy Turnstone	*Arenaria interpres*
Semipalmated Sandpiper	*Calidris pusilla*
Least Sandpiper	*Calidris minutilla*
Pectoral Sandpiper	*Calidris melanotos*
Dunlin	*Calidris alpina*
Stilt Sandpiper	*Calidris himantopus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Snipe	*Gallinago gallinago*
Red-necked Phalarope	*Phalaropus lobatus*
Red Phalarope	*Phalaropus fulicaria*
Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Glaucous Gull	*Larus hyperboreus*
Sabine's Gull	*Xema sabini*
Arctic Tern	*Sterna paradisaea*
Snowy Owl	*Nyctea scandiaca*
Short-eared Owl	*Asio flammeus*

Appendix A. Continued

Common Raven	*Corvus corax*
American Robin	*Turdus migratorius*
Savannah Sparrow	*Passerculus sandwichensis*
Common Redpoll	*Carduelis flammea*

Appendix B. Comparison and summary of wetland classifiction system developed by Bergman et al. (1977) and Murphy et al. (1988).

Bergman et al. Class	Bergman et al. Name	Murphy et al. Name	Characteristics
I	Flooded Tundra	Wet Meadows-Patterned	Low-center polygon basin containing shallow water after spring thaw. Amount of water varies through the season.
II	Shallow-*Carex*	Aquatic Sedge	Small ponds, lake margins, and marshes dominated by aquatic sedge *Carex aquatilio*. Water is usually permanent.
III	Shallow *Arctophila*	Aquatic Grass	Small or medium sized ponds with *A. fulva* present.
IV	Deep Arctophila	Deep Open Lakes	Thaw lake with *A. fulva* along the margin and central zone.
V	Deep-open	Deep Open Lakes	Thaw lake with *A. fulva* present along less than 5 percent of the shoreline.
VI	Basin Complex	Basin Wetland Complex	Drained thaw lake or tapped lake basin containing a mosaic of lakes, ponds, pools, dry ground, and vegetation types.
VII	Beaded Stream	River and Streams	Narrow stream following 16-wedges. Widen into pools at ice-wedge junctions. Not common ont he Colville River Delta.
VIII	Coastal Wetland	Halophytic Wet Meadow	Small pond or lake within relatively stable coastal mudflats associated with river deltas. Influenced by saltwater input. Vegetation dominated by *C. Subspathacea* and *Puccinellia phryganodes*.