WILDLIFE STUDIES FOR THE ALPINE SATELLITE DEVELOPMENT PROJECT, 2003

ANNUAL REPORT

Prepared for

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EXECUTIVE SUMMARY

During 2003, ABR, Inc., conducted wildlife surveys for selected birds and mammals in the Colville River Delta and adjacent Northeast Planning Area of the National Petroleum Reserve–Alaska (NPRA) in support of the Alpine Satellites Development Project (ASDP) of ConocoPhillips, Alaska, Inc. (CPAI). The wildlife studies in 2003 were a continuation of work initiated by CPAI's predecessors, ARCO Alaska, Inc., and Phillips Alaska, Inc., in the Colville River Delta in 1992 and in the northeastern NPRA in 1999.

The primary goal of wildlife investigations in the region since 1992 has been to provide baseline information on the distribution, abundance, and habitat use of selected species before construction of oil development projects. Wildlife species were selected for investigation in consultation with the U.S. Fish and Wildlife Service and included Spectacled Eider, King Eider, Tundra Swan, Brant, Yellow-billed Loon, Glaucous Gull, caribou, and arctic and red foxes. Additional surveys were conducted for brood-rearing and fall-staging geese and for nesting shorebirds and passerines. Information was collected on other species opportunistically during surveys for focal species.

The Colville Delta (552 km²) comprises the CD North, CD South, and northeastern delta study areas. The NPRA study area (1,100 km²) abuts the western edge of the Colville Delta. The Colville Delta includes the Alpine Development (the only producing oilfield on the Colville Delta) and 2 proposed development sites, CD-3 and CD-4. The NPRA study area includes 4 proposed development sites, Alpine West (CD-5), Lookout (CD-6), Spark (CD-7), and Clover (a potential gravel mine site).

Ground-based nest and brood searches were conducted in 2003 at proposed pad sites (with the exception of CD-4) and in the NPRA along portions of 2 road corridors to determine the abundance and habitat use of large waterbirds in areas proposed for development. Tundra-nesting birds (primarily shorebirds and passerines) were studied as part of a region-wide collaborative study of factors affecting nesting success. Aerial surveys were conducted to measure abundance, distribution, and habitat use of the focal species. Systematic transect surveys from fixed wing aircraft were conducted for eiders, Tundra Swans, geese, and caribou. Lake-to-lake surveys from helicopters were conducted for Yellow-billed Loons, Glaucous Gulls, Long-tailed Ducks, and Brant. Fox dens also were surveyed from a helicopter and later observed from the ground.

CONDITIONS IN THE STUDY AREA

The 2003 season was characterized by a cool spring, with lower than average temperatures in early June and a protracted breakup of the Colville River. Snow persisted slightly later than in 2002. Cold temperatures in early June probably slowed breakup of the Colville River, and 2 separate peaks were recorded at the head of the delta on 5–6 June and 11 June. Discharge recorded at the head of the Delta for both peaks was the equivalent of 2–5-year floods. Hatching dates of Lapland Longspurs (an early nesting passerine) indicated phenology was similar to that in 2001.

LARGE WATERBIRD GROUND-SEARCHES

In the CD North search area in 2003, 404 nests of 18 species were recorded on ground searches, which was higher than the number of nests observed in previous years. More than half of the nests belonged to geese, with most belonging to Greater White-fronted Geese. Duck nests also were common in CD North and primarily belonged to Long-tailed Ducks and Spectacled Eiders. Five Tundra Swan nests were found in the CD North search area, which was comparable to the numbers found previously. All 3 species of loons in the CD North search area nested in similar numbers to previous years, with Pacific Loons being most common, followed by Red-throated Loons, and Yellow-billed Loons.

The Alpine West search area contained 110 nests of 15 species in 2003. Three-fourths of these nests belonged to geese, including Greater White-fronted Goose, Canada Goose, and Brant. The density of nests was higher in Alpine West than in the other 2 search areas in the NPRA and was comparable to that observed in the CD North search area in 2003. Four species of ducks (Spectacled and King eiders, Northern Pintail, and Long-tailed Duck) and 2 species of loons

(Red-throated Loon and Pacific Loon) nested in the Alpine West search area in 2003.

The Lookout search area contained 33 nests of 8 species in 2003. Two-thirds of nests belonged to Greater White-fronted Geese and the second-most common nesting species was Willow Ptarmigan. Nest density for all large waterbirds was only a third of the density observed in the Alpine West and CD North search areas.

In the Spark search area, 33 nests of 10 species were found. Nest density for all large waterbirds was about a quarter of that at Alpine West. Pacific Loons were the most abundant nesting species and Greater White-fronted Geese were second. Other notable species nesting in the Spark search area were King Eider, Long-tailed Duck, and Yellow-billed Loon. The density of Pacific Loon nests in the Spark search area was higher than in any other search area in the NPRA or the Colville Delta.

In the 200-m buffer of the NPRA road corridor, 80 nests of 15 species were found, and an additional 101 nests of 15 species were found in the extended buffer. The most abundant nesting species was Greater White-fronted Goose. King Eider was the most abundant nesting duck in the road corridor and extended buffer.

Habitats with polygonal surface forms in CD North contained the highest numbers of nests. Patterned Wet Meadow and Aquatic Sedge with Deep Polygons contained 58% of all nests. About the same percentage of nests in the NPRA search areas were located in Old Basin Wetland Complex, Shallow Open Water with Islands or Polygonized Margins, and Patterned Wet Meadow.

NPRA BREEDING-BIRD PLOTS

In 2003, 199 nests were found belonging to 20 species of birds on 24 breeding-bird plots (10 ha each). The number of nests was similar to that found in 2002. Species composition over all plots was 47% shorebirds, 46% passerines, 6% waterfowl, and 1% other birds. The most common breeding birds were Lapland Longspurs (39% of all nests), Semipalmated Sandpipers (14%), and Pectoral Sandpipers (13%).

Daily survival rates (DSR) during the incubation period in 2003 were quite variable both among groups of birds (i.e., shorebirds, waterfowl, passerines) and among the species composing these groups. Overall, shorebirds had the highest DSR, followed by passerines and waterfowl. Shorebird nesting success in the NPRA study area during 2003 was 60%. Waterfowl nesting success was low overall (~26%). Nesting success of passerines (predominantly of Lapland Longspurs) was 68%.

Jaegers and gulls were the most abundant and widespread nest predators observed during counts at breeding-bird plots. Potential nest predators seen incidentally while working on plots included Long-tailed, Parasitic, and Pomarine jaegers; Glaucous Gulls; caribou; Common Ravens; arctic and red foxes; arctic ground squirrels; and raptors.

EIDERS

Steller's and Common Eiders are rare on the Colville Delta and NPRA study areas and none were seen in 2003. Spectacled Eiders are more common on the Colville Delta than in the NPRA study area, but King Eiders are the more common eider species in NPRA.

During the 2003 pre-nesting survey, we recorded the smallest number of Spectacled Eiders on the Colville Delta of any previous year. Seventeen Spectacled Eiders were sighted in the CD North study area, 7 were sighted in the northeast delta, and none were seen in the CD South study area. Ten Spectacled Eiders were seen during pre-nesting in NPRA, which was a slight decline from the number seen in 2002. The density of Spectacled Eiders in the NPRA study area was half or less that in the CD North study area and on the northeast delta. Survey conditions probably reduced both the number of eiders in the study area as well as the proportion of eiders in the area that were seen from the aircraft. During pre-nesting, 6 habitats were preferred by Spectacled Eiders on the Colville Delta (Brackish Water, Salt Marsh, Salt-killed Tundra, Deep Open Water with Islands or Polygonized Margins, Shallow Open Water with Islands or Polygonized Margins, and Aquatic Sedge with Deep Polygons) and 3 habitats were preferred in the NPRA (Salt Marsh, Shallow Open Water with Islands or Polygonized Margins, and Old Basin Wetland Complex).

Nest searches of the CD North search area in 2003 produced 12 Spectacled Eider nests, similar to the number in previous years. Three Spectacled Eider nests were found in 2003 during searches in NPRA: 1 nest in the Alpine West search area, and 2 in the northern road corridor and extension buffers. Smaller numbers of broods are observed each year because of the cryptic coloration of hens and young. Three Spectacled Eider broods were seen in the CD North search area and 1 Spectacled Eider brood was found in the road corridor search area between Spark and Lookout during 2003. Nesting Spectacled Eiders in CD North used primarily Patterned Wet Meadow, Aquatic Sedge with Deep Polygons, and Salt-killed Tundra. In NPRA, most nests were in Old Basin Wetland Complex.

In 2003 in CD North, the number of pre-nesting King Eiders was the same as the number of Spectacled Eiders (17). Two King Eiders were sighted in the CD South study area, and 32 King Eiders were recorded on the northeast delta. In NPRA, 191 King Eiders were recorded in 2003. Twenty-three King Eider nests were found in NPRA during 2003, whereas 1 King Eider nest was found in CD North. Over 50% of the pre-nesting King Eiders on the Colville Delta were found in River or Stream, and Barrens, neither of which is used for nesting. Nesting King Eiders on the Colville Delta used similar habitats as did nesting Spectacled Eiders. In NPRA, the habitats preferred by pre-nesting King Eiders were both types of Deep Open Water and both types of Shallow Open Water. Old Basin Wetland Complex was the most used habitat. Most of the King Eider nests in NPRA were found in 2 of the same habitats used by pre-nesting birds: Old Basin Wetland Complex and Shallow Open Water with Islands or Polygonized Margins.

LONG-TAILED DUCK

During the pre-nesting aerial survey around the road corridor in NPRA, 143 Long-tailed Ducks were recorded. The resultant density falls within the range of densities reported for fixed-wing aerial surveys for Long-tailed Ducks on the Arctic Coastal Plain. During pre-nesting, 3 habitats were preferred in the NPRA: Deep Open Water without Islands, Deep Open Water with Islands or Polygonized Margins, and Shallow Open Water without Islands.

Long-tailed Ducks were the most common duck nesting in the CD North search area and occurred at about 4 times the density in the NPRA search areas. Long-tailed Duck nests occurred in all 3 pad search areas in the NPRA study area and in the NPRA road corridor in 2003. Long-tailed Duck nesting in CD North preferred Aquatic Sedge with Deep Polygons, both types of Deep Open Water, and Shallow Open Water with Islands or Polygonized Margins. The habitats most used for nesting in NPRA were Old Basin Complex, Patterned Wet Meadow, and Aquatic Sedge Marsh.

YELLOW-BILLED LOON

During nesting in 2003, 16 Yellow-billed Loon nests were found in the CD North study area and 8 nests were found in the CD South study area. The total count of 26 nests for the Colville Delta in 2003 was the highest that has been reported. Ten Yellow-billed Loon broods were observed in the CD North study area in 2003, and 4 broods were observed in the CD South study area.

In the NPRA study area during 2003, 26 Yellow-billed Loon nests and 16 broods were recorded. Both broods and nests were concentrated in lakes adjacent to Fish and Judy creeks, leaving much of the northwestern and southeastern portions of the study area unoccupied by Yellow-billed Loons. The concentration of nests in the Fish and Judy creek area suggests that this area is a regionally important breeding area for the species on the same scale as the Colville Delta.

Three habitats were preferred for nesting Yellow-billed Loons on the Colville Delta (Patterned Wet Meadow, Deep Open Water with Islands or Polygonized Margins, and Aquatic Sedge Marsh), and 3 habitats were preferred for brood-rearing (both types of Deep Open Water and Tapped Lake with High-water Connection). In NPRA, 3 habitats also were preferred for nesting (Deep Open Water with Islands or Polygonized Margins, Aquatic Sedge Marsh, and Aquatic Grass Marsh), and the 2 types of Deep Open Water were preferred for brood-rearing.

OTHER LOONS

In 2003, 19 Pacific Loon nests and 5 broods were found in the CD North search area, and 28 Pacific Loon nests and 14 broods were found in the

NPRA search areas. Eight Red-throated Loon nests and 5 broods were found during ground searches the CD North search area, whereas only 4 Red-throated Loon nests and 1 brood were found in the NPRA areas.

Four habitats were preferred by nesting Pacific Loons in the CD North search area: Deep Open Water with Islands or Polygonized Margins, Tapped Lake with High-water Connection, Brackish Water, and Shallow Open Water with Islands or Polygonized Margins. The most frequently used habitats by nesting Pacific Loons in NPRA were Shallow Open Water with Islands or Polygonized Margins, Aquatic Sedge Marsh, and Deep Open Water with Islands or Polygonized Margins. Red-throated Loons on the Colville Delta nested in Shallow Open Water with Islands or Polygonized Margins and Aquatic Sedge with Deep Polygons, whereas Red-throated Loons in NPRA nested in 3 habitat types: Old Basin Wetland Complex, Shallow Open Water with Islands or Polygonized Margins, and Riverine Complex.

TUNDRA SWAN

The number of Tundra Swan nests on the entire Colville Delta in 2003 was higher than the 10-year average. Of the 43 Tundra Swan nests counted during the aerial survey in 2003, 23 were located in CD North, 7 were located in CD South, and 13 were on the northeast delta. In the NPRA study area, 43 nests also were found during the aerial surveys in 2003, the same number found in 2002. The swan nesting density in the NPRA study area was about half the nest density on the Colville Delta in 2003.

Swan productivity was much lower in CD South and NPRA than in CD North in 2003. Sixteen of the 27 Tundra Swan broods found on the Colville Delta in 2003 were located in CD North. Nesting success in CD North was 70% in 2003, and the mean brood size was 2.6 young. Only 4 swan broods were observed in the CD South study area, yielding an estimated 57% nesting success and a mean brood size of 1.8 young. In NPRA, 18 broods were observed in the NPRA study area in 2003 and estimated nesting success was 42%, down from 63% in 2002. The mean brood size in the NPRA study area in 2003 was 2.3 young.

Nesting Tundra Swans preferred 6 habitats on the Colville Delta (Salt Marsh, Salt-killed Tundra, Deep Open Water with Islands or Polygonized Margins, Aquatic Sedge with Deep Polygons, Patterned Wet Meadow, and Moist Sedge–Shrub Meadow) and 2 habitats in NPRA (Shallow Open Water with Islands or Polygonized Margins and Aquatic Grass Marsh). Tundra Swan broods on the Colville Delta preferred Brackish Water, both types of Tapped Lakes, both types of Deep Open Water, and Aquatic Grass Marsh. Swan broods in NPRA were attracted to large, deep waterbodies, preferring both types of Deep Open Water and Tapped Lake with Low-water Connection.

GREATER WHITE-FRONTED GOOSE

Greater White-fronted Geese are by far the most abundant large bird nesting in the ASDP area. In the CD North search area, 264 Greater White-fronted Goose nests accounted for 65% of all nests found in 2003, and were at higher numbers than all previous years. In NPRA in 2003, 185 Greater White-fronted Goose nests were found in the ground-search areas. Nest density in the Alpine West search area was only slightly less than the density in the CD North search area, whereas nest densities in the other NPRA search areas were much lower. Nesting success of White-fronted Geese in the CD North search area was 73% in 2003 and overall nesting success in the NPRA search areas was 66%. Greater White-fronted Geese in the CD North search area nested in a variety of habitats in 2003, but the 2 most-frequently used habitats were also preferred for nesting: Patterned Wet Meadow and Aquatic Sedge with Deep Polygons. Greater White-fronted Geese nesting in NPRA preferred Patterned Wet Meadow and Old Basin Wetland Complex.

During brood-rearing and fall-staging aerial surveys in NPRA in 2003, Greater White-fronted Geese were the most abundant species of goose. During brood-rearing, 1,547 Greater White-fronted Geese were observed and juvenile geese comprised 21% of the total. During the fall-staging survey in 2003, only 188 Greater White-fronted Geese were observed.

BRANT

Nesting Brant are abundant on the Colville Delta, but the largest colonies lie outside of the CD North search area. In 2003, only 12 Brant nests were found in the CD North search area, less than half of the number found in previous years, because many Brant nests failed before nest searches were conducted. In the NPRA study area, 18 Brant nests were found in the various ground-search areas in 2003. During the nesting aerial survey in 2003, 55 Brant and 11 nests were recorded at 20 locations within the NPRA study area. The majority of the nesting locations were in the northeastern section of the study area in the vicinity of Fish Creek and the Ublutuoch River. Only 2 Brant broods were observed in the NPRA ground-search areas in 2003, and none were observed in the NPRA study area during the brood-rearing aerial survey, which is conducted after most Brant move to coastal areas.

Brant nests on the Colville Delta in 2003 were found primarily in Deep Open Water with Islands or Polygonized Margins and Aquatic Sedge with Deep Polygons. All Brant nests in the NPRA study area were located in Shallow Open Water with Islands or Polygonized Margins, Young Basin Wetland Complex, Deep Open Water with Islands or Polygonized Margins, and Brackish Water.

OTHER GEESE

Canada Geese are relatively uncommon on the Colville Delta, and only 4 nests were found in the CD North search area in 2003. In NPRA, 46 Canada Goose nests were found in the various ground-search areas in 2003. Canada Geese nested in 2 habitat types in the CD North search area (both types of Deep Open Water) and in NPRA, most nested in 2 other habitats (Shallow Open Water with Islands or Polygonized Margins and Old Basin Wetland Complex). During brood-rearing aerial surveys in the NPRA study area, 82 Canada Geese (including 20 young) were observed, and during fall-staging surveys, only 4 Canada Geese were observed.

In 2003, 3 Snow Goose nests were found in the CD North search area. All 3 nests appeared successful, and occurred in Deep Open Water with Islands or Polygonized Margins and Patterned Wet Meadow. During brood-rearing, 35 adult Snow Geese and 38 young were observed in a single group in the CD North search area. No Snow Goose nests were observed in the various search areas in the NPRA study area in 2003. During the brood-rearing aerial survey in NPRA, a single Snow Goose was observed just north of the confluence of Fish and Judy creeks.

GLAUCOUS GULL

Eight Glaucous Gull nests were counted in the CD North study area and 18 nests were counted in the CD South study area during aerial surveys in 2003. An additional 5 nests were found by ground searchers in the CD North search area. In the CD South study area, 14 of the 18 nests were part of a Glaucous Gull colony located ~5 km southeast of the Alpine project area. In NPRA, 93 Glaucous Gull nests were counted during aerial surveys in 2003. Eighteen of the 93 nests were in 3 colonies.

CARIBOU

Caribou from 2 adjacent herds use the ASDP area: the Teshekpuk Herd (TH) and the Central Arctic Herd (CAH). Caribou density was low on the Colville Delta during all 4 aerial surveys in summer and fall 2003. The western segment of the CAH remained well east of the delta, mostly between the Kuparuk and Prudhoe Bay oilfields during the insect season in 2003. The highest count in the Colville Delta caribou survey area in 2003 was 31 caribou on 28 June, and no large aggregations were seen on the delta during 2003. The number of caribou using the Colville Delta in 2003 was low compared with most previous years.

Caribou use of the NPRA study area appears to peak during fall and winter, in contrast to the neighboring Colville Delta, where the greatest use occurs during the insect season. Caribou numbers were high during the late winter survey on 24 April 2003, when >3,100 caribou were estimated in the survey area. Similar to previous years, the NPRA study area was not an important calving area in 2003. No calves were seen on the first calving survey and only 16 total were seen on the 2 other June surveys, even though the number of animals counted ranged from 450 to 1,060 estimated caribou. During insect-season aerial surveys in 2003, only 2 caribou were seen in the study area. On 4 August, 638 caribou were estimated in the survey area, many of which were feeding in riparian shrub habitats or standing on sand bars along Fish and Judy creeks. Caribou numbers in the study area increased dramatically during September 2003, from an estimated total of 216 to 1,130 and the peak of 4,524 on 29 September. The late September 2003 estimate was the highest recorded among our 3 years of study. Although the timing has varied annually, the number of caribou in the study area has increased in the fall in all 3 years. In early October 2003, a highly unusual movement occurred of an estimated 5–10,000 TH caribou east of the NPRA into the Arctic National Wildlife Refuge, an area not known to have been used before by this herd.

FOX DENS

Since 1992, 23 dens of arctic and red foxes have been found on the Colville Delta. In 2003, 16 of the delta sites were classified as arctic fox dens, including 10 of the 12 dens in the CD North study area, 5 of the 9 dens in the CD South study area, and 1 of the 2 dens in the northeast delta area. Pups were present at a minimum of 5 arctic fox dens and totaled 16 pups, 13 of which were at dens in the CD North study area and 3 of which were at a den in the CD South study area. Seven red fox dens were known on the Colville River Delta in 2003, of which 3 sites (all in CD South) were occupied by a total of 7 pups.

In NPRA, 37 fox dens of both species have been recorded and all but 2 sites were arctic fox dens. The density of arctic fox dens in NPRA is higher than on the Colville River Delta. Fourteen arctic fox dens in NPRA were occupied sites, including 9 natal dens and 1 secondary den. Pups were seen at 7 natal dens, the single secondary den, and 2 active dens, and were suspected to be present at the other 4 sites classified as natal or active. We counted 20 pups among 10 sites. Both red fox dens in NPRA, located on sand dunes bordering Fish Creek, were unoccupied.

On the Colville Delta, 16 dens (belonging to both species) were located in Riverine or Upland Shrub, the only habitat that was preferred. The habitat types used most often for denning by both species of foxes in the NPRA study area were the 2 most abundant types mapped: Moist Tussock Tundra and Moist Sedge–Shrub Meadow. The only habitat that was preferred for denning in NPRA was Upland and Riverine Dwarf Shrub.

OTHER MAMMALS

Fewer muskoxen were seen in 2003 and 2002 than in 2001 in the Colville–Kuparuk region. None were seen on the Colville Delta in 2003, but groups were found on several occasions along the east bank of the main channel of the Colville River. No muskoxen were seen in the NPRA study area in 2003 or 2002. In 2001, one small group of muskoxen was seen in the NPRA study area. That group, comprising 5 or 6 adults at various times, was seen on 5 occasions. Muskox numbers in northeastern NPRA are not well-documented, but appear to be lower than in the area east of the Colville River.

A single cow moose was seen southwest of the Alpine pipeline HDD crossing on the Colville Delta in 2003. No moose have been observed in the NPRA study area during bird and mammal surveys in 2001–2003.

No grizzly bear sightings were recorded during our surveys of the Colville Delta in 2003. Grizzly bears were seen 5 times in various parts of the NPRA study area and twice just outside the area between late May and the end of July 2003. ADFG located 9 radio-marked males and 6 radio-marked females, including several with dependent offspring, on the Colville Delta and northeastern NPRA in 2003. These bears were marked in 2002 and 2003 as part of the ADFG grizzly bear study supported by CPAI.

A single wolf was spotted in the NPRA on a branch of the Ublutuoch River during a goose brood-rearing survey in 2003. In winter 2002–2003, at least 1 and possibly 2 wolf packs were seen several times northwest of our study area in northeastern NPRA by local residents.

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INTRODUCTION

During 2003, ABR, Inc., conducted wildlife surveys for selected birds and mammals in the Colville River Delta and adjacent Northeast Planning Area of the National Petroleum Reserve—Alaska (NPRA) in support of the Alpine Satellites Development Project of ConocoPhillips, Alaska, Inc. (CPAI). The wildlife studies in 2003 were a continuation of work initiated by CPAI's predecessors, ARCO Alaska, Inc., and Phillips Alaska, Inc., in the Colville River Delta in 1992 (including, in part, Smith et al. 1993, 1994; Johnson 1995; Johnson et al. 1996, 1997, 1998, 1999a, 1999b, 2000a, 2000b, 2001, 2002, 2003a, 2003b; Burgess et al. 2000, 2002a, 2003a; Lawhead 1999; Lawhead and Prichard 2001, 2002, 2003a) and in the northeastern NPRA in 1999 (Anderson and Johnson 1999; Murphy and Stickney 2000; Johnson and Stickney 2001; Burgess et al. 2002b, 2003b). The Colville River Delta and NPRA studies augment long-term wildlife monitoring programs that have been conducted by CPAI (and its predecessors) across large areas of the central Arctic Coastal Plain since the early 1980s (see Murphy and Anderson 1993, Stickney et al. 1993, Anderson et al. 2003, Lawhead and Prichard 2003b).

The primary goal of wildlife investigations in the region since 1992 has been to describe the distribution and abundance of selected species before, during, and after construction of oil development projects. Baseline information on wildlife also is required for the permitting of development projects and, as development plans have expanded westward, wildlife survey areas also have expanded to establish pre-development baselines and to evaluate construction and operations impacts of oil development on wildlife populations. We report here the results of wildlife surveys in 2003 that were conducted in areas that CPAI currently proposes as potential future oil and gas development sites (the Alpine Satellite Development Project [ASDP] [BLM 2004]) in the Colville River Delta and adjacent NPRA, including the Fiord (CD-3), Nanuq (CD-4), Alpine West (CD-5), Lookout (CD-6), and Spark (CD-7) prospects (Figure 1). Only 2003 data on the distribution and abundance of wildlife species are presented herein. Readers are directed to prior reports for background, distribution, and abundance information from previous years. Habitat selection analyses are presented for key focal species only and are based on observations from all available years of comparable data (since 1992 [for some species] in the Colville River Delta and since 2001 in the NPRA).

In addition to wildlife surveys, ecological land surveys (ELS) were conducted on the Colville River Delta (Jorgenson et al. 1997) and in the northeastern NPRA (Jorgenson et al. 2003, 2004) to allow integration of ecological information with project engineering approaches. The ELS described terrain units (surficial geology, geomorphology), surface forms (primarily ice-related features), and vegetation through the region and was used to develop a GIS (Geographic Information System) map of wildlife habitats, in which regions are identified by the presence of habitat features that are important to various wildlife species. The ELS and derived habitat maps are used in this investigation to assess habitat use and habitat selection (or preferences) of wildlife species and the maps were used to directly compare impacts of various development options and facility configurations (see ARCO 1997, CPAI 2002, BLM 2004), allowing project developers and agency managers to minimize negative impacts on wildlife by design. ELS methodologies and derivation of the habitat map are presented in previous reports (Jorgenson et al. 1997, 2003; Johnson et al. 1997), and the map products have been used extensively in the previously cited ecological investigations in the region. Other habitat maps have been produced for portions of the NPRA, including habitat maps by BLM and Ducks Unlimited (2002) and Jorgenson and Heiner (2003 unpublished map for The Nature Conservancy). These two habitat maps were produced at larger scales and their classifications did not include as many waterbody and wetland types as the ELS derived map, so they were not adequately detailed for analysis of habitat use by the variety of species of interest.

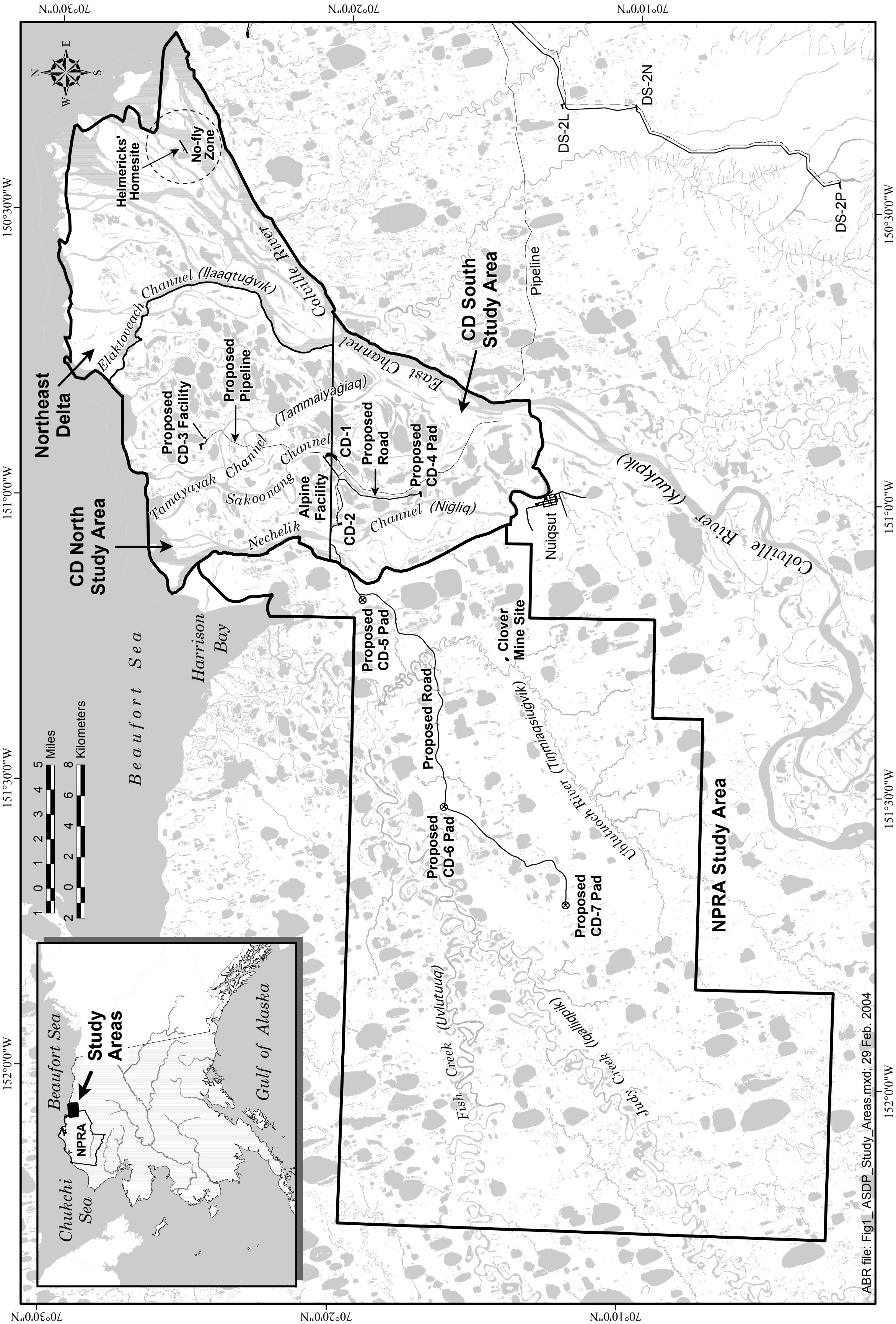

Figure 1. Wildlife study areas for the Alpine Satellite Development Project, northern Alaska, 2003.

Wildlife study objectives and scopes were developed and study progress was reported through a series of agency scoping and planning meetings, including

- 7 March 2001 – presented proposed study program to the Bureau of Land Management (BLM) and the interim Research and Monitoring Team (RMT) in Fairbanks
- 8 May 2001 – met with the Kuukpik Subsistence Oversight Panel (KSOP) in Nuiqsut to discuss NPRA exploration and pre–development baseline study program
- 12 June 2001 – met with BLM Subsistence Advisory Panel concerning NPRA development and summer studies
- 9 July 2001 – met with KSOP concerning NPRA development and summer studies
- 16 July 2001 – met with BLM Fairbanks personnel concerning NPRA issues
- 16 August 2001 – met with BLM Subsistence Advisory Panel concerning NPRA development and summer studies
- 28 & 29 August 2001 – met with regulatory agencies in Anchorage and Fairbanks concerning plans for 2001/2002 winter exploration program
- 10 October 2001 – presentation to BLM's official RMT on progress of summer studies in the NPRA
- 17 October 2001 – met with BLM to discuss preliminary development plans
- 13 December 2001 and 6 June 2002 – met with BLM Subsistence Advisory Panel concerning NPRA development and summer studies
- 5 March 2002 – met with USFWS, Wildlife Conservation Society, and BP Exploration Alaska, Inc. to design collaborative tundra nesting bird study
- 2 May 2002 – met with KSOP to discuss 2001 study results and plans for 2002 studies in the NPRA
- 23 October 2002 – met with BLM to discuss the status of environmental studies conducted through summer 2002 in the NPRA and proposed studies for 2003
- 27–28 January 2003 – presented results of previous studies to regulatory agencies, Kuukpik Corporation representative, and BLM’s EIS consultant during pre-scoping meeting for ASDP environmental impact statement preparation
- 5 March 2003 – presented results of NPRA and Colville avian studies to members of the North Slope Borough Fish and Game Management Committee
- 15 May 2003 – met with KSOP and residents of Nuiqsut to discuss findings from past studies and study plans for 2003

To facilitate public involvement in development planning and to ensure that interested parties were kept well informed, the wildlife surveys were planned with input from North Slope Borough (NSB), state and federal agencies, and Nuiqsut residents. On 8 May 2001, CPAI held a science fair in Nuiqsut to discuss exploration and development in the NPRA, as well as the environmental studies scheduled for 2001. On 9 May 2001, CPAI and ABR scientists met with Nuiqsut elders to discuss NPRA activities and solicit input on traditional use areas. Input from these meetings was used to optimize survey schedules and to avoid conflict with subsistence activities in the area. In addition, CPAI published "NPRA Update," a newsletter on NPRA activities, as an insert in the “Arctic Sounder” newspaper each year since December 2001. The newsletter discussed summer field studies, subsistence representatives and ice-road monitors, public meetings, and other information. On 15 May 2003, an open house was held in Nuiqsut to allow residents to visit with CPAI biologists and other scientists to discuss information on and concerns for resources in the Delta and NPRA areas. Mark Ahmakak and Doreen Nukapigak, representing the KSOP, participated in wildlife surveys in 2003. In September 2003, two groups of Nuiqsut elders were flown to the proposed 2004 exploration sites and CPAI study locations to solicit their input on potential issues associated with development or exploration activities. CPAI visited subsistence cabins with Joeb Woods and Ruth Nukapigak.

Wildlife species were selected for investigation in consultation with the U.S. Fish and Wildlife Service (USFWS), which used the following criteria to identify species of interest: 1) threatened or sensitive status (Spectacled and Steller's Eiders), 2) suspicion of declining populations (King Eiders), 3) restricted breeding range (Yellow-billed Loons), 4) concern of regulatory agencies for development impacts (Brant, Tundra Swans, shorebirds, and passerines), 5) nest predators (foxes and Glaucous Gulls), or 6) subsistence species (caribou and geese). During surveys, additional information was collected opportunistically on Pacific Loons, Red-throated Loons, Sabine's Gulls, Arctic Terns, muskoxen, grizzly bears, and other mammals (common and scientific names of wildlife are listed in Appendix A). Additional studies on the use of the proposed development area by grizzly bears were conducted for CPAI by the Alaska Department of Fish and Game [ADFG] in 2002 and 2003 [see Species Accounts for grizzly bears, below].

Surveys in the Colville River Delta and in the northeastern NPRA in 2003 were designed to provide baseline information on the distribution, abundance, and habitat use of 9 focal species: Spectacled Eider, King Eider, Tundra Swan, Brant, Yellow-billed Loon, Glaucous Gull, caribou, and arctic and red foxes (another focal species survey, for Red-throated Loons, was conducted only in 2001 during the startup of studies in the NPRA). In addition to these focal species, surveys were conducted to collect information on geese during brood-rearing and fall staging (because of their importance as subsistence species) and on nesting shorebirds and passerines (the most abundant nesting birds in the region). Studies on shorebirds and passerines are part of a region-wide collaborative study (with USFWS, Wildlife Conservation Society, Manomet Center for Conservation Sciences, and BP Exploration [Alaska], Inc.) on factors affecting nesting success of tundra nesting birds. Required state and federal permits were obtained for authorized survey activities, including a Scientific and Educational Permit (Permit Nos. 03-084 and 03-095) from ADFG and a Federal Fish and Wildlife Permit—Threatened and Endangered Species (Permit No. TE012155-7) from the USFWS. The 2003 surveys are detailed in Table 1 (avian surveys) and Table 2 (mammal surveys) and described individually in methods. Except for the ground-search areas, which describe differences between specific areas, results for birds are summarized not by survey, but by focal species (i.e., species accounts), incorporating nesting and habitat use data from ground searches with data from aerial surveys for an integrated discussion of the seasonal abundance, distribution, and habitat use for each species.

Six specific objectives were identified for wildlife surveys in the Colville River Delta and northeastern NPRA in 2003:

1. describe the distribution, abundance, and productivity of selected species of waterfowl, loons, and gulls;
2. calculate nest density, nesting success, and habitat use of shorebirds and passerines in representative portions of the study area;
3. evaluate habitat use and habitat preferences of key wildlife species, using the habitat classification and maps of Jorgenson et al. (1997 and 2003);
4. describe the distribution and abundance of caribou during the pre-calving period, calving season, post-calving period (including the insect-harassment season), and late summer through early winter;
5. document the distribution, abundance, and occupancy of fox dens and the production of young foxes; and
6. record the locations and numbers of muskoxen, brown (grizzly) bears, and other mammals encountered opportunistically during surveys.

STUDY AREA

The place names used throughout this report are those depicted on U.S. Geological Survey (USGS) 1:63,360-scale topographic maps, because they are the most widely available published maps of the region. The corresponding local Iñupiaq names for drainages are provided in parentheses, however, at the first usage in text and on the study area maps (Figures 1 and 2). Iñupiaq names are presented out of respect for local residents, to

Table 1. Avian surveys conducted in the CD North, CD South, and NPRA study areas, Alaska, 2003.

SURVEY METHOD Survey Type	Season	Survey Dates: CD North and CD South	Survey Dates: NPRA	Aircraft[a]	Transect Width (km)	Transect Spacing (km)	Aircraft Altitude (m)	Notes
LARGE WATERBIRD GROUND-SEARCHES[b]								
Pad Search Areas[c]	Nesting	18–28 June	12–29 June	–	–	–	–	CD North=17.7 km²; 3 NPRA sites=15.3 km²
	Brood-rearing	18–20 July	15–18 July	–	–	–	–	Includes loon nest search
	Brood-rearing	19 August	20–21 August	–	–	–	–	Primarily for loons
NPRA Road Corridors[d]	Nesting	–	13–24 June	–	–	–	–	2 corridors=16.6 km²
	Brood-rearing	–	15–19 July					Includes loon nest search
	Brood-rearing	–	20–21 August	–	–	–	–	Primarily for loons
NPRA BREEDING-BIRD PLOTS[e]	Nesting	–	6 June–20 July	–	–	–	–	24 plots (2.4 km² total)
AERIAL SURVEYS[f, g]								
Eider Surveys	Pre-nesting	13–15 June	–	C185	0.4	0.4	30–35	100% coverage
	Pre-nesting	–	12–13 June	C185	0.4	0.8	30–35	50% coverage
Yellow-billed Loon Surveys[h]	Nesting	26 June	26, 29–30 June	206L	–	–	60	All lakes ≥10 ha
	Brood-rearing	19, 21 August	20–21 August	206L	–	–	60	Lakes with nests
Tundra Swan Surveys	Nesting	21–22 June	23–24 June	C185	1.6	1.6	150	100% coverage
	Brood-rearing	19, 22, 24 August	25 August	C185	1.6	1.6	150	100% coverage
Long-tailed Duck Survey	Pre-nesting	–	17–18 June	206L	–	–	60	Lake-to-lake survey
Goose Surveys	Nesting	–	18–19 June	206L	–	–	60	Lake-to-lake survey for Brant only
	Brood-rearing	–	31 July	C185	0.8	1.6	90	50% coverage
	Fall staging	–	25 August	C185	0.8	1.6	90	50% coverage

[a] C185 = Cessna 185 fixed-wing airplane; PA18 = Piper "Super Cub" fixed-wing airplane; 206L = Bell "Long Ranger" helicopter
[b] Large waterbirds included loons and grebes, waterfowl, gulls, terns, jaegers, ptarmigan, and large shorebirds (Whimbrel, Bar-tailed Godwit, and Wilson's Snipe)
[c] Large waterbird ground-searches were conducted in pad area of CD North, but not in CD South
[d] Two road corridors were searched; plans for the north corridor subsequently were dropped by CPAI and results for that corridor are presented in appendices
[e] Nest searches included all avian species, but plot design targeted shorebirds and passerines
[f] Each aerial survey covered all or most of the 2003 CRD and NPRA Study Areas. See text for details on aerial survey coverage
[g] Glaucous Gull nests were recorded during surveys for Eiders, Yellow-billed Loons, Tundra Swans, Brant, and Long-tailed Ducks
[h] Pacific and Red-throated loons and colonies of Sabine's Gulls were recorded incidentally

Table 2. Mammal surveys conducted in the NPRA and Colville River Delta survey areas, Alaska, 2003.

SURVEY TYPE Season	Survey Area	Date	Aircraft[a]	Transect Strip Width (km)	Transect Spacing (km)	Aircraft Altitude (m)	Area Sampled (km^2) [b]
CARIBOU STRIP-TRANSECTS							
Late winter	NPRA	24 April	C185	1.6	3.2	150	654
Pre-calving	NPRA	20 May	C206	1.6	3.2	150	654
Calving	NPRA	30 May	C206	1.6	3.2	150	654
Calving	NPRA	8 June	C206	1.6	3.2	150	654
Post-calving	NPRA	16 June	C206	1.6	3.2	150	654
Post-calving	NPRA	24 June	C206	1.6	3.2	150	654
Insect season	Delta	28 June	C206	1.6	3.2	150	247
Insect season	NPRA	7 July	C206	1.6	3.2	150	654
Insect season	Delta	7 July	C206	1.6	3.2	150	247
Insect season	NPRA	20 July	C206	1.6	3.2	150	654
Insect season	Delta	20 July	C206	1.6	3.2	150	247
Insect season	NPRA	4 August	C206	1.6	3.2	150	654
Fall	NPRA	3 September	C206	1.6	3.2	150	654
Fall	NPRA	16 September	C206	1.6	3.2	150	654
Fall	Delta	16 September	C206	1.6	3.2	150	237[c]
Fall	NPRA	29 September	C185	1.6	3.2	150	654
Fall	NPRA	28 October	C185	1.6	3.2	150	654
FOX DEN STATUS CHECK & SEARCH							
Denning	Delta	27 June	206L	–	–	60–90	–
Denning	NPRA	30 June–1 July, 9 July	206L	–	–	60–90	–
FOX DEN OBSERVATIONS[d]							
Denning		8–11 July	206L	–	–	–	–

[a] C185 = Cessna 185 fixed-wing airplane; C206 = Cessna 206 fixed-wing airplane; 206L = Bell "Long Ranger" helicopter
[b] 50% coverage of 1,310-km^2 survey area in NPRA and 494-km^2 survey area on Colville Delta
[c] Easternmost transect not flown due to deteriorating weather conditions
[d] Principally ground-based observations that relied on helicopter access

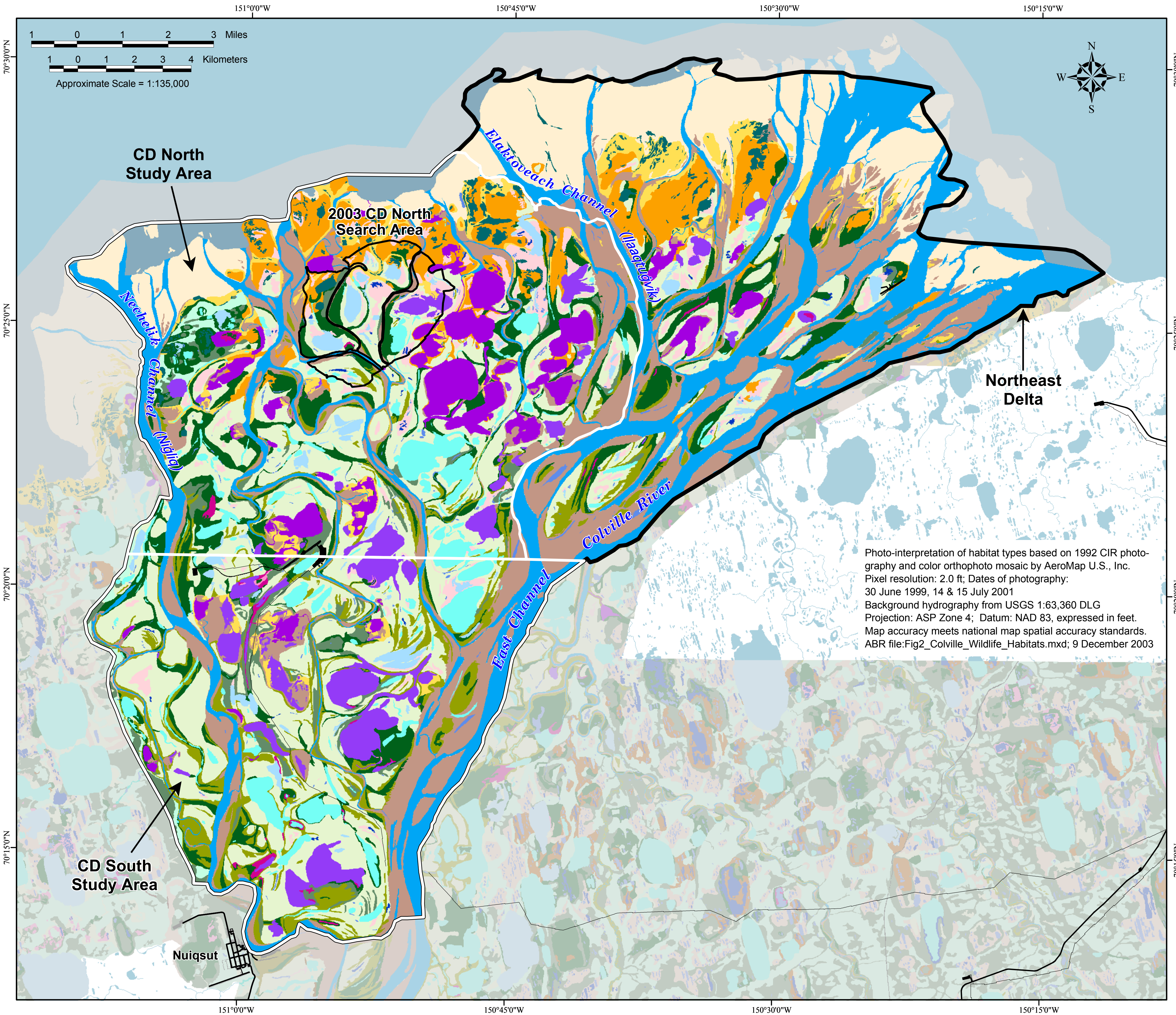

Figure 2. Wildlife habitats in the Colville River Delta, Alaska, 2003.

facilitate clear communication with Iñupiaq speakers, and because they pre-date the English names used on USGS maps. We acknowledge that the Iñupiaq names presented are not comprehensive and we understand that the published USGS names for some streams (notably the Ublutuoch and Tingmeachsiovik rivers) do not correctly reflect local usage. The Iñupiaq names we use for Fish and Judy creeks in northeastern NPRA are taken from the *Iñupiat–English Map of the North Slope Borough* (NSB Planning Department, Barrow, Alaska, May 1997). Additional information was supplied to CPAI in recent years by Nuiqsut elders. Ruth Nukapigak and Sarah Kunaknana provided the name of Ulamniġiaq channel, which is not named on USGS maps, on the outer Colville River Delta (S. Geddes, CPAI, pers. comm.). Even in cases where USGS attempted to use the correct Iñupiaq names, the anglicized spellings are outdated and so have been corrected to the modern Iñupiaq spellings through consultation with Emily Ipalook Wilson and Dr. Lawrence Kaplan of the Alaska Native Language Center at the University of Alaska Fairbanks. Marjorie Kasak Ahnupkanna and Archie Ahkiviana were consulted to confirm the names of other channels on the Colville River Delta (E. Wilson, ANLC, pers. comm.). Efforts to update Iñupiaq names on maps of the study area are ongoing.

The climate in the region is arctic maritime (Walker and Morgan 1964). Winter lasts ~8 months and is cold and windy. The thaw period lasts only about 90 days during summer (1 June–31 August) and the mean summer air temperature is 5º C (43º F; Kuparuk Oilfield records: National Oceanic and Atmospheric Administration, unpubl. data), ranging from –10° C in mid-May to +15° C in July and August (North 1986), with a strong gradient of increasing temperatures with distance from the coast. Mean summer precipitation is under 8 cm, most of which falls as rain in August. The soils are cold and underlain by permafrost, and temperature of the active layer of thawed soil above permafrost ranges from 0º to 10º C (32º–50º F) during the growing season. Spring is brief, lasting ~3 weeks in late May and early June, and is characterized by the flooding and breakup of rivers. In late May, water from melting snow flows both over and under the ice on the Colville River, resulting in flooding on the delta that peaks during late May or the first week of June (Walker 1983). Breakup of the river ice usually occurs when floodwaters are at maximal levels. Water levels subsequently decrease in the delta throughout the summer, with the lowest levels occurring in late summer and fall, just before freeze-up (Walker 1983). Summer weather is characterized by low precipitation, overcast skies, fog, and persistent, predominantly northeast winds. The less common westerly winds often bring storms that are accompanied by high wind-driven tides and rain (Walker and Morgan 1964). Summer fog is more common in coastal areas and on the delta than it is in the more inland NPRA study area.

The areas in which wildlife surveys were conducted are divided into 3 large study areas, the CD North and CD South study areas in the Colville River Delta (henceforth, the Colville Delta or the delta) and the NPRA study area (Figure 1). The Colville Delta includes the Alpine Development (CD-1 and CD-2, at present, the only producing oilfield on the Colville Delta) and 2 proposed development sites, CD-3 and CD-4 (located in the CD North and CD South study areas, respectively). The CD-3 development is proposed as a roadless development that would be accessed via a landing strip (see BLM 2004 for complete descriptions and maps of these sites). A road is proposed to connect the CD-4 development to the Alpine Development, and the entire road corridor was included in the CD South study area. The NPRA study area includes 4 proposed development sites, Alpine West (CD-5), Lookout (CD-6), Spark (CD-7), and Clover (a potential gravel mine site). A proposed road corridor connects these sites and connects the Alpine West pad to the Alpine Development at CD-2.

COLVILLE RIVER DELTA

The Colville Delta (552 km²) comprises the CD North and CD South study areas and the northeastern delta, an area that was included in many aerial surveys (Figure 1). Together these 3 areas encompass the entire delta from the east bank of the East Channel to the west bank of the westernmost distributary of the Nechelik (Niġliq) Channel and inland to the juncture of these channels. The Colville Delta is one of the most prominent and important landscape features on the Arctic Coastal Plain of Alaska, both because of its large size and because of the concentrations of birds, mammals, and fish that are found there. Two permanent human settlements occur on the Colville Delta—the Iñupiat village of Nuiqsut and the Helmericks' family home site. Both rely heavily on these fish and wildlife resources.

The Colville River (Kuukpik) drains a watershed of ~53,000 km², or ~29% of the Arctic Coastal Plain of Alaska (Walker 1976). The high-volume flow and heavy sediment load of the Colville have created a large, dynamic delta system, which includes a diversity of lakes, aquatics, and terrestrial habitats. The Colville River has 2 main distributaries in the delta, the Nechelik Channel and the East Channel (Figure 1). These 2 channels together carry ~90% of the water flowing through the delta during spring floods and 99% of the water after those floods subside (Walker 1983). The East Channel is deep and flows under the ice during winter, whereas the Sakoonang, Tamayayak (Tammaiyaġiaq), Nechelik, and other channels are shallow in places and freeze to the bottom in winter. Decreased river flow during winter results in an intrusion of salt water into the delta's channels, with the depth of the river at freeze-up being the main factor determining the inland extent of this intrusion (Walker 1983). For its entire length, the Colville River flows through land that is underlain by continuous permafrost. This extensive permafrost, combined with freezing of the upper layer of surface water in winter, influences the volume, timing, and character of river flow and erosion within the delta (Walker 1983).

Landforms, vegetation, and wildlife habitats in the Colville Delta were described in the Ecological Land Survey (Jorgenson et al. 1997). Coastal and riverine landforms dominate the delta. Fluvial processes predominate, although eolian and ice-aggradation processes are important to landscape development, as are lacustrine and basin-drainage processes. Twenty-four wildlife habitat types were identified in the delta (Figure 2). The wildlife habitat types are described in Appendix B. Four habitats were predominant on the delta (Table 3): Patterned Wet Meadow (18.6% of the entire delta), River or Stream (14.9%), Barrens (14.3%), and Tidal Flat (10.2%). No other habitats comprised more than 8% of the delta study area. Four habitats occurred only in trace amounts (<0.1%): Aquatic Sedge Marsh, Young Basin Wetland Complex, Old Basin Wetland Complex, and Artificial. And an additional 4 habitats comprised <1% of the total area: Shallow Open Water without Islands, Shallow Open Water with Islands or Polygonized Margins, Aquatic Grass Marsh, and Moist Tussock Tundra. Together, aquatic habitats comprised 34% of the total delta. In addition to Barrens and Tidal Flats, several coastal salt-affected habitats—Salt-killed Tundra, Salt Marsh, Open Nearshore Water, and Brackish Water—are important constituents of the delta and together these coastal habitats comprise 21% of the total area and contribute greatly to avian biodiversity. Tapped lakes (Tapped Lake with Low-water Connection and Tapped Lake with High-water Connection) are unique to the delta environment and also are important to the physical and biological diversity of the delta, although they comprise <8% of the total area. Also important to birds are emergent aquatic habitats (Aquatic Sedge with Deep Polygons, Aquatic Grass Marsh, and Aquatic Sedge Marsh), which together comprise <3% of the total area, and waterbodies with islands and polygonized margins (Deep Open Water with Islands or Polygonized Margins and Shallow Open Water with Islands or Polygonized Margins), together comprising only 1.5% of the total area. A strong north-south gradient occurs across the delta in the distribution of many of these recognized habitats, with coastal habitats, Tapped Lakes with Low-water Connections, Aquatic Sedge with Deep Polygons, and Nonpatterned Wet Meadow decreasing in abundance with distance from the coast and Tapped Lakes with High-water Connections, Aquatic Sedge Marsh, Aquatic Grass Marsh, Patterned Wet Meadow, Moist Sedge–Shrub Meadow, and Riverine or Upland Shrub increasing in abundance with distance from the coast. These patterns of habitat distribution have strong effects on the distribution and abundance of various wildlife species in the delta.

Lakes and ponds are dominant physical features of the Colville Delta. The most abundant waterbodies on the delta are polygon ponds, which generally are shallow (i.e., ≤2 m deep), freeze to the bottom during winter, and thaw by June. Deep ponds and lakes (>2 m deep) with steep, vertical

Table 3. Habitat availability in the CD North and CD South study areas, the northeast delta, the combined Colville River Delta, and the NPRA study area, Alaska, 2003.

Habitat	CD North Study Area Area (km²)	CD North Study Area Availability (%)	CD South Study Area Area (km²)	CD South Study Area Availability (%)	Northeast Delta Area (km²)	Northeast Delta Availability (%)	Colville River Delta Area (km²)	Colville River Delta Availability (%)	NPRA Study Area Area (km²)	NPRA Study Area Availability (%)
Open Nearshore Water	7.18	3.5	0	0	2.94	1.6	10.12	1.8	3.40	0.5
Brackish Water	4.01	1.9	0	0	2.54	1.3	6.55	1.2	1.34	0.2
Tapped Lake with Low-water Connection	17.86	8.6	1.61	1.0	2.25	1.2	21.73	3.9	1.70	0.2
Tapped Lake with High-water Connection	5.86	2.8	13.58	8.7	1.33	0.7	20.77	3.8	0.07	<0.1
Salt Marsh	7.74	3.7	1.53	1.0	7.17	3.8	16.44	3.0	3.65	0.5
Tidal Flat	12.46	6.0	0	0	43.36	22.9	55.82	10.1	8.18	1.2
Salt-killed Tundra	15.13	7.3	0	0	10.50	5.5	25.63	4.6	0.14	<0.1
Deep Open Water without Islands	9.99	4.8	10.02	6.4	0.71	0.4	20.72	3.8	49.95	7.2
Deep Open Water with Islands or Polygonized Margins	4.21	2.0	2.42	1.6	1.14	0.6	7.78	1.4	36.22	5.2
Shallow Open Water without Islands	0.89	0.4	0.39	0.3	0.74	0.4	2.02	0.4	7.03	1.0
Shallow Open Water with Islands or Polygonized Margins	0.30	0.1	0.11	0.1	0.14	0.1	0.54	0.1	11.43	1.6
River or Stream	15.03	7.3	16.72	10.7	51.04	26.9	82.79	15.0	6.17	0.9
Aquatic Sedge Marsh	0	0	0.13	0.1	0	0	0.13	<0.1	11.55	1.7
Aquatic Sedge with Deep Polygons	8.57	4.1	1.72	1.1	2.88	1.5	13.18	2.4	0.30	<0.1
Aquatic Grass Marsh	0.34	0.2	0.87	0.6	0.24	0.1	1.44	0.3	1.97	0.3
Young Basin Wetland Complex	0	0	<0.01	<0.1	0	0	<0.01	<0.1	2.52	0.4
Old Basin Wetland Complex	0	0	0.14	0.1	0	0	0.14	<0.1	61.18	8.8
Riverine Complex	–	–	–	–	–	–	–	–	2.78	0.4
Dune Complex	–	–	–	–	–	–	–	–	7.59	1.1
Nonpatterned Wet Meadow	21.69	10.5	10.01	6.4	9.92	5.2	41.61	7.5	21.47	3.1
Patterned Wet Meadow	41.70	20.2	47.40	30.4	13.41	7.1	102.51	18.6	78.86	11.3
Moist Sedge–Shrub Meadow	4.23	2.0	7.43	4.8	0.64	0.3	12.30	2.2	161.55	23.2
Moist Tussock Tundra	1.80	0.9	1.44	0.9	<0.01	<0.1	3.24	0.6	190.61	27.4
Riverine or Upland Shrub[a]	5.29	2.6	18.24	11.7	4.05	2.1	27.59	5.0	–	–
Riverine Low and Tall Shrub[a]	–	–	–	–	–	–	–	–	7.26	1.0
Upland and Riverine Dwarf Shrub[a]	–	–	–	–	–	–	–	–	8.97	1.3
Upland Low and Tall Shrub[a]	–	–	–	–	–	–	–	–	2.80	0.4
Barrens	22.24	10.8	21.91	14.1	34.57	18.2	78.71	14.3	6.84	1.0
Artificial	0.16	0.1	0.22	0.1	0.03	<0.1	0.41	0.1	–	–
SUBTOTAL (Total mapped area)	206.67	100	155.88	100	189.63	100	552.19	100.0	695.53	100
Unknown (Unmapped areas)	–	–	–	–	–	–	–	–	404.67	–
TOTAL	206.67	100	155.88	100	189.63	100	552.19	100	1,100.20	–

[a] Because of the greater importance of shrub habitats in the NPRA study area, the Riverine or Upland Shrub habitat type in the Colville River Delta areas was replaced by 3 shrub habitat classifications in the NPRA study area

sides, are more common on the delta than elsewhere on the Arctic Coastal Plain, where deep waterbodies are much less common. Lakes >5 ha in size cover 16% of the delta's surface (Walker 1978) and some of these lakes are deep (to 10 m), freezing only in the upper 2 m during winter and retaining floating ice until the first half of July (Walker 1978). Several other types of lakes occur on the delta, including oriented lakes, abandoned-channel lakes, point-bar lakes, perched ponds, thaw lakes, and tapped lakes (Walker 1983). Tapped lakes are connected to the river by narrow channels that result from thermokarst of ice wedges and by the migration of river channels (Walker 1978). Channel connections allow water levels in tapped lakes to fluctuate more dramatically than in untapped lakes, resulting in barren or partially vegetated and often salt-affected shorelines. River sediments gradually fill these narrow channels and adjacent lake bottoms, eventually limiting the flow of river water or restricting it to only the most extreme flood events. Because tapped lakes and river channels are the first areas of the delta to become flooded in spring, they constitute important staging habitat for migrating waterfowl in that season (Rothe et al. 1983).

The Colville Delta supports a wide variety of wildlife, providing breeding habitat for passerines, shorebirds, gulls, and predatory birds, such as jaegers and owls. The delta is a regionally important nesting area for waterbirds, including Yellow-billed Loons, Tundra Swans, Brant, and Spectacled Eiders (Rothe et al. 1983, North et al. 1984, Meehan and Jennings 1988). In spring, the delta provides some of the earliest open water and snow-free areas on the Arctic Coastal Plain for migrating birds. In fall, the extensive salt marshes and mudflats on the outer delta are used by geese and shorebirds for feeding and staging (Andres 1994). In addition to use by birds, the delta is used seasonally by highly variable numbers of caribou for insect-relief habitat, by arctic and red foxes for denning, and by spotted seals for foraging and haul-out sites (Seaman et al. 1981). In recent years, the delta and adjacent areas have been visited increasingly by muskoxen. Brown bears occur regularly, and the delta is used occasionally for denning by both brown and polar bears (see reviews in Johnson et al. 1997).

NPRA STUDY AREA

The 2003 NPRA study area (1,100 km²) abuts the western edge of the Colville Delta and encompasses 6 exploratory sites that were drilled during winter 1999–2000 and 2000–2001 (Clover A, Lookout 1, Spark 1A, Rendezvous A, Rendezvous 2, and Moose's Tooth C) and 4 proposed development sites (Alpine West, Lookout, and Spark and the Clover gravel mine site; Figure 1), which are part of the ASDP. The NPRA study area and the included ASDP development sites are located in the northeastern section of the NPRA, 6–39 km west of the village of Nuiqsut and 1–43 km west and southwest of the Alpine facilities (Figure 1). A proposed road corridor links the 3 proposed pad sites with the existing Alpine facilities on the Colville Delta (BLM 2004). The road route proposed in the ASDP Draft Environmental Impact Statement (BLM 2004) differs slightly from the road corridor that was searched during this study (Figure 1), because it was modified (for hydrological and other engineering concerns) after fieldwork commenced. In this report, the proposed road corridor (or road corridor) represents the initial road route proposal in June 2003 and not the final route presented as Alternative A (the "proposed" alternative) in the Draft EIS. In addition to the proposed road corridor, a northern road corridor alternative was surveyed for birds in 2003 (Appendix C1). The northern alternative was subsequently abandoned and data from that area are reported in appendices in this report. The "preferred" alternative for the ASDP has yet to be chosen by the time of this report; the preferred alternative may or may not include one of the road routes or portions of the road routes described above (BLM 2004).

Three major streams flow through the NPRA study area (Figure 1). On USGS topographic maps (Harrison Bay 1:63,360 series, 1955), these drainages are labeled as Fish Creek, Judy Creek, and the Ublutuoch River, but are commonly known by other names by Iñupiat residents: Fish Creek is called Uvlutuuq, Judy Creek is called Iqalliqpik, and the Ublutuoch River is called Tiŋmiaqsiuġvik (Figure 1).

Landforms, vegetation, and wildlife habitats in the northeastern NPRA were described in the recent Environmental Impact Statement for the lease area (BLM 1998) and in the Ecological Land Survey (ELS; Jorgenson et al. 2003) and are similar to those of the western Kuparuk Oilfield and the Alpine Transportation Corridor (Johnson et al. 1997, Jorgenson et al. 1997). Coastal plain and riverine landforms dominate the northeastern section of the NPRA. Coastal landforms also are present but limited to northeast corner of the study area. On the coastal plain, lacustrine processes, basin drainage, and ice aggradation are the primary geomorphic factors that modify the landscape. In riverine areas along Fish and Judy creeks, fluvial processes predominate, although eolian and ice-aggradation processes also contribute to ecological development (Jorgenson et al. 2003). Twenty-seven wildlife habitat types (based on vegetation and surface form and geomorphology) were identified within the ELS mapped portion of the NPRA study area (Figure 3). Common habitat types included Moist Tussock Tundra, Moist Sedge–Shrub Meadow, Patterned Wet Meadow, Old Basin Complex, and Deep Open Water without Islands.

Of the 27 wildlife habitats identified in the NPRA study area, 2 habitats predominated: Moist Tussock Tundra (27.4% of area) and Moist Sedge-Shrub Meadow (23.2%) (Table 3). Patterned Wet Meadow comprised 11.3% of the total area and no other habitat comprised >9% of the study area. Three habitats occurred only in trace amounts (<0.1%): Tapped Lake with High-water Connection, Salt-killed Tundra, and Aquatic Sedge with Deep Polygons. And an additional 12 habitats comprised ≤1% of total area: Open Nearshore Water, Brackish Water, Tapped Lake with Low-water Connection, Salt Marsh, Shallow Open Water without Islands, River or Stream, Aquatic Grass Marsh, Young Basin Wetland Complex, Riverine Complex, Riverine Low and Tall Shrub, Upland Low and Tall Shrub, and Barrens. Aquatic habitats comprised 18.9% of the study area. Although the NPRA study area includes some coastal habitats and tapped lakes, there is much less of a coastal gradient than in the adjacent Colville Delta, and coastal and salt-affected habitats are rare, being limited to only the northernmost reaches of the study area. Riparian habitats also are much less common in the NPRA than they are on the Colville Delta. Other habitats appear to be distributed throughout the study area with no discernable north-south gradient in the occurrence of habitat types.

The NPRA also is an important area for wildlife and for subsistence harvest. The northeastern NPRA supports a wide array of wildlife, providing breeding habitat for geese, swans, passerines, shorebirds, gulls, and predatory birds, such as jaegers and owls. The Fish Creek and Judy Creek drainages in the NPRA study area are a regionally important nesting area for Yellow-billed Loons, actually supporting annually a larger number of nesting pairs than the Colville Delta (Burgess et al. 2003b). The NPRA study area is used by caribou from 2 adjacent herds: the Teshekpuk Herd (TH), primarily, and the Central Arctic Herd (CAH), secondarily (BLM 1998, Prichard et al. 2001, Arthur and Del Vecchio 2003).

METHODS

LARGE WATERBIRD GROUND-SEARCHES

PAD SEARCH AREAS

Four ground-search areas were centered on each of 4 proposed pad sites: CD-3 (CD North), CD-5 (Alpine West), CD-6 (Lookout), and CD-7 (Spark). The CD-4 pad site (the CD South search area of previous reports) was not searched in 2003, based on prior discussions with the USFWS. To reduce disturbance of nesting birds, the study plan developed with USFWS consultation included the option of searching the CD-4 area only if Spectacled Eiders or Steller's Eiders were observed there during pre-nesting aerial surveys. The previous 3 years of data on nesting birds in the CD South search area were judged adequate for the purposes of evaluating the site-specific impacts of the proposed road and pad, in the event that eiders were not observed during pre-nesting and ground surveys were cancelled.

The CD North search area, located within the larger CD North study area on the Colville Delta, encompassed 17.9 km² (similar to the 2001 and 2002 search areas) (Figure 4). The search area boundaries were selected to encompass conservatively the area of potential disturbance by aircraft landings and takeoffs (approximately 1.9 km from the proposed airstrip location) and were

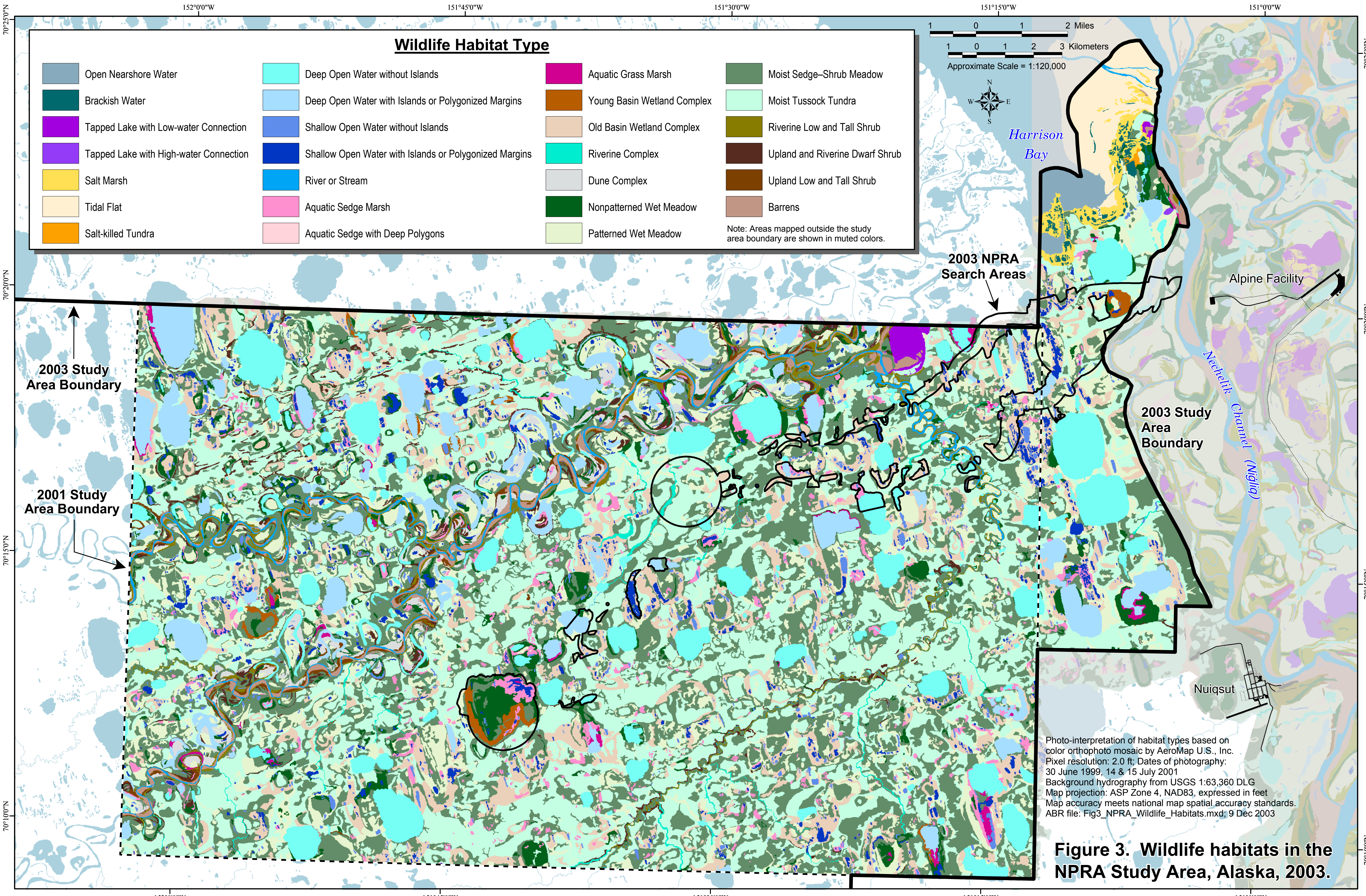

Figure 3. Wildlife habitats in the NPRA Study Area, Alaska, 2003.

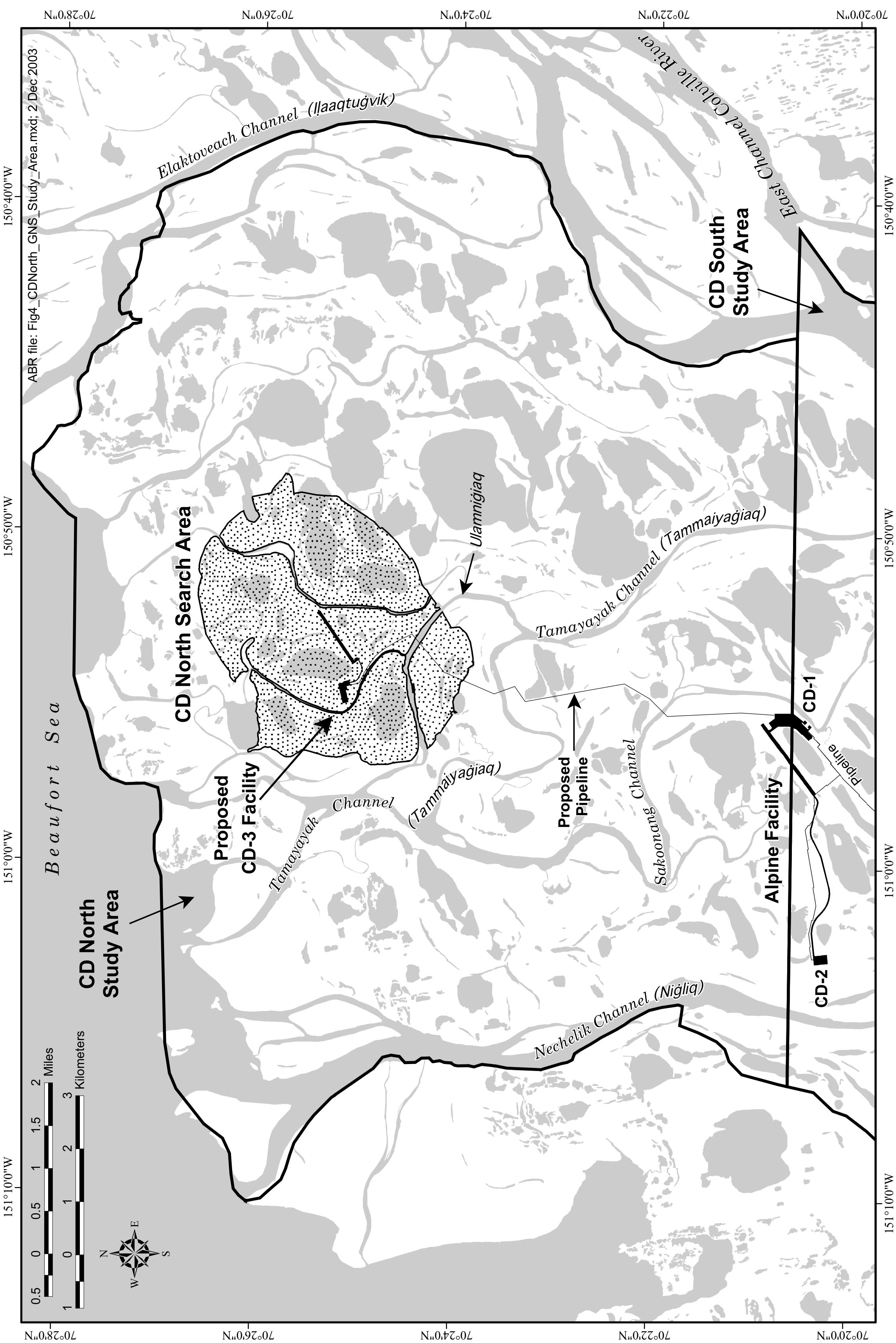

Figure 4. Ground-search area for large waterbird nests and broods in the CD North study area, Colville River Delta, Alaska, 2003.

based on noise contours originally estimated for the Alpine Development landing strip (see Johnson et al. 2003a). The Alpine West, Lookout, and Spark search areas were located in the NPRA study area (Figure 5) and each comprised a circular area of 1 km radius (4.5 km^2 minimum). The Spark search area was located in a basin wetland and the boundaries of that area were expanded to include the entire basin (5.9 km^2). Each of these sites also was searched in 2002 and the 2003 search areas overlap the 2002 search areas, but the boundaries shifted somewhat as the locations of potential development were refined (by CPAI).

Ground-based nest and brood searches were conducted to determine the diversity and abundance of large waterbirds and to estimate nesting success of waterfowl. These searches employed the same techniques used in the CD North and CD South search areas in 2000–2002 (Burgess et al. 2000, 2002a, 2003a; Johnson et al. 2000a, 2002, 2003b) and the NPRA search areas in 2001–2002 (Burgess et al. 2002b, 2003b). These techniques were originally developed in the Colville wildlife studies in 1996–1998 and used in the Alpine project area in 1999–2001 (Johnson et al. 1997, 1998, 1999a, 1999b, 2000b, 2001, 2003a).

Nest searches were conducted between 12 and 28 June (Table 1) by 6–10 observers walking a regular search pattern throughout each search area with ~10-m spacing between adjacent observers. Each team member thoroughly searched all dry ground (non-aquatic) between themselves and adjacent observers for nests of all large birds, including ducks, geese, swans, ptarmigan, loons, jaegers, gulls, terns, and raptors. Nests of larger shorebirds, such as Whimbrel, Bar-tailed Godwits, and Wilson's Snipe were recorded incidentally, although it should be noted that the survey method was not comprehensive for these species. The following data were recorded for each nest found: species, distance to nearest waterbody, waterbody class, habitat type, and, if the bird flushed, the number of eggs in the nest. Observers attempted not to flush birds from nests but, when a bird was flushed, the observer counted the eggs, collected a small sample of down (including contour feathers, if present), and covered the eggs with down and vegetation (except for loon, gull, and shorebird eggs, which were left uncovered) before leaving the site. When necessary (for example, when nests were unattended by an adult bird at discovery), down and contour feather samples were used to identify nests to species (by comparison with feathers from known nests), generally by down color and by classification of color patterns on contour feathers (Anderson and Cooper 1994). In the field, all nest locations were plotted on color photomosaics (~1:14,000–1:18,000 scale) and recorded as waypoints on handheld global positioning systems (GPS).

Brood surveys, additional nest searches for loons, and nest checks (to determine fate) for other species were conducted between 15 and 20 July (Table 1). All shorelines, lakes, and islands were searched for nests of loons and for the presence of broods of other species. Loon nests were recorded as described above, and each brood observed was plotted on color photomosaics (as for other nests, above) and the numbers of adults and young were recorded. In addition, each nest site known from the June search was revisited and these nest bowls were examined for evidence of nest fate. Waterfowl and ptarmigan nests were classified as successful if thickened egg membranes were found that had detached from the eggshells. For these species, if no membranes were found, the nest was classified as failed. For all nests, evidence of predation, such as crushed egg remnants, was recorded. Because nearly all waterfowl and ptarmigan nests could be classified as successful or failed, estimates of nesting success were calculated for these species. Other bird species typically remove egg shells from their nests after hatching, so nests of other species were classified as successful or failed only if additional evidence was available, such as observations of young at the nest, direct observations of a predation event, or other clear evidence of predation. For these species, unbiased estimates of nesting success were not possible.

The ground-search areas were revisited again between 19 and 21 August and all waterbodies greater than about 25 m long were searched for loon broods. Loon nests were classified as successful if a brood was observed on the nesting lake (or an adjacent lake associated with the nest site). Data collected were similar to the July survey. Broods of other species also were recorded during the August search and, for each species

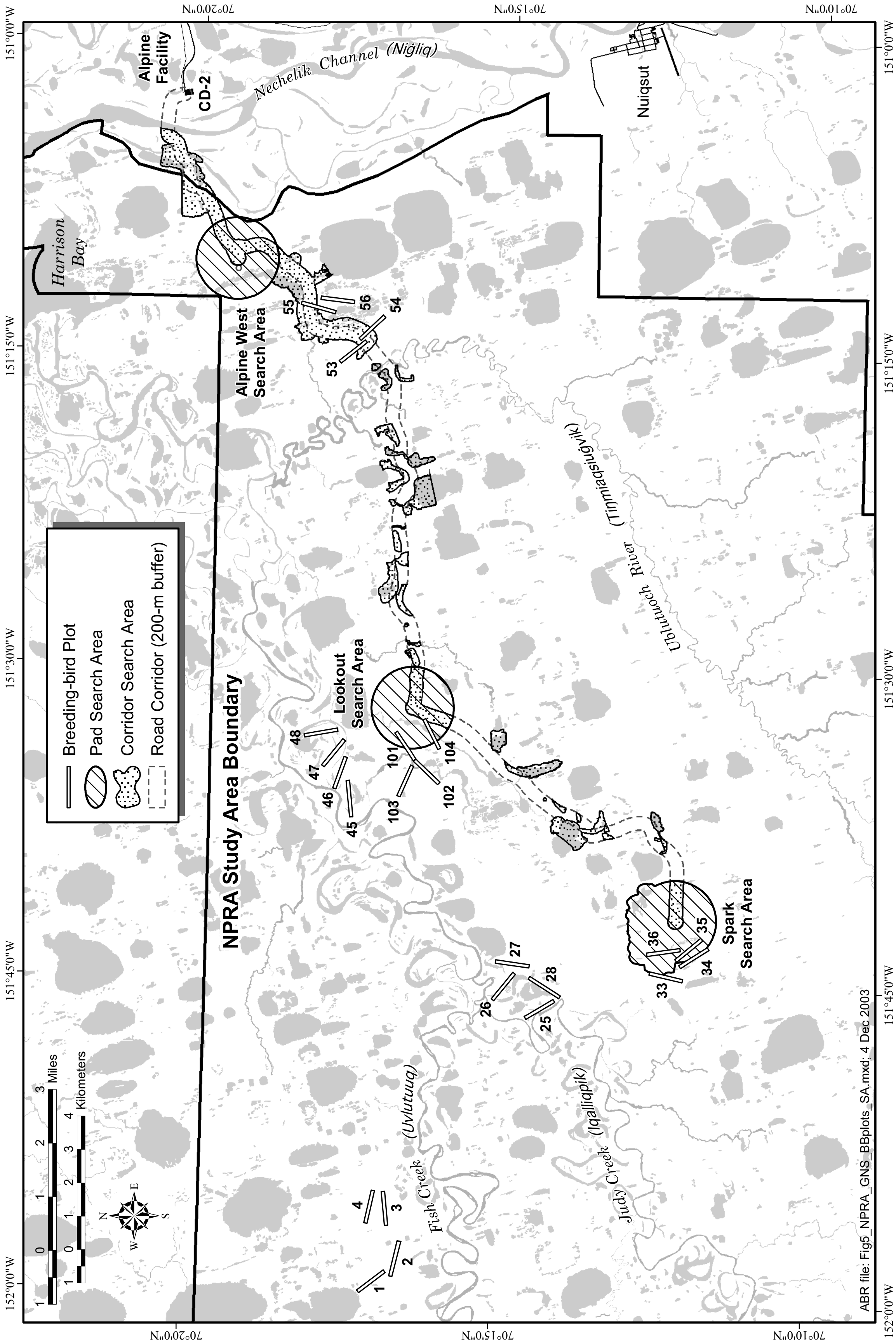

Figure 5. Ground-search areas for large waterbird nests and broods and breeding-bird plots in the NPRA study area, Alaska, 2003.

observed, the higher count of either the July or August survey (and the habitats associated with that higher count) are reported in text and tables.

Despite the intensive nature of the search effort, additional nests of Tundra Swans and loons occasionally were found in the ground-search areas during aerial surveys. These birds typically flush at great distances and can be missed by ground observers. For comprehensive treatment, we have included all known nests (from either aerial or ground searches) in summaries for the search areas.

NPRA ROAD CORRIDOR SEARCHES

Ground searches also were conducted in the proposed NPRA road corridor. Methods were similar to the pad search areas, except that we focused mainly on aquatic and wet habitats, yielding many disjunct, small search areas (Figure 5). Per discussions with the USFWS, these habitats were prioritized (and broad areas of Moist Tussock Tundra were excluded) to focus effort on habitats preferred by focal species because the entire corridor was too extensive for a complete ground search. Searches were conducted within 200 m of the proposed road centerline (the 200-m buffer) but were extended 400–1,250 m where the road intersected larger wetland basins (the extended buffer, comprising all areas searched beyond the 200-m buffer). Data are reported separately for each of the 2 buffers. Prior to conducting nest searches, wet and aquatic search areas were identified with the wildlife habitat map (Jorgenson et al. 2003). In aquatic habitats, the searches included islands and a 25-m strip along shorelines of all large waterbodies within the 200-m buffer. The road corridor search areas overlap the pad search areas wherever the proposed road crosses or approaches a proposed pad. These overlap areas were searched only once for nests or broods, but observations of nests or broods in these overlap areas were assigned to both the pad search area and the corridor search areas in separate summaries of numbers, densities, and habitat use. Because specific high-value habitats were selected for the corridor searches, calculated densities in the corridor are not strictly comparable to those computed for the pad search areas.

Ground searches also were conducted in a northern road corridor alternative (Appendix C1). This corridor subsequently was abandoned, so data on nest densities and broods are presented in appendices only (Appendix C1-C5). However, nesting success and habitat use are reported for all NPRA search areas combined, which includes the pad search areas and both road corridors (200-m and extended buffers).

NPRA BREEDING-BIRD PLOTS

In 2003, 24 breeding-bird plots (arranged in 6 clusters of 4 plots each) were sampled in the NPRA study area to determine nest densities, nesting success, and habitat associations of tundra-nesting birds (Figure 5). Each cluster of plots was located to sample representative habitats in each of 3 general areas: the Fish and Judy creek floodplain, north of Fish Creek, and south of Judy Creek. The plot clusters sampled in 2003 (1–4, 25–28, 33–36, 45–48, 53–56, and 101–104) were also sampled in 2002. All but one of these plot clusters (plots 101–104) also was sampled in 2001. Plots 65–68 (see Burgess et al. 2002b) were sampled only in 2001, and were replaced by plots 101–104 in 2002. Three plot clusters, 33–36, 53–56, and 101–104, occur near proposed areas of development, namely, Spark, Alpine West, and Lookout, respectively. The distribution of plots allows for future comparisons between plot clusters near development areas with those at greater distances from development areas.

Breeding-bird plots measured 100 m × 1,000 m (0.1 km² [10 ha]) and were marked with 1 row of survey lath that delineated 50 m × 50 m grids (40 grids/plot) (Figure 6). Each grid was subdivided into 4 quadrants. Plots were visited up to 13 times in 2003, with 3–6 days (mean = 3.9 days, SD = 1.2) between visits. The first visit to remark and set-up the plots occurred 6–8 June. During the next 4 visits on 9–29 June, plots were searched for new nests and known nests were checked for fate. During the remaining 6–8 visits from 29 June–20 July, known nests were monitored for fate. On the first and third nest-search visits, 2 people dragged a 50-m rope through each plot to flush birds from their nests. During the second and fourth nest-search visits, 1 person walked a "W" pattern through each grid. With either method, if a bird flushed and the nest was not immediately located, the observer moved farther away or used nearby

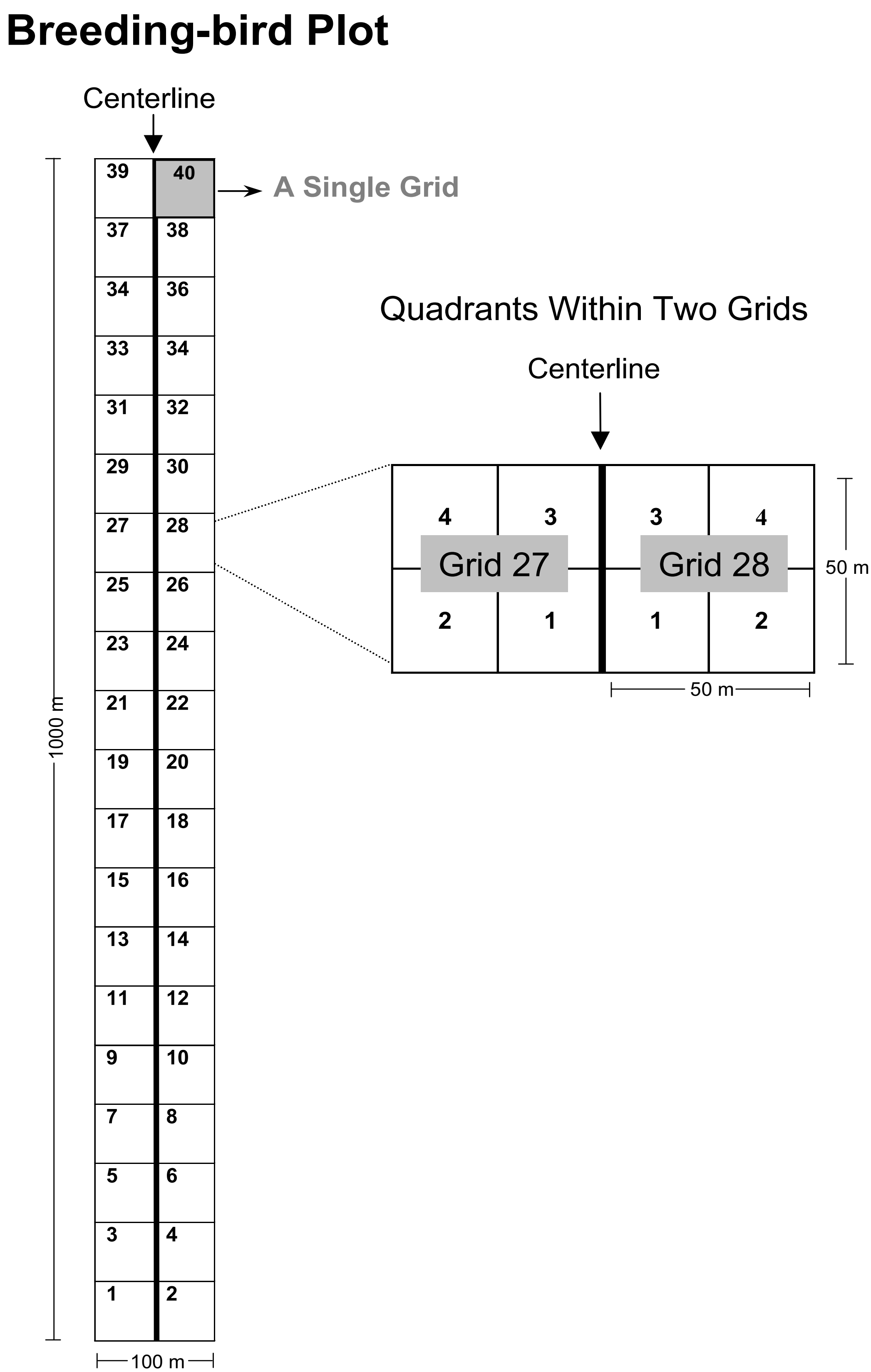

Figure 6. Typical breeding-bird plot grid system used in the NPRA study area, Alaska.

terrain features as cover until the bird returned and the nest could be located. During nest-monitoring visits, the plot was not searched systematically for new nests, but new nests were marked if encountered. Known nests were checked during both nest-search and nest-monitoring visits to collect data on hatching and fledging success. The number and density of nests found during plot set-up and nest-searching visits were summarized by species and plot, species and plot cluster, and species group and plot cluster. Nests found during nest-monitoring visits were reported but not included in these summaries.

To assist in locating known nests, an orange wooden stake (~2.5 × 15 cm) was placed in the ground on the plot centerline perpendicular to the nest and a small wooden marker (~1 × 10 cm) was placed 1–3 m from the nest toward the plot centerline. Each centerline marker was labeled with the perpendicular distance to the nest location. Markers near nests were placed low in vegetation so that they were visible when walking from the centerline, but concealed from other directions.

For each nest found, the observer recorded the species, the number of birds present, the status of the nest (active, inactive, unknown), the flushing distance of the incubating adult, the number of eggs or young, the estimated age of the young, and the nest location by grid number, distance from centerline, and quadrant within the grid (Figure 6). For nests found close to plot boundaries, a meter tape was used to determine whether they were on or off plot. To estimate the age of nests of shorebirds, waterfowl, loons, terns, and ptarmigan, 4 eggs from each nest (or all eggs if <4 in nest) were floated in water in a plastic container. Measurements were collected on the position of the egg in the water column (i.e., on the bottom, neutrally buoyant, on the surface), the angle between the center axis of the egg and the water surface, and, if the egg was breaking the surface, the percent volume (nearest 5%) of the egg above the surface. Eggs that were cracked, starred, or pipped were noted and not floated. Eggs of shorebirds and ptarmigan were floated during each visit to a plot. If waterfowl, loons, and terns were incubating when a plot was visited, observers attempted not to flush them off their nests, but if they did flush, their eggs also were floated. Waterfowl nests were covered with down and vegetation before leaving the site.

When a nest was inactive, data were collected to help determine the fate of the nest, including the presence or absence of egg membranes, broken eggs, eggshell pipping fragments (1–5 mm), eggshell pieces (>5 mm), and eggshell tops or bottoms. If adult behavior suggested the presence of a brood or if a brood was observed, distance to nest was recorded. Any evidence of predation (fox smell, fox scat, or a disturbed nest site) was noted. Habitat information was recorded at each nest, including the landform at the nest site, the terrestrial habitat within a 5-m radius of the nest and within the nest quadrant (25 m × 25 m), and the estimated percent of the nest (nearest 10%) obscured by vegetation. Summaries of habitat use by nesting birds on breeding-bird plots are not presented in this report. The location of the nest was recorded using a GPS receiver.

For shorebirds, a nest was classified as successful when at least 1 chick was observed in or near a nest scrape, when an eggshell top or bottom indicative of a hatched egg was found (Mabee 1997), or when 2 lines of supportive evidence were confirmed (e.g., eggshell fragments consistent with pipped eggs and egg flotation data indicating a nest could have hatched). Successful nests of shorebird species generally contain eggshell fragments 1–5 mm in length (Mabee 1997). The presence or absence of eggshell fragments was tallied for shorebird nests with chicks to confirm this. Nest age could be determined for nests found during laying, for nests with starred or pipped eggs, and for nests with chicks by backdating from the estimated hatch date or chick age. Incubation periods were from Poole et al. 2003, with modifications from our data. The egg floatation data for these nests was plotted and used to age the other nests. A shorebird nest was classified as failed when a clutch of eggs disappeared too early in incubation to have hatched (i.e., eggs at least 4 d younger than the mean incubation period for each species, as indicated by nest records or flotation data), the nest area contained indications of predation (e.g., broken eggs), or the clutch was abandoned. A nest was classified as having an unknown fate when neither success nor failure (listed above) could be confirmed.

Passerine nest age could be determined for nests found during laying and for nests with nestlings. A nest was considered successful for fledging young if the age of the nestlings at the midpoint between the last date active and the first date inactive was greater or equal to the age reported for the day of fledging (fledging periods were from Poole et al. 2003). A nest was considered failed if the midpoint age of the nestlings was less than the age reported for fledging or if the nest never had nestlings. Waterfowl and ptarmigan nests were classified as successful for hatching if thickened egg membranes were found that had detached from the eggshells. For these 2 species, if no membranes were found the nest was classified as failed.

Mean daily survival rates (DSR) were calculated for species groups (i.e., shorebirds, passerines, and waterfowl) and for individual species in each plot cluster (groups of 4 plots in a similar geographic location) and over all plots combined. DSRs were calculated using program, MARK (White and Burnham 1999). The nest survival model in MARK has its roots in the Mayfield method, so our results with MARK should be comparable to a Mayfield analysis (Mayfield 1961, 1975), in which the necessary assumptions for that method are met.

During all visits to breeding-bird plots, all observations of avian and mammalian predators occurring on plot (flying over or on the ground) were recorded during the entire time observers were on plot. During some visits, timed observation counts of predators also were made. Timed counts of 10 minutes length were conducted on each plot 3 times during the plot-marking visit, 1 time during the final nest searching visit, and 2 times during the nest monitoring visits. The timed count was conducted at the center of the plot, except during the plot-marking visit, when 3 10-min counts were conducted at centerline stakes at least 200 m apart. During each count, binoculars were used to scan for predators. Observers recorded predator species and behavior. Observations were converted to number of predators per hour for comparison of means.

EIDER AERIAL SURVEYS

To evaluate regional abundance and distribution of eiders, aerial surveys were flown during the pre-nesting period (Table 1), while male eiders (the more visible of the 2 sexes in breeding plumage) were still on the breeding grounds. The pre-nesting survey in 2003 (Figure 7) covered the same area as in 2002 and was conducted on 12–15 June using the same methods that were used in previous years on the Colville Delta (1993–1998 and 2000–2002) and in the NPRA study area (1999–2003), although the survey areas and survey coverage differed among years (see Anderson and Johnson 1999, Murphy and Stickney 2000, Johnson and Stickney 2001, Burgess et al. 2003b, and Johnson et al. 2003b). Flight altitude was 30–35 m above ground level (agl) and flight speed was approximately 145 km/h. A GPS was used to navigate pre-determined east–west transect lines that were spaced 400 m apart on the Colville Delta and 800 m apart in the NPRA study area. An observer on each side of the airplane (in addition to the pilot) counted eiders in a 200-m-wide transect (delimited by tape on windows and wing struts, as per Pennycuick and Western 1972), thereby covering 100% of the Colville Delta survey area and 50% of the NPRA study area. Three areas were not surveyed on the Colville Delta: the tidal flats and marine waters on the outermost delta were not included because eiders rarely use those habitats, a 2.4-km radius circle around the Helmericks' home site was avoided to reduce disturbance to its residents, and similarly, the extreme southern delta was avoided to limit disturbance to Nuiqsut residents (Figure 7). Eider locations were recorded on color photomosaic maps (~1:63,360-scale) and audio tapes were used to record transect number, species, numbers of individuals of each sex and number of identifiable pairs, and activity (flying or on the ground).

We calculated the observed number of birds, the observed number of pairs, the "indicated" number of birds, and densities (number/km²) for each study area. Following the USFWS (1987a) protocol, the total indicated number of birds was twice the number of males not in groups (defined as >3 birds of mixed sex that cannot be separated into singles or pairs) plus the number of birds in groups.

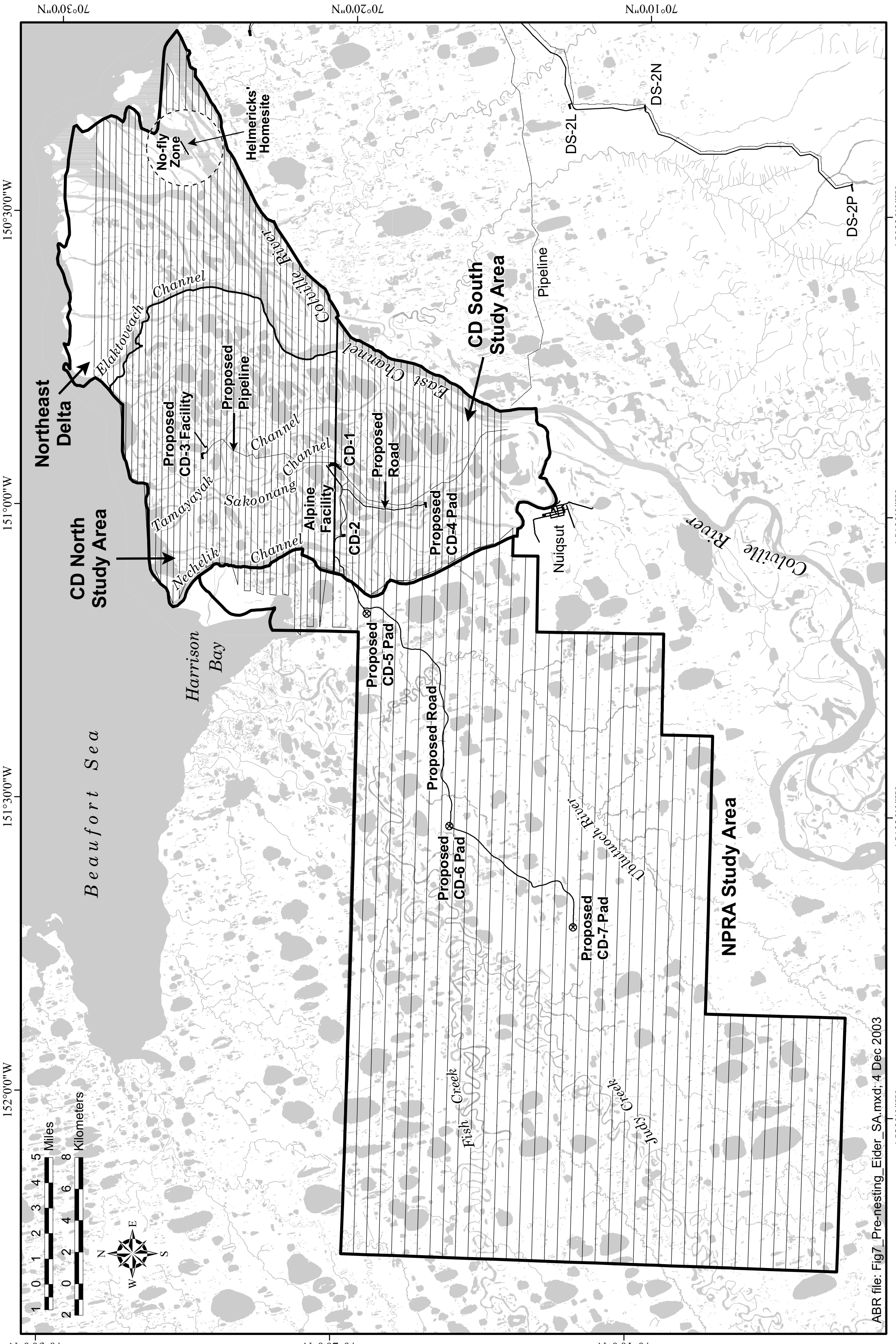

Figure 7. Transect lines and survey areas for pre-nesting eider aerial surveys, CD North, CD South, and NPRA study areas, Alaska, 2003.

LONG-TAILED DUCK AERIAL SURVEYS

A pre-nesting survey for Long-tailed Ducks was conducted on 17–18 June 2003. The survey was conducted by 1 observer in a helicopter flying at 40–50 m agl in a lake-to-lake pattern and circling as necessary to obtain counts. All aquatic habitats (lakes, wetlands, and streams) were surveyed within a 1-mile buffer around the proposed road corridor, inclusive of the proposed pad sites, and around the subsequently abandoned northern road corridor (Figure 8). The number of individuals of each sex was recorded for each group of Long-tailed Ducks observed and locations were plotted on color photomosaics (~1:30,000 scale). Densities were calculated by dividing the number of birds observed by the total area within the buffer. The total indicated birds was calculated by the procedures of the USFWS survey protocol (described above for eiders, USFWS 1987a).

LOON AERIAL SURVEYS

Aerial surveys for nesting Yellow-billed Loons were conducted on 26 and 29–30 June 2003 and for brood-rearing loons on 19–21 August 2003 in the CD North, CD South, and NPRA study areas (Figure 9, Table 1). The nesting survey was conducted in a helicopter flying at ~60 m agl in a lake-to-lake pattern covering most lakes ≥10 ha in size and immediately adjacent aquatic habitats, comprising the typical breeding habitats for nesting Yellow-billed Loons (Sjolander and Agren 1976, North and Ryan 1989). Tapped Lakes with Low-water Connections (lakes whose levels fluctuate with the river) were excluded because Yellow-billed Loons do not use such lakes for nesting (North 1986, Johnson et al. 2003b). During the brood-rearing survey, only lakes where Yellow-billed Loons were observed during the nesting survey were surveyed. Observations of Pacific and Red-throated loons were recorded incidentally. All locations of loons and their nests were recorded on color photomosaics (~1:30,000 scale).

The total number of adults, nests, broods, and young counted on aerial surveys were summarized by season for each species of loon in the CD North, CD South, and NPRA study areas. Density of adults, nests, and broods was calculated only for Yellow-billed Loons because the smaller lakes that typically are used by Pacific and Red-throated loons were not included in the survey.

TUNDRA SWAN AERIAL SURVEYS

In 2003, aerial surveys for nesting and brood-rearing Tundra Swans were flown during 21–24 June and 21–25 August, respectively (Table 1). Aerial surveys covered the entire Colville Delta, including the CD North and CD South study areas, and the NPRA study area (Figure 10). Surveys were conducted in accordance with USFWS protocols (USFWS 1987b, 1991) and the same methods were used for nesting and brood-rearing surveys on the Colville Delta in 1993, 1995–1998, and 2000–2002 (Smith et al. 1994, Johnson et al. 2003b) and in the NPRA in 1999–2002 (Anderson and Johnson 1999, Murphy and Stickney 2000, Johnson and Stickney 2001, Burgess et al. 2003b, Johnson et al. 2003b). East-west transects spaced 1.6 km apart were flown in a fixed-wing airplane that was navigated with the aid of a GPS receiver. Flight speed was 145 km/h and altitude was 150 m agl. Two observers each searched 800-m-wide transects on opposite sides of the airplane while the pilot navigated and scanned for swans ahead of the airplane, providing 100% coverage of the surveyed area. Locations and counts of swans and their nests were recorded on color photomosaics (1:63,360-scale). Each nest on the Colville Delta was photographed with a 35-mm camera for site verification.

Numbers of swans, nests, and broods were summarized and densities calculated for each season for each study area. Nesting success was estimated from the ratio of broods to nests counted during aerial surveys only. The accuracy of these estimates can be affected by several factors. First, swan broods are more likely to be detected than swan nests during aerial surveys (see Stickney et al. 1992), thus inflating the estimated nesting success. Second, some broods probably are lost to predation between hatching and the aerial survey, thus deflating estimated nesting success. In addition, swan broods are mobile and can move into or out of a survey area prior to the survey, thus biasing the estimated nesting success in either direction. Immigration and emigration of broods are less of a problem, however, for estimating

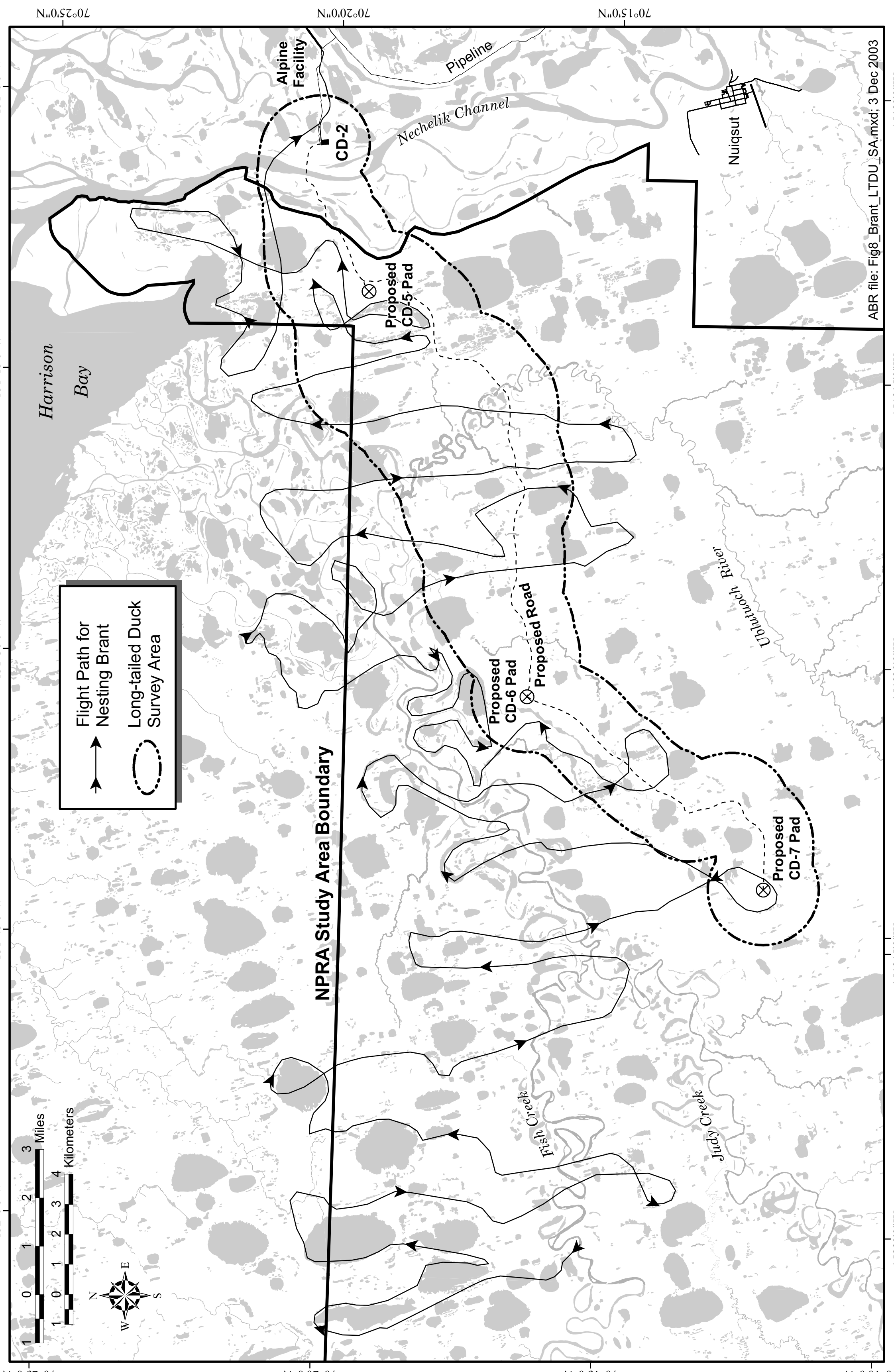

Figure 8. Flight path of the aerial survey for nesting Brant and survey area for Long-tailed Ducks, NPRA study area, Alaska, 2003.

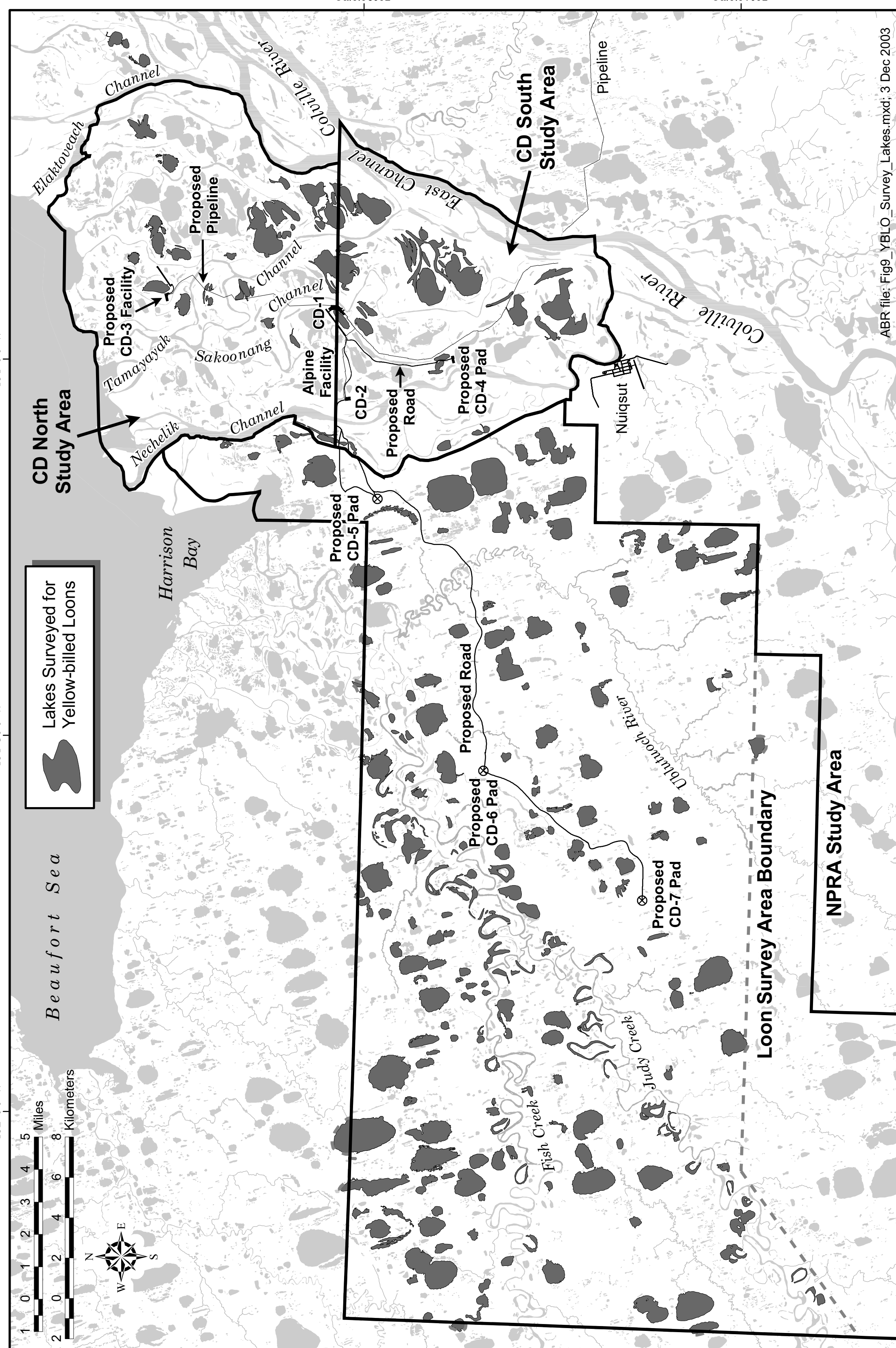

Figure 9. Lakes included in aerial surveys for nesting Yellow-billed Loons, CD North, CD South, and NPRA study areas, Alaska, 2003.

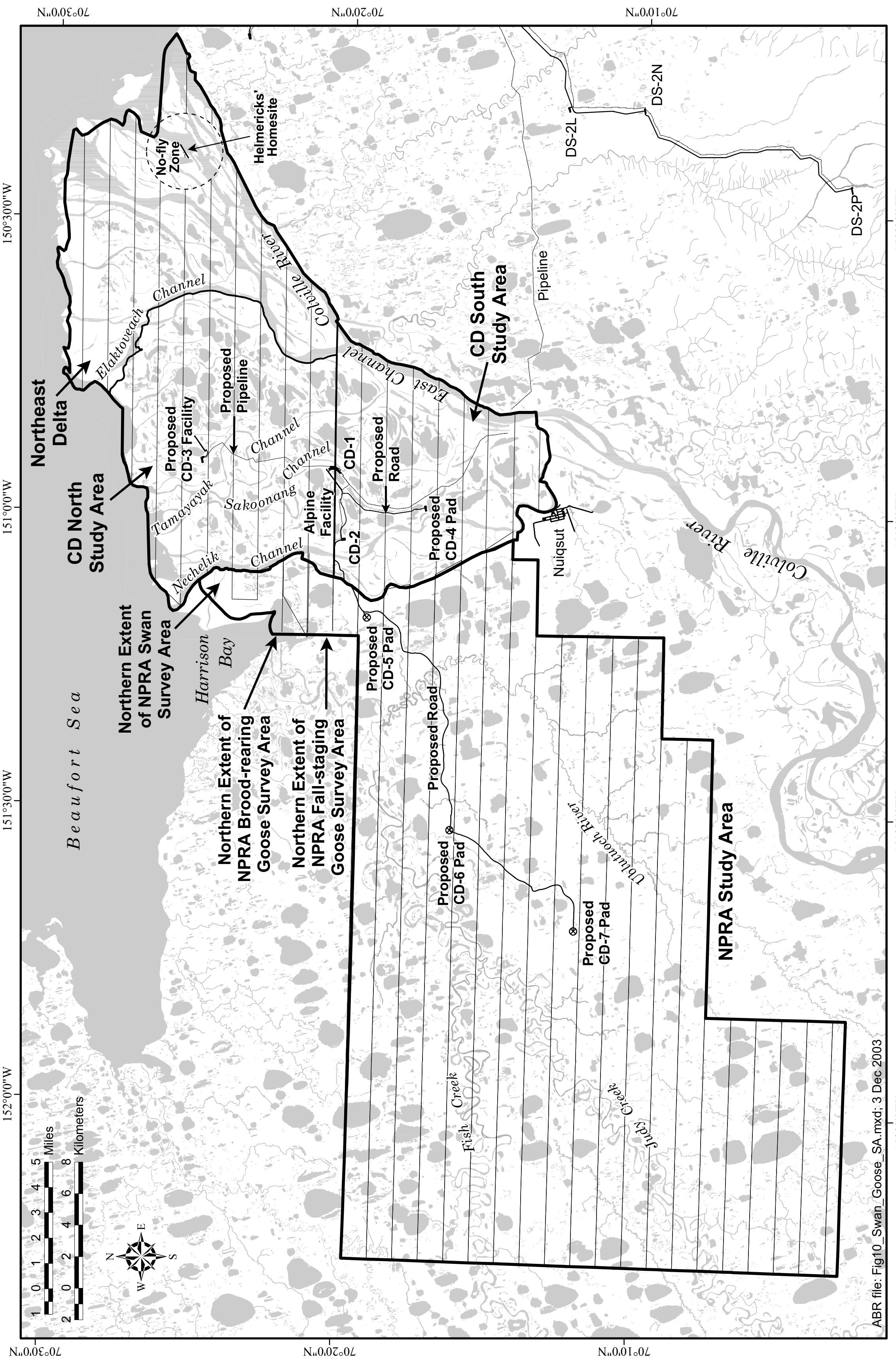

Figure 10. Transect lines and survey areas for aerial surveys of nesting and brood-rearing swans and for brood-rearing and fall-staging geese, CD North, CD South, and NPRA study areas, Alaska, 2003.

nesting success in large, well-defined areas, such as the Colville Delta. Nonetheless, nesting success estimates based on aerial-survey data should be considered relative indices.

GOOSE AERIAL SURVEYS

In 2003, 3 aerial surveys were flown for geese in the NPRA study area (goose surveys were not flown on the Colville Delta in 2003): nesting Brant (18–19 June), brood-rearing geese (all species, 31 July), and fall staging (all species, 25 August; Table 1). The aerial survey methods for nesting Brant were similar to those used from the Sagavanirktok River to the Colville River between 1989 and 1998 (Ritchie et al. 1990, Anderson et al. 1999), except that the survey platform was not a fixed-wing airplane. Using a Bell 206L helicopter and 1 observer, the nesting survey was flown along a predetermined lake-to-lake path that included lakes with islands, basin wetland complexes, and sites where Brant had been observed in previous years (Figure 8). The Brant survey pattern was non-systematic, so the surveyed area in 2003 differed slightly from that in previous years (2001–2002), although efforts were concentrated in the same general area, largely in the northern half of the NPRA study area. Flight altitude was 60 m agl and flight speed was approximately 95 km/h, although speeds were decreased to 70 km/h over lakes. Brant and nests (down-filled bowls or adults in incubation posture) were recorded on color photomosaics (1:63,360-scale) or on color enlargements for specific wetlands. The resulting counts of Brant and their nests should be considered minimums because incubating Brant are inconspicuous, unattended nests are difficult to see, and the number of passes flown over a nesting location was limited purposely to minimize disturbance. All observations of birds on the ground were recorded, because these may represent nesting locations. However, only confirmed nests were included in summaries. Nests of other species, such as Canada Geese, were recorded incidentally during the survey.

Systematic aerial surveys were conducted for all species of geese during the brood-rearing and fall-staging seasons. These surveys were flown in a Cessna 185 aircraft at 90 m agl and approximately 145 km/h on east-west flight lines that were 1.6 km apart, the same transects flown for the Tundra Swan surveys (Figure 10). The survey area for the brood-rearing survey was slightly larger than that for staging (Figure 10). Two observers searched 400-m-wide strips, 1 on each side of the plane, yielding 50% coverage of the survey area. The numbers of adults and young and their locations were recorded on color photomosaics (1:63,360-scale).

GULL AERIAL SURVEYS

Glaucous Gulls nests were recorded on the Colville Delta and in the NPRA study area during the pre-nesting aerial survey for eiders and during nesting aerial surveys for Yellow-billed Loons and Tundra Swans (see individual species sections for survey methods). Additionally, Glaucous Gull nests were recorded in the NPRA study area during the pre-nesting aerial survey for Long-tailed Ducks and the nesting aerial survey for Brant. Glaucous Gull broods were recorded opportunistically during brood-rearing surveys for Yellow-billed Loons. Colonies of Sabine's Gulls also were recorded during the nesting survey for Yellow-billed Loons, and the number of nests at each colony was estimated based on the number of adults observed (Sabine's Gull nests are difficult to confirm in aerial surveys). All nest and brood observations were recorded on color photomosaics (1:30,000 scale).

Additional information on the abundance of gulls was obtained from results of the various ground-searches. Nest locations of Glaucous and Sabine's gulls were marked on photomosaics and the coordinates stored in a GPS receiver during ground searches in large waterbird ground-search areas (see ground search methods, above). The number and density of nests was calculated for Glaucous Gulls in the CD North, CD South, and NPRA study areas.

CARIBOU SURVEYS

Four aerial surveys of the Colville Delta were conducted between 28 June and 16 September (Table 2); additional surveys were attempted in late summer and fall but were canceled due to inclement weather. The Colville Delta surveys followed 10 transect lines (Figure 11), constituting the same area surveyed in 2002 by Lawhead and

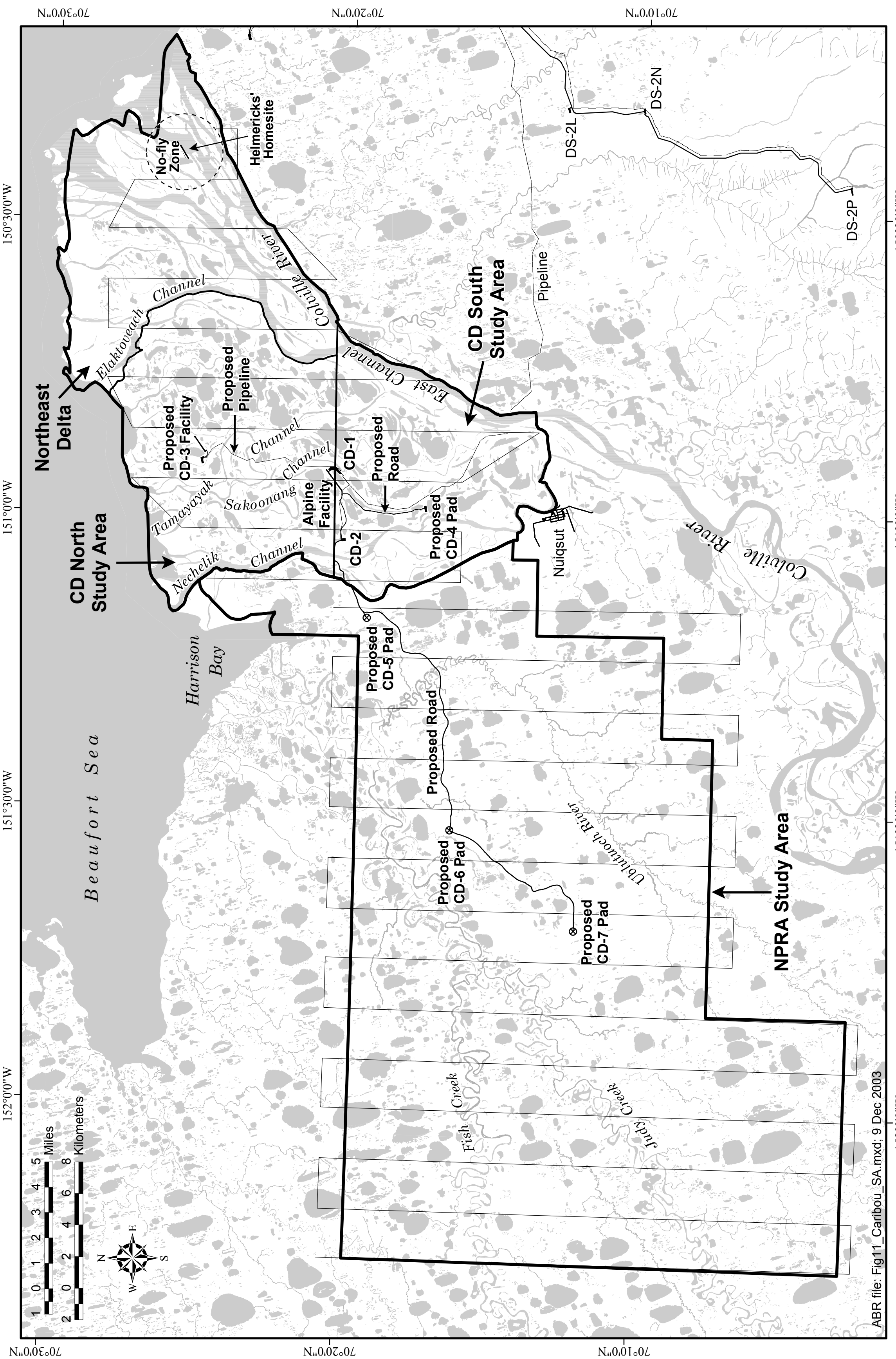

Figure 11. Transect lines and survey areas for caribou aerial surveys in the Colville River Delta and in the NPRA study area, Alaska, 2003.

Prichard (2003a) and encompassing a 492-km² survey area.

Thirteen aerial surveys were conducted in NPRA in 2003, beginning on 24 April and ending on 28 October (Table 2). The NPRA caribou survey area in 2002 and 2003 was larger than the NPRA study area and encompassed all of that area except for the northernmost extension along the Nechelik Channel of the Colville River, which was covered as part of the adjacent Colville Delta caribou survey area (Figure 11). NPRA surveys followed 14 north–south-oriented transect lines and encompassed 1,310 km². The area surveyed in 2002 and 2003 was larger than was surveyed in 2001 (Burgess et al. 2002).

Caribou surveys of the NPRA and Colville Delta areas were conducted by 2 observers on opposite sides of a Cessna 206 airplane. A third observer recorded data. The pilot navigated the transect lines using a GPS receiver and maintained an altitude of ~150 m agl using a radar altimeter.

Transect lines were spaced at intervals of 3.2 km following section lines on USGS topographic maps (scale 1:63,360). Observers counted caribou within an 800-m-wide strip on each side of the transect centerline, thus sampling 50% of the survey area. Therefore, the number of caribou observed was doubled to obtain the total estimated number of caribou in the survey area. The strip width was delimited visually using tape markers on the struts and windows of the aircraft, as recommended by Pennycuick and Western (1972).

When caribou were observed within the transect strip, the perpendicular location on the transect centerline was recorded using a GPS receiver, the number of adults (including yearlings) and calves were recorded, and the perpendicular distance from the transect centerline was estimated in 200-m intervals. For plotting on maps, the midpoint of the distance interval was used (e.g., 300 m for the 200–400-m interval). Thus, the maximal mapping error was estimated to be ~100 m.

FOX SURVEYS

Aerial and ground-based surveys were used to evaluate the distribution and status of arctic and red fox dens on the Colville Delta and in the NPRA study area from mid-June through mid-July 2003, using the same methods as used in previous years on Colville Delta (Johnson et al. 2003a, Burgess et al. 2003b). A helicopter was used to search for dens and aerial observations were supplemented with reports of dens from avian nest searches conducted in June. Most of the study area was searched by helicopter in 2001, except for the northernmost portion and the riverine dunes and banks of Fish and Judy creeks. Additional search effort was expended in the latter areas in July 2002 and 2003. Continuing survey effort will be required to search those drainages fully, however, due to the abundance of ground squirrel burrows, which are difficult to distinguish from fox dens during aerial surveys. Soil disturbance caused by foxes digging at den sites, together with fertilization resulting from feces and food remains, results in a characteristic, lush flora that makes perennially used sites easily visible from the air after “green-up” of vegetation (Chesemore 1969, Garrott et al. 1983). Green-up occurs earlier on traditionally used den sites than on surrounding tundra, a difference that is helpful in locating dens as early as the third week of June.

Surveys and ground visits in 2003 to evaluate den status were conducted on 27 June on the Colville Delta and 30 June–1 July and 9 July in the NPRA study area (Table 2). Active dens were observed during 8–11 July to count pups. During ground visits, evidence of use by foxes was evaluated and the species using the den was confirmed. Following Garrott (1980), we examined the following fox sign to assess den status: presence or absence of adult and pup foxes; trampled vegetation in play areas and beds; presence and appearance of droppings, diggings, and tracks; prey remains; shed fur; and signs of predation (e.g., pup remains). Dens were classified into 4 categories (derived from Burgess et al. 1993), the first 3 of which we consider to be “occupied” dens:

- natal—dens at which young were whelped, characterized by abundant adult and pup sign early in the current season;
- secondary—dens not used for whelping, but used by litters moved from natal dens later in the season (judged from sequential visits or from amount and age of pup sign);

- active—dens showing evidence of consistent use and suspected to be natal or secondary dens, but at which pups were not seen during our visits; or
- inactive—dens with either no indication of use in the current season or those showing evidence of limited use for resting or loafing by adults, but not inhabited by pups.

Because foxes commonly move pups from natal dens to secondary dens, repeated observations during the denning season are needed to classify den status with confidence. Our efforts focused on assessing den occupancy and on counting pups at occupied sites. Based on the assessment of den activity on initial visits, dens judged to be occupied were observed ~2 weeks later to count pups. Observers were dropped off by helicopter at suitable vantage points several hundred meters from den sites, from which they conducted observations with binoculars or spotting scopes over periods of 2.5–4 h. Observations usually were conducted early and late in the day, when foxes tend to be more active.

HABITAT USE AND SELECTION ANALYSES

As described above, wildlife location data from the ground and aerial surveys were plotted on the maps of wildlife habitats (Figures 2 and 3) using GIS coordinates, recorded either from GPS readings taken in the field, or by plotting locations on georeferenced maps or photomosaics and subsequently deriving coordinates. By this method, a wildlife habitat was assigned to each observation (nests on breeding-bird plots were an exception, as no habitat analysis was conducted on those nests, see below). For each species, habitat use (% of observations in each identified habitat type) was determined separately for various seasons (e.g., pre-nesting, nesting, and brood-rearing), as appropriate. For each species/season, we calculated 1) the number of adults, flocks, nests, young, broods, or dens in each habitat, 2) the percent of total observations in each habitat (habitat use), and 3) the percent availability of each habitat in the search or survey area. Habitat use was calculated from group locations for species or seasons when birds were in flocks or broods, because we could not reasonably assume independence of selection among individuals in these groups (i.e., a few large groups could bias results).

For a subset of species/surveys, a statistical evaluation of habitat selection was used to evaluate whether habitats were used in proportion to their availability. (Note that habitat availability often differed among species, because survey areas often differed, as described below). When multiple years of survey data were available, all comparable data were used in statistical evaluation of habitat selection. For this purpose, annual surveys were considered comparable only when the survey areas were similar in habitat composition, because habitat availability was calculated as an average among years (i.e., by summing annual habitat availability over years and dividing by the number of years).

Habitat selection was evaluated for the following species and seasons:

- pre-nesting Spectacled Eiders and King Eiders (aerial surveys, Colville Delta 1993–2003 and NPRA study area 2001–2003)
- nesting Spectacled Eiders, Pacific Loons, and Long-tailed Ducks (ground searches, CD North search area 2000–2003)
- nesting and brood-rearing Tundra Swans (aerial surveys, Colville Delta 1992–2003 and NPRA study area 2001–2003)
- nesting and brood-rearing Yellow-billed Loons (aerial surveys, Colville Delta 1993–2003 [nests] and 1995–2003 [broods], and NPRA study area 2001–2003)
- nesting Greater White-fronted Geese (ground searches, CD North search area 2000–2003 and NPRA pad search areas 2003)
- denning arctic and red foxes (Colville Delta 1993–2003 and NPRA study area 2001–2003, all known dens irrespective of year of discovery or species, because dens may be reused by either species in subsequent years)

For other species, the number of observations of individual species from comparable annual surveys was inadequate for statistical analysis. For analysis of habitat selection, the aerial survey observations were evaluated without the additional observations of those species from the ground searches (for example, swan nests located during ground searches but not during aerial surveys were not included in the analysis of habitat selection) to avoid any possible biases for habitats in areas that were searched with greater intensity on the ground. Selection analyses for 2 species did not use the entire set of habitats within their survey areas. In the analysis for Long-tailed Ducks, only aquatic habitats were considered available because our aerial surveys were focused there and detection of these small ducks in terrestrial habitats was unreliable. Conversely, aquatic habitats and tidal flats were considered unavailable for fox denning, because only terrestrial habitats provide sites suitable for denning.

Monte Carlo simulations (1,000 iterations) were used to calculate a frequency distribution of random habitat use, and this distribution was used to compute 95% confidence intervals (Haefner 1996, Manly 1997). Random habitat use was based on the percent availability of each habitat and the sample sizes in each simulation equaled the number of observed nests, dens, or groups of birds in that season. We defined habitat preference (i.e., use > availability) as observations of habitat use greater than the 95% confidence interval of simulated random use, which represents an alpha level of 0.05 (2-tailed test). Conversely, we defined habitat avoidance (i.e., use < availability) as observations below the 95% confidence interval of simulated random use. The simulations and calculations of confidence intervals were conducted in a Microsoft® Excel spreadsheet.

RESULTS

CONDITIONS IN THE STUDY AREA

The 2003 season was characterized by a cool spring, with lower than average temperatures in early June and a protracted breakup of the Colville River. We summarized weather records from 2 locations in the region: the Colville Village station at the Helmericks' home site, which is representative of conditions on the outer Colville Delta (including the CD North study area), and the Kuparuk Oilfield station, which is representative of conditions farther inland (probably comparable to much of the NPRA study area, although it is ~55 km east). At both the Kuparuk station and at Colville Village, snow persisted through the first week of June in 2003, about 2 weeks later than in the warm spring of 2002 (Burgess et al. 2003b, Johnson et al. 2003b). In May 2003, the mean temperature was –4.6° C at Kuparuk and –4.7° C at Colville Village, slightly warmer than the long-term May averages of –5.0° C at Kuparuk ($n = 16$) and –6.1° C at Colville Village ($n = 7$) (NOAA: http://lwf.ncdc.noaa.gov). In June 2003, the mean temperature was 3.2° C at Kuparuk and 1.6° C at Colville Village, both of which were cooler than the long-term means for June of 4.6° C and 3.2° C for Kuparuk and Colville Village, respectively.

From both the Kuparuk and Colville Village stations, cumulative thawing degree-days were computed for the periods of bird arrival (approximately 15–31 May) and nest initiation (1–15 June) for each year of record (Figure 12). (On the Celsius scale, the value of cumulative thawing-degree days [hereafter, thawing-degree days] for any particular period is the sum of mean daily temperatures for each day of that period in which the daily mean temperature was above freezing.) At Colville Village, temperatures during bird arrival in 2003 were near the mid-range of values, at 9.4 thawing degree-days (range 0–23.9) and ranked third of 7 years. Similarly, at the Kuparuk station, the bird arrival period in 2003 was only slightly cooler than the 16-year mean, ranking seventh overall. In contrast to the arrival period, the 2003 nest initiation period was among the coldest on record for both stations. At the Colville Village station, the 2003 nest initiation period was the coldest, at 8.3 thawing degree-days, compared with 13.9–52.8 among other years. At the Kuparuk station, the 2003 nest initiation period was the fourth coldest on record and was colder than any year since 1991.

The cold temperatures in early June protracted breakup of the Colville River and 2 separate peaks were recorded at the head of the delta (Michael Baker Jr., Inc. 2003). The first peak occurred around 5–6 June and had the highest surface elevation (peak water levels) in the delta, which resulted from the persistence of ice in the main channels of the delta. The date of peak surface

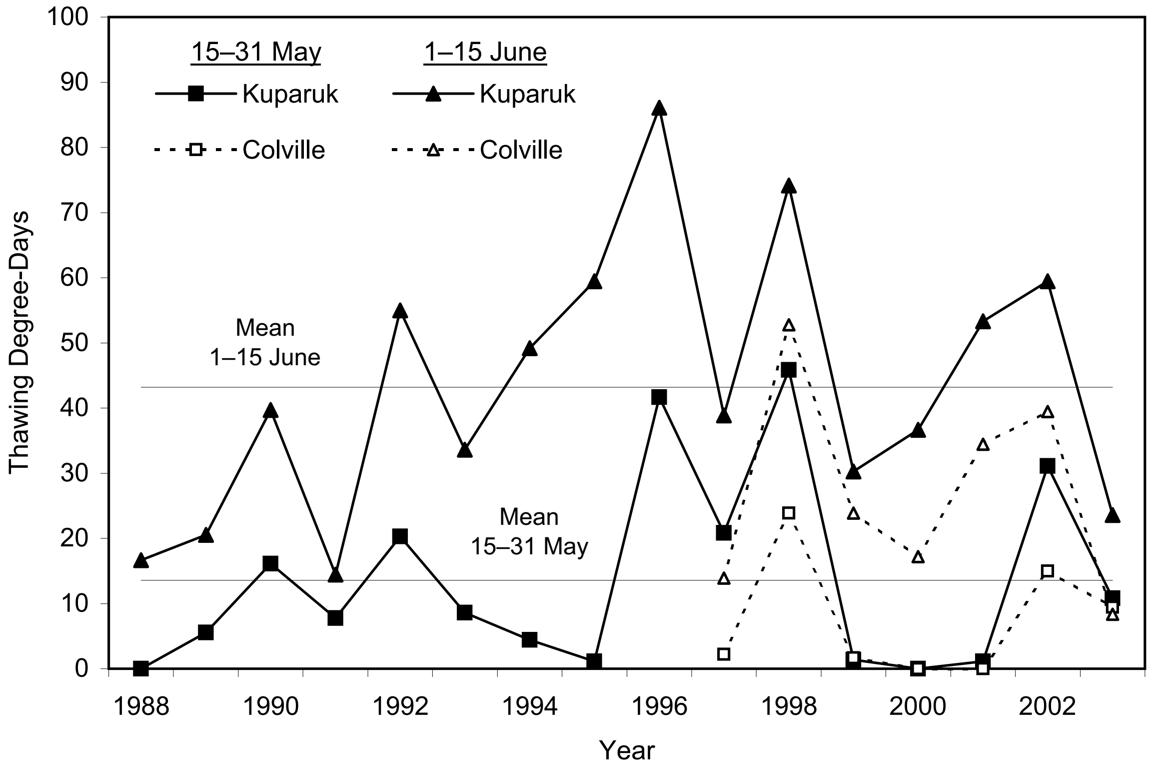

Figure 12. Cumulative number of thawing degree-days recorded for 15–31 May and 1–15 June, Kuparuk Oilfield (1988–2003) and Colville River Delta (1997–2003), Alaska. Mean values computed from Kuparuk data (*n* = 16 years).

elevation in 2003 was 2 weeks later than in 2002. The second peak in 2003 was around 11 June and peak discharge was recorded at that time, although surface elevations were lower than during the earlier peak. Discharge recorded at the head of the Delta for both peaks was the equivalent of 2–5-year floods (Michael Baker Jr., Inc. 2003). As late as 18 June, nest searchers encountered areas of localized flooding near the coast. Extensive areas of meltwater in low-lying areas in the NPRA were also recorded in mid-June, and some ephemeral streams flowed well outside their usual summer channels (L. Moulton, MJM Research, pers. comm.).

Relatively early or near average snow melt in inland areas in 2003 and cool temperatures in early June 2003 resulted in less than favorable conditions for nest initiation of some species of birds. The first Lapland Longspur hatchling was found on 20 June, which is a relatively late date and indicative of a cold spring (Johnson et al. 2003b). Some eider and Long-tailed Ducks were incubating in mid-July, when nests were being checked for fate, so the cool June temperatures may have led to greater asynchronony in nest initiation in some species. Mosquitoes began to emerge in NPRA on 27 June, which is about normal for this insect, and caribou movements in response to mosquito harassment were noted by 29 June in the Kuparuk Oilfield (Lawhead and Prichard 2003b).

LARGE WATERBIRD GROUND-SEARCHES

COLVILLE RIVER DELTA

Distribution, Abundance, and Nesting Success

Only the CD North search area was included in the ground-based field effort on the Colville Delta in 2003. (The CD South search area was omitted in 2003, as described above). The CD North search area was located in the north-central CD North study area, near the outer Colville Delta (Figure 4) in an area comprising more than 90% wet, aquatic, or salt-affected habitats (Table 4). The

Table 4. Habitat availability in the CD North, Alpine West, Lookout, and Spark search areas, Colville River Delta and NPRA study area, Alaska, 2003.

	CD North		Alpine West		Lookout		Spark	
Habitat	Area (km²)	Availability (%)	Area (km²)	Availability (%)	Area (km²)	Availability (%)	Area (km²)	Availability (%)
Brackish Water	0.50	2.8	0	0	0	0	0	0
Tapped Lake with Low-water Connection	0.27	1.5	0	0	0	0	0	0
Tapped Lake with High-water Connection	0.88	4.9	0	0	0	0	0	0
Salt Marsh	0.75	4.2	0	0	0	0	0	0
Salt-killed Tundra	1.88	10.5	0	0	0	0	0	0
Deep Open Water without Islands	0.75	4.2	0	0	0.06	1.3	0	0
Deep Open Water with Islands or Polygonized Margins	1.81	10.1	0	0	0	0	<0.01	<0.1
Shallow Open Water without Islands	0.05	0.3	<0.01	0.1	0	0	0.04	0.6
Shallow Open Water with Islands or Polygonized Margins	0.15	0.8	0.36	7.6	<0.01	0.1	0.23	4
River or Stream	<0.01	<0.1	0	0	0	0	0	0
Aquatic Sedge Marsh	0	0	0.07	1.4	0.07	1.5	0.71	12.2
Aquatic Sedge with Deep Polygons	2.17	12.1	0	0	0	0	0	0
Aquatic Grass Marsh	0.04	0.2	0	0	0	0	0.01	0.2
Young Basin Wetland Complex	0	0	0	0	0	0	1.1	18.7
Old Basin Wetland Complex	0	0	0.85	18.0	0.18	3.8	0	0
Riverine Complex	0	0	0	0	0.18	3.8	0	0
Nonpatterned Wet Meadow	2.69	15.0	0.06	1.2	0	0	1.99	33.9
Patterned Wet Meadow	4.59	25.6	1.28	27.1	0.54	11.4	0.16	2.7
Moist Sedge–Shrub Meadow	0.44	2.4	0.92	19.5	0.93	19.6	1.1	18.8
Moist Tussock Tundra	0	0	1.19	25.1	2.77	58.6	0.49	8.4
Riverine or Upland Shrub[a]	0.27	1.5	–	–	–	–	–	–
Upland and Riverine Dwarf Shrub[a]	–	–	0	0	0	0	0.02	0.4
Barrens	0.70	3.9	0	0	0	0	0	0
Total	17.92	100	4.74	100	4.74	100	5.86	100

[a] Because of the greater importance of shrub habitats in the NPRA, the Riverine or Upland Shrub habitat type in the Colville River Delta areas was classified into 3 shrub habitat in the NPRA study area (see Table 3)

search area in 2003 was 17.9 km² and included 17 wildlife habitats (Table 4). Patterned Wet Meadow was the largest single component (>25% of the total area), and Nonpatterned Wet Meadow, Aquatic Sedge with Deep Polygons, Salt-killed Tundra, and Deep Open Water with Islands or Polygonized Margins each comprised over 10% of the area. All other habitats comprised <5% of the search area.

In 2003, 404 nests of 18 species were recorded in the CD North search area (Figures 13 and 14, Table 5), which was greater than in previous years (245–346 nests). Overall nest density in 2003 was 22.5 nests/km², which also was higher than the density observed in previous years (range 16.7–20.1 nests/km², 2000–2002).

More than half of the nests in the CD North search area in 2003 belonged to geese, with most belonging to Greater White-fronted Geese (264 nests) and smaller numbers to Brant (≥12 nests), Canada Geese (4 nests), and Snow Geese (3 nests) (Figure 13; Table 5). The density of Greater White-fronted Goose nests was higher than in any previous year in CD North (14.7 nests/km², prior range 9.8–11.3 nests/km²) and has increased in each year since 2000 (Johnson 2003b). In contrast, the density of Brant nests was lower than in any prior year (0.7 nests/km², prior range 1.2–2.5 nests/km²) and has decreased in each year since 2000. However, it was suspected that the number of Brant nests was underestimated in 2003 due to early failures. Duck nests also were common in CD North in 2003, primarily Long-tailed Ducks (26 nests) and Spectacled Eiders (12 nests), but also Northern Pintails (3 nests), King Eiders (1 nest), and unidentified eiders (1 nest). The densities of duck nests all were within the ranges observed in prior years. Five Tundra Swan nests were found in the CD North search area, yielding a nest density of 0.3 nests/km², which is comparable to the density in previous years (0.2–0.4 nests/km²).

All 3 species of loons nested in the CD North search area, with Pacific Loons being most common (19 nests, including a suspected renesting attempt), followed by Red-throated Loons (8 nests), and Yellow-billed Loons (5 nests) (Figure 14, Table 5). Loon nest density is typically low and, in 2003, densities were generally comparable to those of prior years (Johnson 2003b). Gulls and terns also nested in the CD North search area in 2003, with Arctic Terns being more common (21 nests) than either Glaucous Gulls (4 nests) or Sabine's Gulls (6 nests). The density of Glaucous Gull nests in 2003 was at the low end of the range observed in prior years (0.2 nests/km² in 2003, prior range 0.2–0.8 nests/km²). Two Parasitic Jaeger nests were found in the CD North search area in 2003, similar to previous years. One Willow Ptarmigan nest and 2 Bar-tailed Godwit nests were found in the search area in 2003.

In general, nesting success of geese was high and comparable to prior years, as approximately 75% of Greater White-fronted Geese and Canada Geese were successful (Table 5). As is typical for Brant, their nesting success was lower than other geese in 2003, <42% successful, which is within the range of values from prior years (10–62%). Nesting success of Tundra Swans was only 25%, which is lower than was observed in the previous 3 years (67–100%). Nesting success of ducks is typically poor by comparison with geese and swans and, over all species, only 6 of 43 duck nests of known fate hatched (14% successful).

During nest-fate checks and ground searches for broods in the CD North search area in 2003, 39 brood-rearing groups of 13 species were recorded within the search area (Figure 15, Table 6). The brood-rearing groups ranged from unattended young (1 Parasitic Jaeger observed during the August visit), to single broods (loons) to a large brood-rearing group (73 birds) of Snow Geese. Broods of all 3 species of loons were observed in the search area, but only 2 species of geese (Greater White-fronted and Snow Geese) were recorded. Three Tundra Swan broods were seen during both the July and August visits. No duck broods were observed during the July visit, but during the August visit, broods of Spectacled Eiders (3 broods) and King Eiders (1) were recorded, as well as 6 broods of Long-tailed Ducks. Broods of Arctic Terns, Sabine's Gulls, and Glaucous Gulls were observed in the search area only during at least 1 visit. Broods were undoubtedly undercounted, because young of many species are cryptic and use vegetation to hide; thus, numbers reported here are minimal counts.

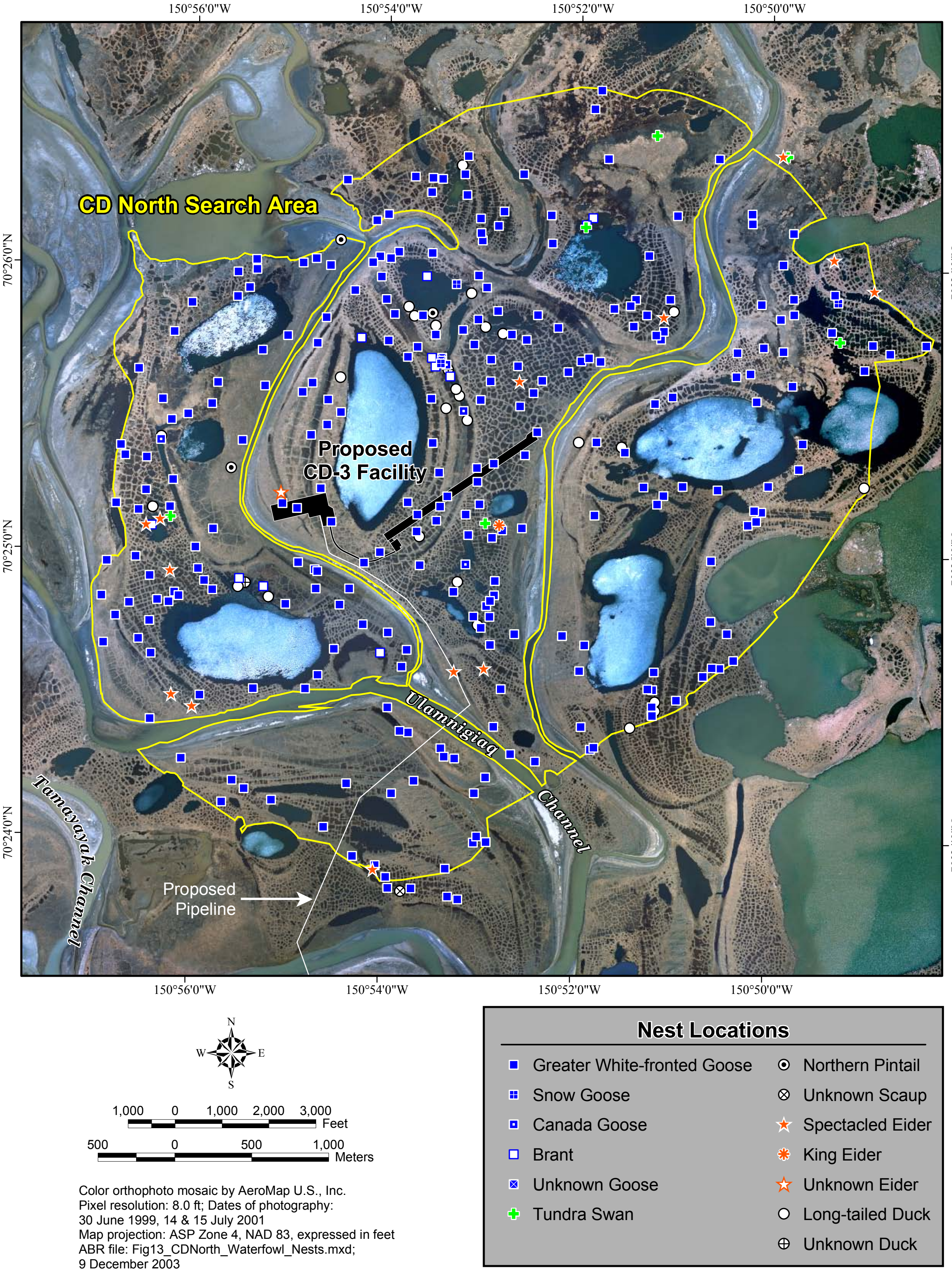

Figure 13. Waterfowl nests in the CD North search area, Colville River Delta, Alaska, 2003.

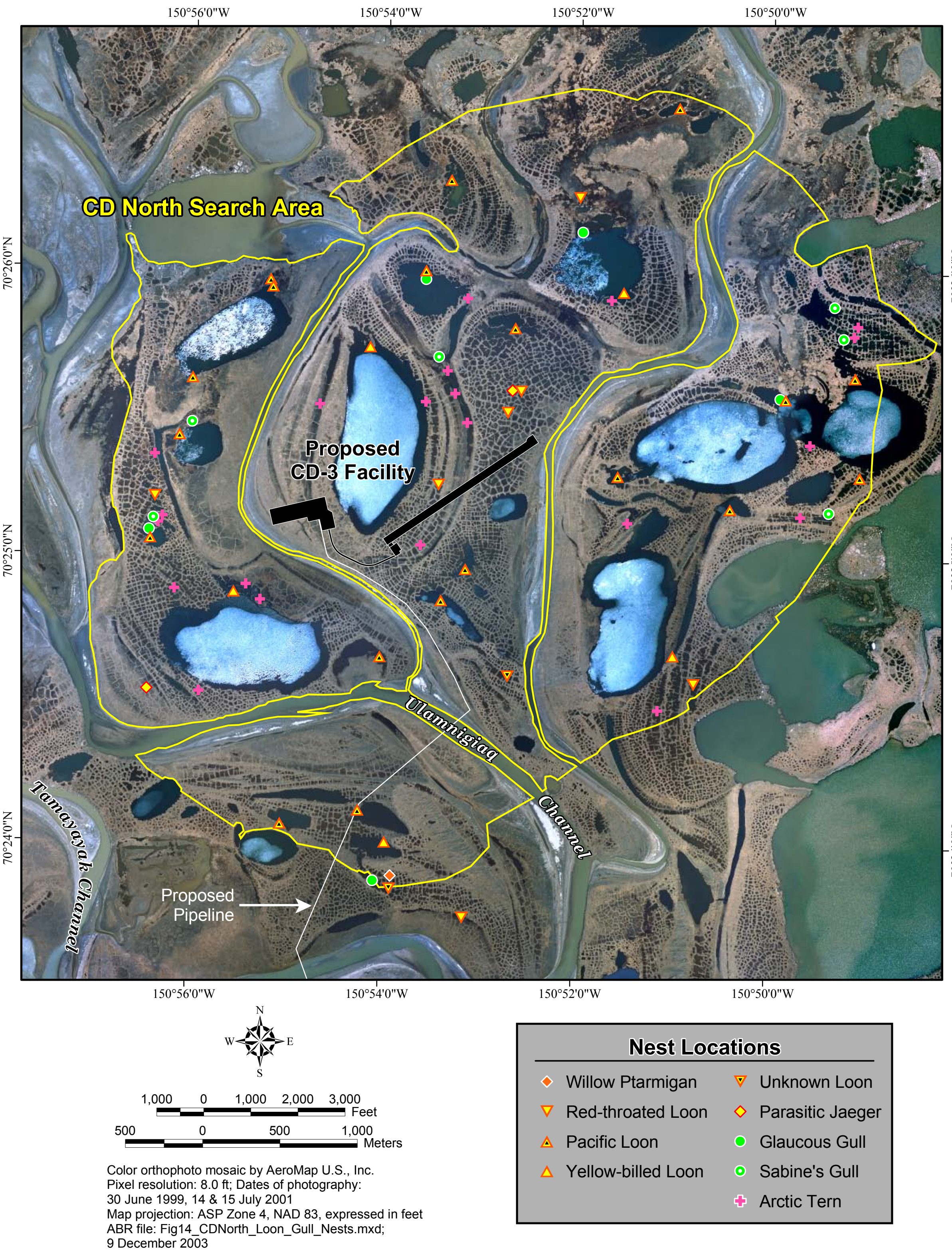

Figure 14. Loon, gull, and other bird nests in the CD North search area, Colville River Delta, Alaska, 2003.

Table 5. Number and density of nests and nesting success of birds in the CD North search area, Colville River Delta, Alaska, 2003.

Species	Number of Nests				Success[a] (%)	Density[b] (nests/km²)
	Total	Successful	Failed	Unknown		
Greater White-fronted Goose	264	185	68	11	73	14.7
Snow Goose	3	3	0	0	100	0.2
Canada Goose	4	3	1	0	75	0.2
Brant[c]	12[d]	5	7[d]	0	42[d]	0.7
Unknown goose	2	0	2	0	0	0.1
Tundra Swan	5	1	3	1	25	0.3
Northern Pintail[c]	3	0	3	0	0	0.2
Spectacled Eider[c]	12	3	9	0	25	0.7
King Eider[c]	1	0	1	0	0	0.1
Unknown eider	1	0	1	0	0	0.1
Long-tailed Duck[c]	26	3	22	1	12	1.5
Unknown duck	2	0	1	1	0	0.1
Willow Ptarmigan	1	0	0	1	–	0.1
Red-throated Loon[e]	8	5	1	2	–	0.5
Pacific Loon[f]	19	8	4	7	–	1.1
Yellow-billed Loon	5	5	0	0	–	0.3
Unknown Loon	1	0	0	1	–	0.1
Bar-tailed Godwit	2	0	1	1	–	0.1
Parasitic Jaeger	2	1	0	1	–	0.1
Glaucous Gull	4	1	0	3	–	0.2
Sabine's Gull	6	3	0	3	–	0.3
Arctic Tern	21	6	0	15	–	1.2
Total	404	203[a]	118[a]	48	63	22.5

[a] Estimates are provided only for waterfowl, as explained in text; nest success = no. successful / (no. successful + no. failed) × 100

[b] Density calculations based on a search area of 17.9 km²

[c] Includes nests identified to species from down and feather characteristics

[d] Minimum count, as an undetermined number of nests had failed before the search

[e] Includes 2 nests that were presumed present from the presence of broods observed during July

[f] Includes 1 case of renesting (loon pair used two nest sites in one season); density without the renesting = 1.0 nests/km²

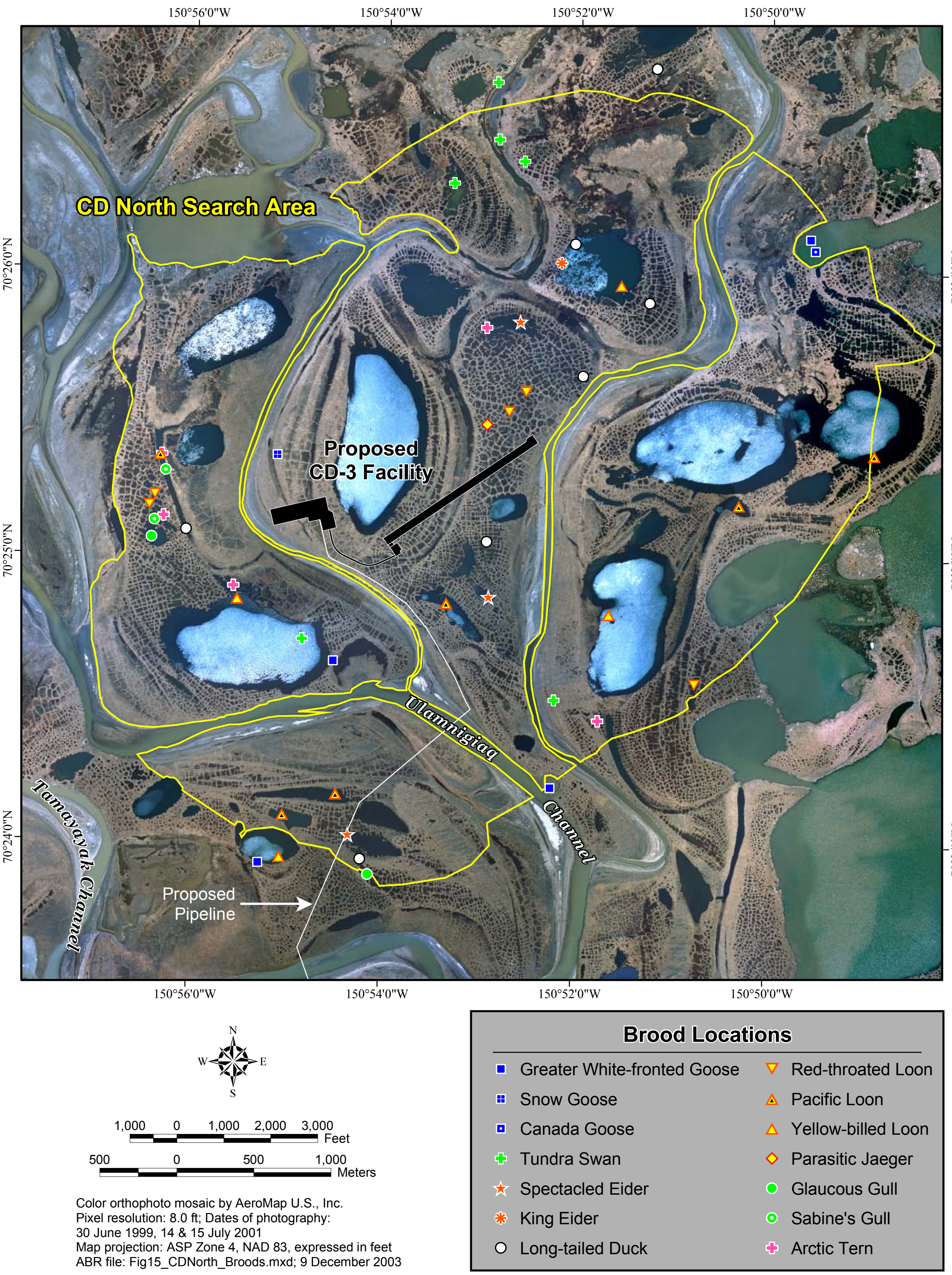

Figure 15. Brood locations in the CD North search area, Colville River Delta, Alaska, July and August, 2003.

Table 6. Number of brood-rearing adults and young in the CD North search area, Colville River Delta, Alaska, 2003.

Species	Adults	Young	Broods or Groups
Greater White-fronted Goose	6	7	1
Snow Goose	35	38	1[a]
Tundra Swan	10	11	5
Spectacled Eider	3	7	3
King Eider	1	4	1
Long-tailed Duck	6	16	6
Red-throated Loon	7	6	5
Pacific Loon	9	7	5
Yellow-billed Loon	6	5	3
Parasitic Jaeger	0	1	1
Glaucous Gull	2	1	1
Sabine's Gull	4	2	2
Arctic Tern	11	8	5
Total	100	113	39

[a] Large brood-rearing group, number of broods unknown

Habitat Use

Habitats with polygonal surface forms contained the highest numbers of nests. Patterned Wet Meadow contained 133 nests (34% of the total) while Aquatic Sedge with Deep Polygons contained 96 nests (24%) (Table 7). Other habitats that contained ≥10% of all nests included Nonpatterned Wet Meadow and Deep Open Water with Islands or Polygonized Margins. The 2 habitat types with the highest species richness were Deep Open Water with Islands or Polygonized Margins and Aquatic Sedge with Deep Polygons (12 species each). Patterned Wet Meadow and Nonpatterned Wet Meadow each supported 9 nesting species and no other habitat type had more than 5 nesting species. Only 1 habitat type was used for nesting in considerably greater proportion than availability: Aquatic Sedge with Deep Polygons (24% of nests, 12% of total area).

Most (76%) broods and/or brood-rearing groups were observed in aquatic habitats (Table 8), including both types of Deep Open Lakes (46% of all groups), Shallow Open Water with Islands or Polygonized Margins (15%), and Aquatic Sedge with Deep Polygons (15%). Species richness was greatest in Deep Open Water with Island or Polygonized Margins (8 species). Three habitat types were used in substantially greater proportion than their availability: Deep Open Water without Islands (18% of broods, 4.2% of total area), Deep Open Water with Islands or Polygonized Margins (28% of broods, 10.2% of total area), and Shallow Open Water with Islands or Polygonized Margins (15% of broods, 0.8% of total area).

NPRA STUDY AREA

Distribution and Abundance

Pad Search Areas

Alpine West—The Alpine West search area was located in the northeast corner of the NPRA study area (Figure 5) in an area dominated by moist and wet polygonal habitats (Table 4). Four habitat types occupied most of the Alpine West search area: Patterned Wet Meadow (27.1%), Moist Tussock Tundra (25.1%), Moist Sedge–Shrub Meadow (19.5%), and Old Basin Wetland Complex (18.0%). No other habitat type comprised >8% of the total area. Aquatic habitats covered 27% of the Alpine West search area in 2003. Alpine West also was surveyed in 2002 (Burgess et al. 2003b), although the boundaries were shifted

Table 7. Habitat use during nesting in the CD North search area, Colville River Delta, Alaska, 2003.

Habitat	Greater White-fronted Goose	Snow Goose	Canada Goose	Brant[a]	Tundra Swan	Northern Pintail	Spectacled Eider[a]	King Eider[a]	Unknown Eider	Long-tailed Duck[a]	Red-throated Loon[b]	Pacific Loon	Yellow-billed Loon	Bar-tailed Godwit	Parasitic Jaeger	Glaucous Gull	Sabine's Gull	Arctic Tern	All Species	Total Nests	Number of Species
Brackish Water	0	0	0	0	0	0	0	0	0	0	17	21	0	0	0	0	0	0	1	5	2
Tapped Lake with High-water Connection	<1	0	0	0	20	0	0	0	0	0	0	21	0	0	0	25	0	5	2	8	5
Salt Marsh	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	3	10	2
Salt-killed Tundra	8	0	0	8	0	0	0	0	0	0	0	5	0	0	0	0	17	5	7	26	5
Deep Open Water without Islands	1	0	25	0	0	0	0	0	0	4	0	5	0	0	0	0	0	0	2	6	4
Deep Open Water with Islands or Polygonized Margins	<1	67	75	58	20	0	8	0	0	19	0	21	60	0	0	75	50	29	10	39	12
Shallow Open Water with Islands or Polygonized Margins	<1	0	0	0	0	0	0	0	0	12	33	5	0	0	0	0	0	0	2	8	4
Aquatic Sedge with Deep Polygons	26	0	0	17	20	33	25	100	0	27	50	5	0	0	50	0	17	29	24	96	12
Aquatic Grass Marsh	0	0	0	8	0	0	0	0	0	0	0	5	0	0	0	0	0	0	<1	2	2
Nonpatterned Wet Meadow	16	0	0	8	20	0	8	0	100	8	0	0	0	50	50	0	0	10	13	52	9
Patterned Wet Meadow	41	33	0	0	20	0	58	0	0	23	0	11	40	50	0	0	0	24	34	133	9
Moist Sedge–Shrub Meadow	2	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	2	7	2
Riverine or Upland Shrub	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	17	0	<1	2	2
Barrens	<1	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	<1	2	2
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		17
Total Nests	264	3	4	12	5	3	12	1	1	26	6	19	5	2	2	4	6	21		396	

[a] Includes nests identified to species from feather and down samples
[b] Excludes 2 nests whose exact locations were unknown, but whose presence was presumed due to the observation of broods

Table 8. Habitat use during brood-rearing in the CD North search area, Colville River Delta, Alaska, 2003.

Habitat	Greater White-fronted Goose	Snow Goose	Tundra Swan	Spectacled Eider	King Eider	Long-tailed Duck	Red-throated Loon	Pacific Loon	Yellow-billed Loon	Parasitic Jaeger	Glaucous Gull	Sabine's Gull	Arctic Tern	All Species	Total Brood Locations	Number of Species
Salt Marsh	0	0	20	0	0	0	0	0	0	0	0	0	0	3	1	1
Salt-killed Tundra	0	0	20	0	0	0	0	0	0	0	0	0	0	3	1	1
Deep Open Water without Islands	0	0	0	0	0	17	0	60	33	0	0	50	20	18	7	5
Deep Open Water with Islands or Polygonized Margins	0	0	40	0	100	33	0	20	67	0	100	50	20	28	11	8
Shallow Open Water with Islands or Polygonized Margins	0	0	0	33	0	0	60	20	0	0	0	0	20	15	6	4
Aquatic Sedge with Deep Polygons	0	0	0	33	0	50	40	0	0	0	0	0	0	15	6	3
Nonpatterned Wet Meadow	0	100	20	0	0	0	0	0	0	0	0	0	0	5	2	2
Patterned Wet Meadow	100	0	0	33	0	0	0	0	0	100	0	0	40	13	5	4
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100		13
Total Brood Locations	1	1	5	3	1	6	5	5	3	1	1	2	5		39	

slightly northward in 2003, resulting in slightly different habitat composition.

One hundred and ten nests of 15 species were located in the Alpine West search area in 2003 (Figure 16, Table 9). Three-fourths of these nests belonged to geese, including: Greater White-fronted Goose (56 nests), Canada Goose (17 nests), Brant (9 nests) and unidentified goose (3 nests). All other species had ≤5 nests in the study area. The total nest density in the Alpine West search area was 23.2 nests/km² (Table 9). The density of nests was higher in Alpine West than in the other 2 search areas in the NPRA in 2003 and higher than was reported for any search area in the NPRA during 2001 and 2002 (6.0–18.1 nests/km²; Burgess et al. 2002b, 2003b). Overall nest density in Alpine West in 2003 was comparable to that observed in the CD North search area in 2003 and the number of nesting species was only slightly lower than in CD North (Table 5). High nesting densities at Alpine West are largely attributable to the occurrence of a mixed-species nesting colony

Table 9. Number and density of nests in the Alpine West, Lookout, and Spark search areas, NPRA, Alaska, 2003.

	Alpine West		Lookout		Spark	
Species	Number	Density (nests/km²)	Number	Density (nests/km²)	Number	Density (nests/km²)
Greater White-fronted Goose	56	11.8	21	4.4	6	1.0
Canada Goose	17[a]	3.6	0	0	0	0
Brant	9	1.9	0	0	0	0
Unknown goose	3	0.6	0	0	0	0
Tundra Swan	1	0.2	0	0	0	0
Northern Pintail	1	0.2	0	0	0	0
Green-winged Teal	0	0	1	0.2	0	0
Unknown scaup	0	0	0	0	1	0.2
Spectacled Eider	1	0.2	0	0	0	0
King Eider	3[b]	0.6	0	0	3[b]	0.5
Long-tailed Duck	3	0.6	1	0.2	2[b]	0.3
Willow Ptarmigan	3	0.6	4	0.8	0	0
Unknown ptarmigan	1	0.2	0	0	0	0
Red-throated Loon	1	0.2	1	0.2	0	0
Pacific Loon	3	0.6	0	0	8[c]	1.4[c]
Yellow-billed Loon	0	0	1	0.2	1	0.2
Bar-tailed Godwit	0	0	3	0.6	0	0
Parasitic Jaeger	1	0.2	0	0	2	0.3
Long-tailed Jaeger	1	0.2	0	0	0	0
Glaucous Gull	5	1.1	0	0	2	0.3
Sabine's Gull	0	0	0	0	4	0.7
Arctic Tern	1	0.2	1	0.2	4	0.7
Area Searched (km²)	4.74		4.74		5.86	
Waterbird[d] Nest Density	22.8		6.2		5.6[c]	
Total Nest Density	23.2		7.0		5.6[c]	
Total Number of Nests	110		33		33[c]	
Number of Species	15		8		10	

[a] Includes 2 nests identified to species by feather and down samples
[b] Includes 1 nest identified to species by feather and down sample
[c] Includes 1 case of renesting (pair used 2 nest sites in one season)
[d] Waterbirds include: loons, grebes, geese, swans, ducks, cranes, jaegers, gulls, terns, and large shorebirds

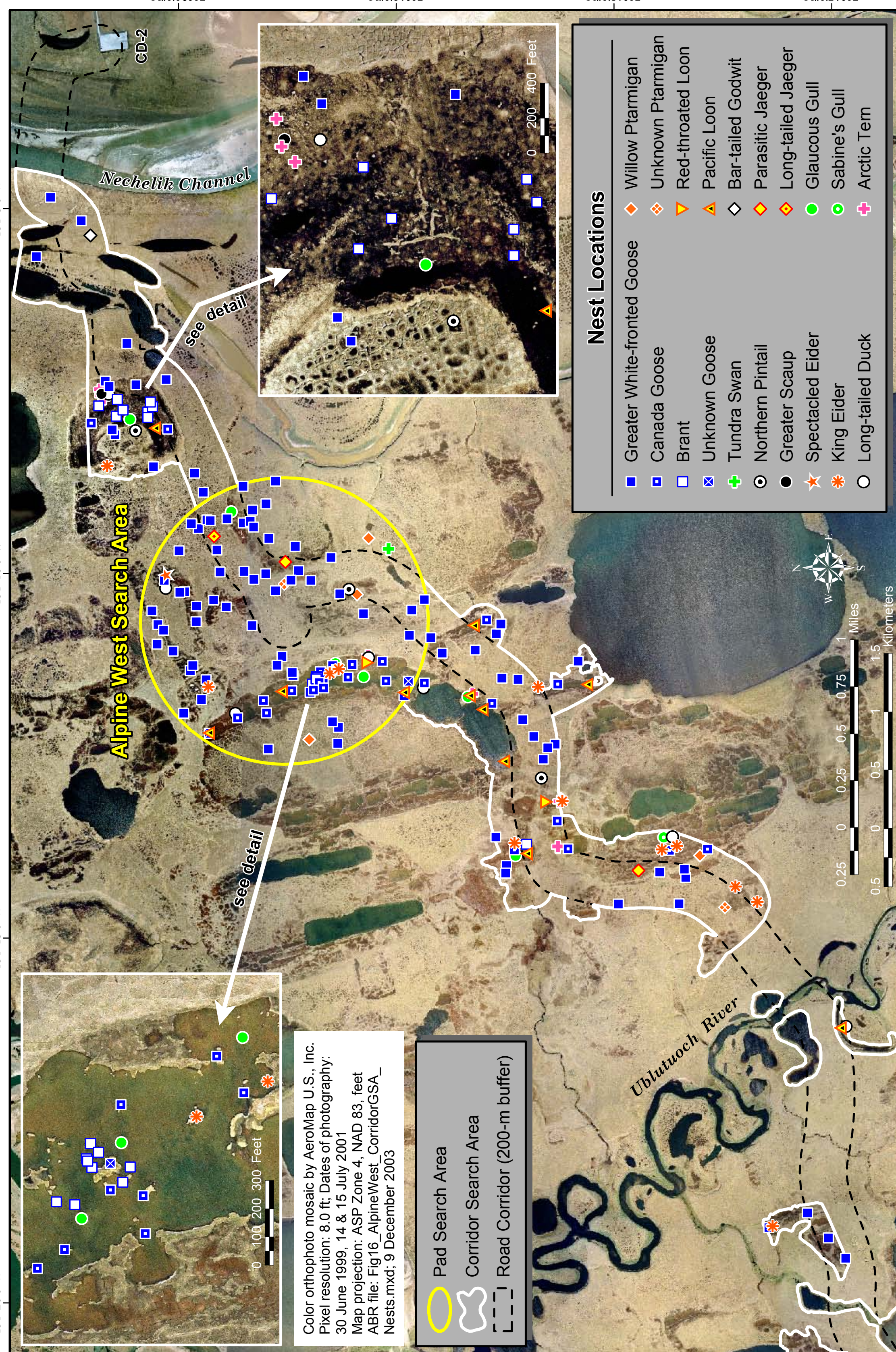

Figure 16. Large waterbird nests in the Alpine West search area and eastern parts of the NPRA road corridor, Alaska, 2003.

in a wetland basin with complex shorelines and many small islands (Figure 16). All Canada Goose, Brant, Pacific Loon, and Red-throated Loon nests, and most of the duck and gull nests in the Alpine West search area were located on this waterbody.

The density of goose nests in the Alpine West search area in 2003 (17.9 nests/km²) was higher than has been recorded in any ground-search area in the NPRA study area or Colville Delta since surveys were initiated. The Greater White-fronted Goose was the most abundant large waterbird nesting in Alpine West and Canada Goose was the second-most abundant (Table 9). The density of Greater White-fronted Goose nests in Alpine West was only slightly lower than that observed in CD North in 2003 and the nest densities of Canada Goose and Brant were higher than were observed in any other search area in the NPRA or CD North study areas since studies began (Burgess et al. 2003b, Johnson et al. 2003b).

Four species of ducks nested in Alpine West in 2003 (Spectacled and King eiders, Northern Pintail, and Long-tailed Duck). Of 8 total duck nests in Alpine West in 2003, 3 belonged to King Eiders and 3 to Long-tailed Ducks (Figure 16, Table 9). Overall nesting density of ducks (1.6 nests/km²) in Alpine West was higher than in the other NPRA search areas, but lower than in CD North.

Two species of loons nested in the Alpine West search area in 2003; 1 Red-throated Loon and 3 Pacific Loon nests were found (Figure 16, Table 9). Glaucous Gulls and Arctic Terns also nested in Alpine West in 2003. The number of Glaucous Gull nests increased from 4 in 2002 to 5 in 2003.

Six broods of 4 species were observed in the Alpine West search area in 2003 (Figure 17). Three of those broods were Glaucous Gulls, and the remainder comprised single broods of Arctic Tern, Northern Pintail, and Willow Ptarmigan (Table 10).

Lookout—In 2003, the Lookout search area was located in the north-central portion of the NPRA study area (Figures 5 and 18) and comprised 4.74 km², mainly of Moist Tussock Tundra (58.6%, Table 4). Only 2 permanent waterbodies occurred in the Lookout search area: Deep Open Water without Islands and a beaded stream (Riverine Complex). Eight habitat types occurred in the Lookout search area, and in addition to Moist Tussock Tundra, only Moist Sedge–Shrub Meadow (19.6%) and Patterned Wet Meadow (11.4%) comprised >4% of the area. Aquatic habitats comprised only 9.1% of the Lookout search area.

Thirty-three nests of 8 species were found in the Lookout search area in 2003 (Table 9, Figure 18). A larger number of nests and nesting species were observed in 2003 than in 2002 (21 nests, 5 species; Burgess et al. 2003b), although the search areas were somewhat different. New species found nesting in the Lookout area in 2003 were Yellow-billed Loon, Red-throated Loon, and Arctic Tern. Two-thirds of nests belonged to Greater White-fronted Geese (21 nests) and the second-most common nesting species was Willow Ptarmigan (4 nests). All other species had ≤3 nests. Nest density for all species was 7.0 nests/km² in the Lookout search area in 2003, which is only a third of the density observed in the Alpine West and CD North search areas.

Greater White-fronted Goose was the only goose species found nesting in the Lookout search area in 2003. The density of Greater White-fronted Goose nests increased nearly 3-fold between 2002 and 2003. Two duck nests (Green-winged Teal and a Long-tailed Duck) and 2 loon nests (Yellow-billed Loon and Red-throated Loon) were found in the 2003 search area.

Only 2 broods were observed in the Lookout search area. One brood belonged to Willow Ptarmigan and another to Arctic Terns (Figure 19, Table 10).

Spark—The 2003 Spark search area (5.86 km²) was located near the geographic center of the NPRA study area in a recently drained wetland basin (Figures 5 and 18). The Spark search area comprised 36% aquatic habitats and 36% wet meadow habitats (Table 4). Eleven habitat types occurred in the 2003 search area, and the 4 major habitat types were Nonpatterned Wet Meadow (33.9%), Moist Sedge–Shrub Meadow (18.8%), Young Basin Wetland Complex (18.7%), and Aquatic Sedge Marsh (12.2%). No other habitat comprised >9% of the 2003 search area.

Thirty-three nests of 10 species were found in the Spark search area (Figure 18, Table 9). Unlike all other search areas in the NPRA study area and Colville Delta, Greater White-fronted Geese (with 6 nests) were not the most abundant nesting species at Lookout, being supplanted by Pacific Loons

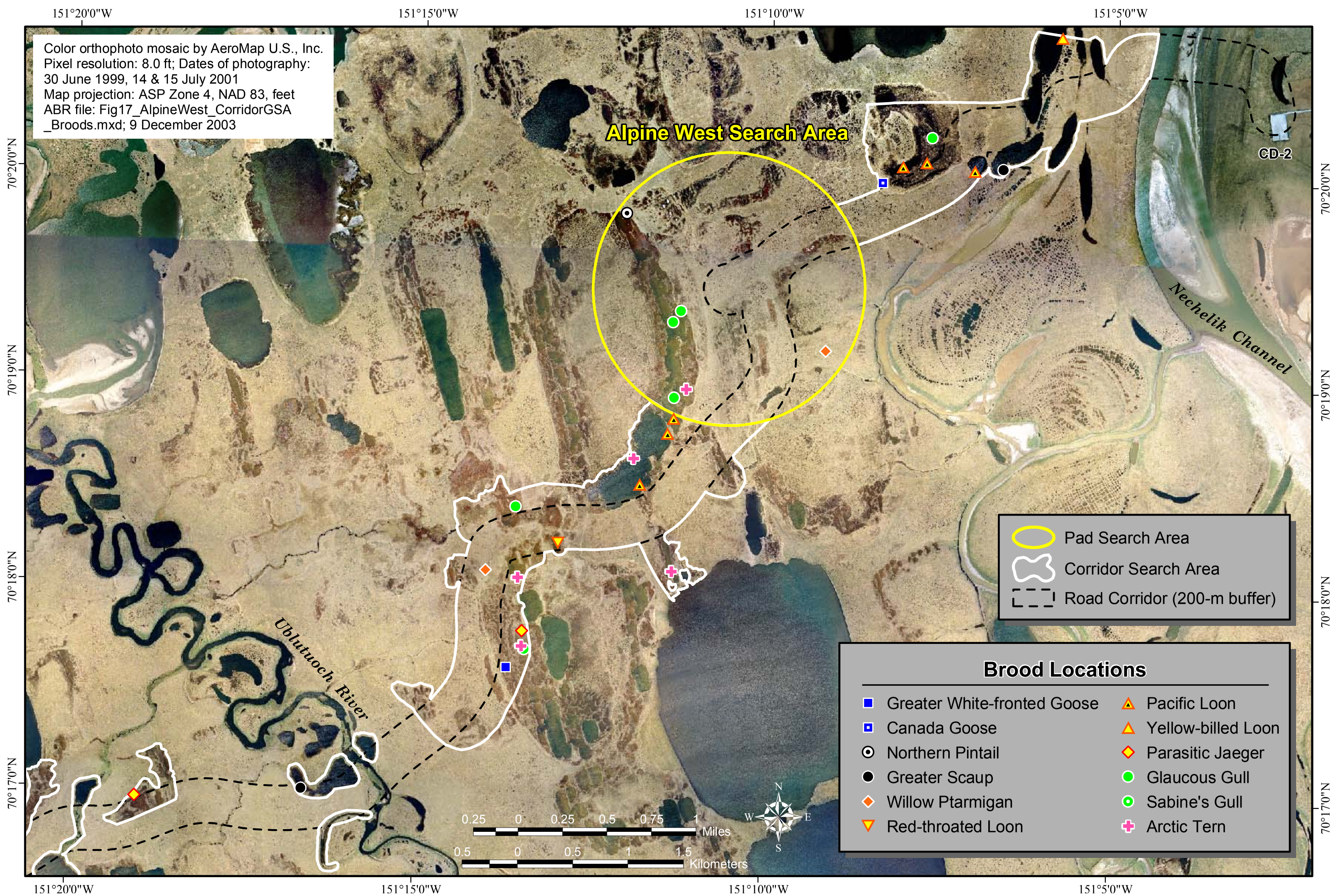

Figure 17. Brood locations in the Alpine West search area and eastern parts of the NPRA road corridor, Alaska, July and August 2003.

Table 10. Number of brood-rearing adults and young in the Alpine West, Lookout, and Spark search areas and in the road corridor, NPRA, Alaska, 2003.

										Road Corridor					
	Alpine West			Lookout			Spark			200-m Buffer			Extended Buffer		
Species	Adults	Young	Groups	Adults	Young	Groups	Adults	Young	Groups	Adults	Young	Groups	Adults	Young	Groups
Greater White-fronted Goose	0	0	0	0	0	0	1	4	1	2	5	1	10	13	3
Canada Goose	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Brant	0	0	0	0	0	0	0	0	0	0	0	0	4	8	2
Northern Pintail	1	6	1	0	0	0	0	0	0	0	0	0	0	0	0
Greater Scaup	0	0	0	0	0	0	0	0	0	1	2	1	1	3	1
Spectacled Eider	0	0	0	0	0	0	0	0	0	0	0	0	1	3	1
Long-tailed Duck	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1
Willow Ptarmigan	1	7	1	1	5	1	0	0	0	1	7	1	0	0	0
Red-throated Loon	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
Pacific Loon	0	0	0	0	0	0	5	4	3	1	2	1	12	10	7
Yellow-billed Loon	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
Parasitic Jaeger	0	0	0	0	0	0	2	2	1	2	2	1	3	2	2
Glaucous Gull	4	6	3	0	0	0	3	2	2	0	0	0	6	6	4
Sabine's Gull	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Arctic Tern	2	1	1	4	2	1	0	0	0	6[a]	2	1	12	7	5
Total	8	20	6	5	7	2	11	12	7	14	21	7	54	59	29

[a] Includes adults other than the parents in the vicinity of the young

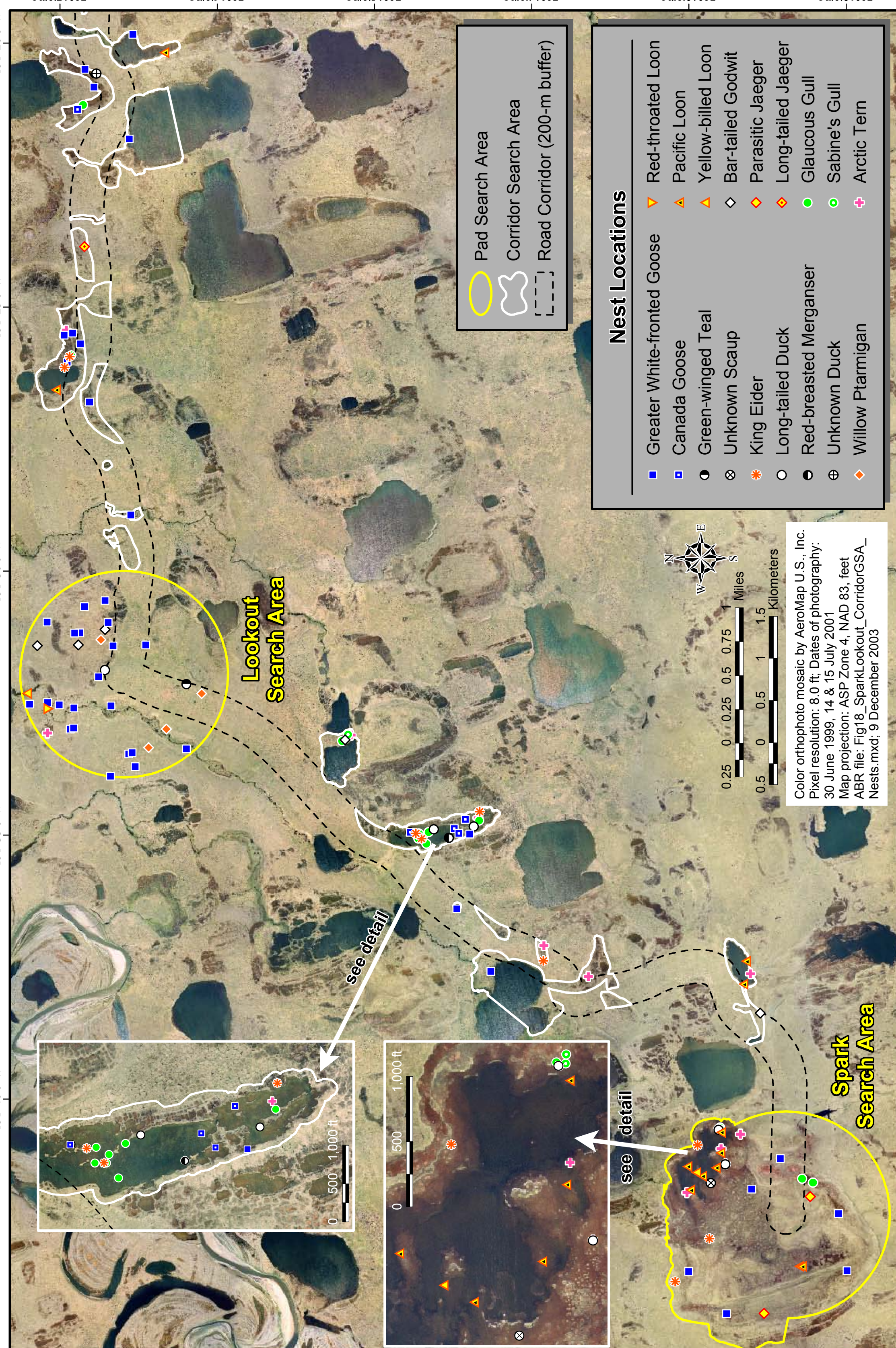

Figure 18. Large waterbird nests in the Lookout and Spark search areas and western parts of the NPRA road corridor, Alaska, 2003.

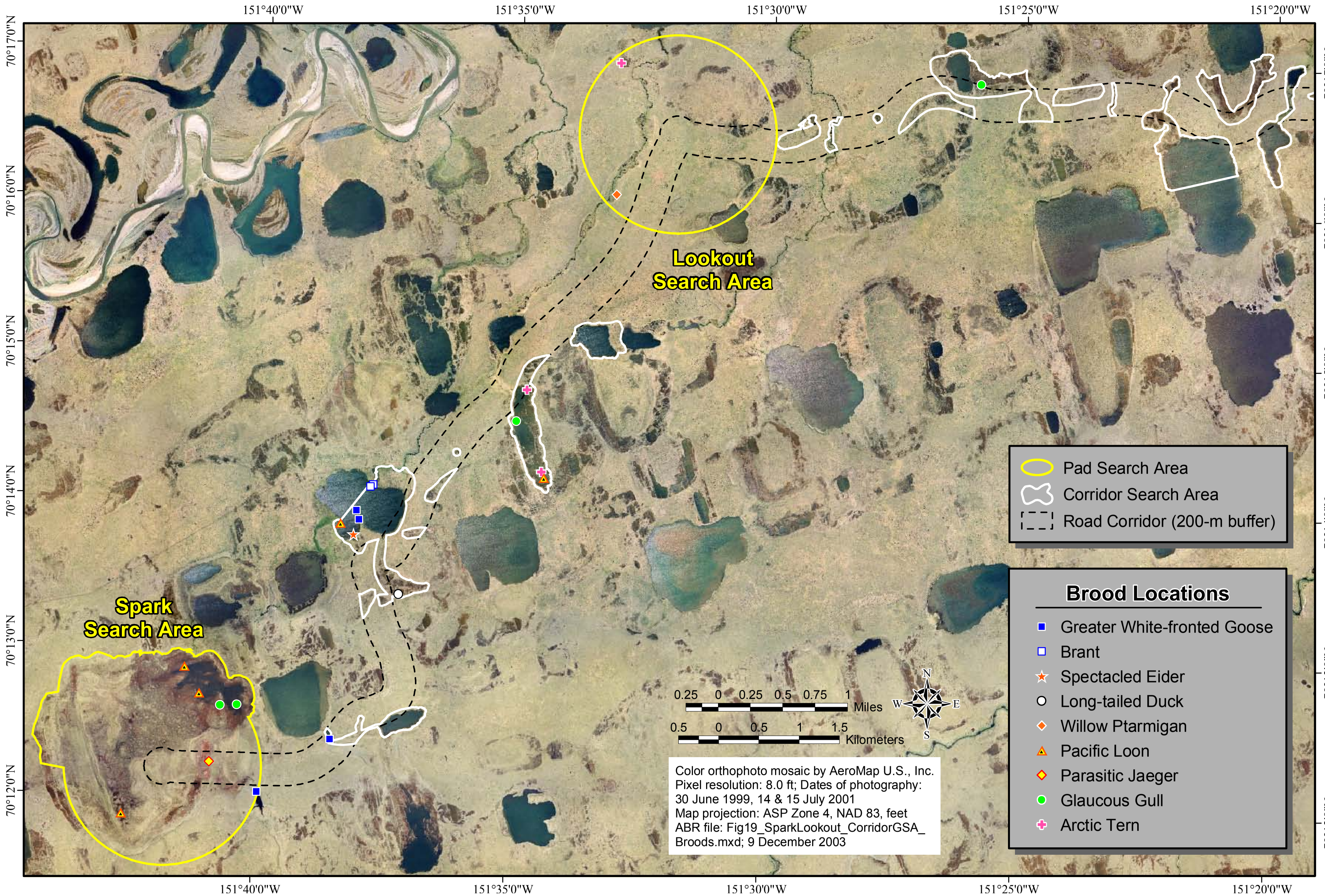

Figure 19. Brood locations in the Lookout and Spark search areas and western parts of the NPRA road corridor, Alaska, July and August 2003.

(with 8 nests, 1 of which was a suspected renesting attempt). Sabine's Gulls and Arctic Terns each had 4 nests. Other notable species nesting in the Spark search area were King Eider (3 nests), Long-tailed Duck (2 nests), and Yellow-billed Loon (1 nest). Nest density in the Spark search area in 2003 was 5.6 nests/km² for all species, which was the lowest density of the 3 NPRA pad search areas (Table 9).

As was the case at the Lookout search area, the only goose species nesting at Spark was Greater White-fronted Goose (Table 9). The density of Greater White-fronted Goose nests in the Spark search area was low (1.0 nests/km²) compared to all other search areas since surveys were initiated in NPRA in 2001 (Burgess et al. 2002b). Six duck nests—3 King Eider, 2 Long-tailed Duck, and an unidentified scaup—were found, yielding 1.0 duck nests/km². The density of ducks at Spark was higher than in the Lookout search area, but lower than in the search areas for Alpine West or CD North.

Nine loon nests (8 Pacific Loon and 1 Yellow-billed Loon) made Lookout the search area with the highest density of loon nests (1.5 nests/km²) among the NPRA search areas (Table 9). The density of Pacific Loon nests (1.4 nests/km²) in the Spark search area was higher than in any other search area in the NPRA or the Colville Delta since surveys were initiated (Burgess et al. 2003b, Johnson et al. 2003a, 2003b). Most of these Pacific Loon nests were located on the same lake, which had a complex shoreline and an abundance of emergent vegetation (Figure 18).

Seven broods were observed in the Spark search area. Most of the broods belonged to Pacific Loons (3 broods) and the remainder belonged to Glaucous Gull (2), Greater White-fronted Goose (1), and Parasitic Jaeger (1) (Figure 19, Table 10).

NPRA Road Corridor Searches

The entire NPRA road corridor (within 200 m of the centerline) comprised 14.2 km², of which 7.4 km² (52%) were searched, with effort focused primarily in wet and aquatic habitats (Figure 5, Table 11). Ninety-one percent of the aquatic habitats in the road corridor were searched. An additional 5.2 km² (extended buffer) were searched where the road intersected waterbodies or wetland basins that extended beyond the 200-m buffer. The 4 most common habitats types in the 200-m buffer (the portion of the road corridor that was searched) were Moist Tussock Tundra (28.4%), Moist Sedge–Shrub Meadow (18.5%), Pattern Wet Meadow (18.5%), and Old Basin Wetland Complex (13.8%). All other habitat types covered ≤6.1% of the 200-m buffer area. Aquatic habitats accounted for 72% of the searched area in the extended buffer and wet meadow habitats accounted for another 16%. The 4 most common habitats types in the extended buffer were Old Basin Wetland Complex (17.9%), Deep Open Water with Islands or Polygonized Margins, (18.3%), Deep Open Water without Islands (15.5%), and Patterned Wet Meadow (13.5%). All other habitats individually accounted for ≤8.4% of the total area of the extended buffer.

In 2003, 80 nests of 15 species were found in the 200-m buffer of the road corridor, and an additional 101 nests of 15 species were found in the extended buffer (Figures 16 and 18, Table 12). The total nest density for all species in the 200-m buffer was 10.9 nests/km². When the extended buffer (which comprises almost exclusively high-quality waterfowl habitats, with 19.4 nests/km²) is included, nest density in the total searched area of the corridor was 14.4 nests/km². These densities are not strictly comparable to those from the pad search areas because effort was concentrated on higher quality waterfowl habitats in the 200-m buffer and extended buffer, and drier and less productive areas (e.g., Moist Tussock Tundra) were avoided.

As in most other search areas in 2003, the most abundant nesting species was Greater White-fronted Goose, with 48 nests in the 200-m buffer and an additional 20 in the extended buffer (Table 12). In the 200-m buffer, no other species had more than 3 nests. However, in the extended buffer, an additional 14 Canada Goose nests, 13 King Eider nests, 11 Glaucous Gull, 11 Arctic Tern nests, and 9 Pacific Loon nests were found. No other species had more than 6 nests in the extended buffer.

Three species of geese nested in the 200-m buffer, Greater White-fronted Geese, Canada Geese, and Brant. The 48 White-fronted Goose nests (6.5 nests/km²) in the 200-m buffer were widely dispersed (Figures 16 and 18). Brant (0.4 nests/km²) and Canada Goose nests (0.4 nests/km²)

Table 11. Habitat availability in the NPRA road corridor, Alaska, 2003.

Habitat	Entire Corridor[a] Area (km²)	Entire Corridor[a] Availability (%)	Areas Searched[a]: 200-m Buffer Area (km²)	200-m Buffer Availability (%)	Extended Buffer Area (km²)	Extended Buffer Availability (%)
Deep Open Water without Islands	0.21	1.5	0.18	2.4	0.81	15.5
Deep Open Water with Islands or Polygonized Margins	0.10	0.7	0.10	1.4	0.96	18.3
Shallow Open Water without Islands	0.06	0.4	0.06	0.8	0.11	2.1
Shallow Open Water with Islands or Polygonized Margins	0.14	1.0	0.14	1.9	0.44	8.4
River or Stream	0.09	0.6	0.00	0.0	<0.01	<0.1
Aquatic Sedge Marsh	0.20	1.4	0.20	2.7	0.20	3.8
Aquatic Grass Marsh	0	0	0	0	<0.01	0.1
Young Basin Wetland Complex	0.36	2.6	0.36	5.0	0.27	5.2
Old Basin Wetland Complex	1.05	7.4	1.01	13.8	0.93	17.9
Riverine Complex	0.05	0.4	0.03	0.4	0.02	0.3
Nonpatterned Wet Meadow	0.62	4.4	0.45	6.1	0.19	3.7
Patterned Wet Meadow	1.63	11.5	1.36	18.5	0.70	13.5
Moist Sedge–Shrub Meadow	3.23	22.8	1.36	18.5	0.32	6.2
Moist Tussock Tundra	6.16	43.5	2.09	28.4	0.23	4.4
Riverine Low and Tall Shrub	0.03	0.2	0.01	0.1	0.02	0.3
Riverine or Upland Shrub[b]	0.14	1.0	<0.01	<0.1	0	0
Upland and Riverine Dwarf Shrub	0.01	<0.1	<0.01	<0.1	0.01	0.1
Upland Low and Tall Shrub	0.01	0.1	0	0	0	0
Barrens	0.07	0.5	0	0	0	0
Total	14.16	100	7.36	100	5.22	100

[a] Entire corridor = total area within 200 m of road centerline; 200-m buffer = area searched within road corridor; extended buffer = area searched outside the 200-m buffer (see Figure 5)

[b] The road corridor extends onto the Colville River Delta to connect with CD-2; Riverine and Upland Shrub habitat was classified only on the Colville River Delta

occurred in 2 loose clusters or colonies in the 200-m buffer, but Canada Geese also were found nesting as singles or in small groups (<5) on islands in shallow lakes or basins in many parts of the extended buffer. Brant nests also were located in 1 basin in the extended buffer.

Four species of duck nested in the 200-m buffer and an additional 2 species nested in the extended buffer. No duck species had more than 2 nests in the 200-m buffer. With 2 King Eider nests in the 200-m buffer and 13 in the extended buffer, that species was the most abundant nesting duck in the road corridor. Six Long-tailed Duck nests also were found, 5 of which were in the extended buffer. No other duck had more than 1 nest in the extended buffer.

Spectacled Eider and Yellow-billed Loon nests were not found in the road corridor search areas but these 2 species did nest in the northern road corridor alternative (Appendix C1 and C2). Two Spectacled Eider nests were found in the northern road corridor 200-m buffer and 1 additional nest was found in its extended buffer (Appendix C1 and C2).

A total of 7 broods of 7 species were observed in the 200-m buffer search area of the road corridor (Figures 17 and 19, Table 10). An additional 29 broods of 12 species were observed in the extended buffer area. King Eider broods were not seen in the 200-m buffer or extended buffer but 2 broods were sighted in the northern road corridor alternative (Appendix C3 and C4). One Spectacled Eider brood was found in the road corridor between Lookout and Spark (Figure 19).

Nesting Success

Due to the small number of nests for most species in the separate areas in 2003, nesting

Table 12. Number and density of nests in the NPRA road corridor, Alaska, 2003.

	200-m Buffer		Extended Buffer		Total	
Species	Number	Density (nests/km²)	Number	Density (nests/km²)	Number	Density (nests/km²)
Greater White-fronted Goose	48	6.5	22	4.2	70	5.6
Canada Goose	3	0.4	14[a]	2.7	17[a]	1.4
Brant	3	0.4	6	1.2	9	0.7
Northern Pintail	2	0.3	1	0.2	3	0.2
Green-winged Teal	1	0.1	0	0	1	0.1
Greater Scaup	0	0	1	0.2	1	0.1
King Eider	2	0.3	13[a]	2.5	15[a]	1.2
Long-tailed Duck	1	0.1	5	0.9	6	0.5
Red-breasted Merganser	0	0	1	0.2	1	0.1
Unknown duck	1	0.1	1	0.2	2	0.2
Willow Ptarmigan	2	0.3	1	0.2	3	0.2
Unknown ptarmigan	2	0.3	0	0	2	0.2
Red-throated Loon	1	0.1	0	0	1	0.1
Pacific Loon	3	0.4	9	1.7	12	0.9
Bar-tailed Godwit	2	0.3	1	0.2	3	0.2
Parasitic Jaeger	2	0.3	0	0	2	0.2
Long-tailed Jaeger	2	0.3	0	0	2	0.2
Glaucous Gull	2	0.3	11	2.1	13	1.0
Sabine's Gull	0	0	4[c]	0.8	4	0.3
Arctic Tern	3	0.4	11	2.1	14	1.1
Area Searched (km²)	7.36		5.22		12.58	
Waterbird[b] Nest Density	10.3		19.2		13.9	
Total Nest Density	10.9		19.4		14.4	
Total Number of Nests	80		101		181	
Number of Species	15		15		18	

[a] Includes 2–3 nests identified to species by feather and down sample
[b] Waterbirds include: loons, grebes, swans, ducks, cranes, jaegers, gulls, terns, and large shorebirds
[c] Includes one nest sighted on aerial survey

success was evaluated for all of the NPRA search areas combined (Table 13). Nesting success for geese ranged from 29% for Brant to 53% for Canada Geese to 66% for Greater White-fronted Geese. Nesting success for King Eiders and Long-tailed Ducks was 43% and 38%, respectively. For all duck species combined, nesting success was 39% (19 successful of 49 known fate). Fifty percent of Willow Ptarmigan nests were successful.

Nesting success varied among search areas for some species. Notably, ≥73% of the Greater White-Fronted Goose nests in the Alpine West search area and searched portions of the road corridor hatched, similar to the success rate in CD North. Canada Goose nests in Alpine West had a similar success rate (65%). However, only 10% of the Greater White-fronted Goose nests hatched in the Lookout search area. Both arctic and red foxes were active in the Lookout search area; observers saw 3 goose nests depredated by red and arctic foxes, and evidence at many of the remaining failed nests suggested that foxes were responsible for many nest failures in the Lookout area.

Habitat Use

As with nesting success, habitat use was evaluated for all NPRA ground-search areas

Table 13. Number and density of nests and nesting success of birds in the NPRA search areas, Alaska, 2003.

Species	Number of Nests				Success[a] (%)	Density[b] (nests/km²)
	Total	Successful	Failed	Unknown		
Greater White-fronted Goose	185	119	62	4	66	5.8
Canada Goose	46[c4]	24	21	1	53	1.4
Brant	18	5	12	1	29	0.6
Unknown goose	3	1	2	0	33	0.1
Tundra Swan	1	0	1	0	0	<0.1
Northern Pintail	4	1	3	0	25	0.1
Green-winged Teal	1	0	1	0	0	<0.1
Greater Scaup	1	1	0	0	100	<0.1
Scaup	1	0	1	0	0	<0.1
Spectacled Eider	3[c1]	2	1	0	67	0.1
King Eider	23[c5]	10	13	0	43	0.7
Long-tailed Duck	14[c1]	5	8	1	38	0.4
Red-breasted Merganser	1	0	0	1	–	<0.1
Unknown duck	3	0	3	0	0	0.1
Willow Ptarmigan	12	5	5	2	50	0.4
Unknown ptarmigan	2	1	1	0	50	0.1
Red-throated Loon	4	2	0	2	–	0.1
Pacific Loon	28[d]	9	3	16	–	0.9[e]
Yellow-billed Loon	3	1	1	1	–	0.1
Bar-tailed Godwit	6	0	1	5	–	0.2
Parasitic Jaeger	7	5	0	2	–	0.2
Long-tailed Jaeger	2	0	0	2	–	0.1
Glaucous Gull[f]	22	15	2	5	–	0.7
Sabine's Gull[f]	8	1	0	7	–	0.2
Arctic Tern	21	10	1	10	–	0.7
Total Nests	419	217	142	60	–	13.1

[a] Estimates are provided only for waterfowl and ptarmigan, as explained in text; nest success = number successful / (number successful + number failed) × 100
[b] Density calculations based on a search area of 31.9 km²
[c] Superscript denotes number of nests identified to species by feather and down sample
[d] Includes 2 renesting attempts, one attempt was successful and the other was not
[e] Density includes 2 cases of renesting; density without renesting = 0.8 nests/km²
[f] Includes nests sighted on aerial survey

combined (31.9 km²), including both pad and road corridor search areas (Tables 4 and 11; Appendix C5). Habitat use was documented for 406 nests of 21 species in the 2003 NPRA ground-search areas (Table 14). Seventy percent of nests were located in 4 habitat types: Old Basin Wetland Complex (22% of nests, 15% of total area), Shallow Open Water with Islands or Polygonized Margins (19% of nests, 5% of total area), Patterned Wet Meadow (17% of nests, 14% of total area), and Moist Sedge–Shrub Meadow (12% of nests, 18% of total area). Shallow Open Water with Islands or Polygonized Margins was used for nesting in far greater proportion than its availability, while Moist Tussock Tundra was used very little in proportion to availability (9% of nests, 22% of total area). Species richness was greatest in Old Basin Wetland Complex (12 species), Shallow Open Water with Islands or Polygonized Margins (11 species), and Moist Sedge–Shrub Meadow (10 species). Nine

Table 14. Habitat availability and habitat use during nesting in the NPRA search areas, Alaska, 2003.

Habitat	Habitat Availability[a]	Greater White-fronted Goose	Canada Goose	Brant	Tundra Swan	Northern Pintail	Green-winged Teal	Greater Scaup	Spectacled Eider	King Eider	Long-tailed Duck	Red-breasted Merganser	Willow Ptarmigan	Red-throated Loon	Pacific Loon	Yellow-billed Loon	Bar-tailed Godwit	Parasitic Jaeger	Long-tailed Jaeger	Glaucous Gull	Sabine's Gull	Arctic Tern	All Species	Number of Nests	Number of Species
Deep Open Water without Islands	4	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	<1	2	1
Deep Open Water with Islands or Polygonized Margins	3	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0	0	13	5	1	5	3
Shallow Open Water without Islands	1	<1	7	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	5	0	5	2	8	5
Shallow Open Water with Islands or Polygonized Margins	5	<1	59	56	0	0	0	0	0	22	14	100	0	25	32	0	0	0	0	73	13	24	19	78	11
River or stream	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aquatic Sedge Marsh	4	<1	0	0	0	25	0	0	0	13	14	0	0	0	21	33	0	14	0	5	50	29	6	26	10
Aquatic Grass Marsh	<1	0	0	0	0	0	0	0	33	0	0	0	0	0	7	0	0	0	0	0	0	0	1	3	2
Young Basin Wetland Complex	5	4	4	44	0	0	0	100	0	4	7	0	0	0	0	0	0	29	0	5	0	14	6	26	9
Old Basin Wetland Complex	15	26	30	0	0	25	0	0	67	35	29	0	9	50	0	0	0	57	50	9	0	9	22	88	12
Riverine Complex	1	2	0	0	0	0	0	0	0	0	0	0	0	25	4	0	0	0	0	0	0	0	2	6	3
Nonpatterned Wet Meadow	8	2	0	0	0	0	0	0	0	4	0	0	0	0	7	0	0	0	0	0	0	5	2	8	4
Patterned Wet Meadow	14	29	0	0	100	50	0	0	0	13	21	0	18	0	0	33	50	0	0	5	0	0	17	68	9
Moist Sedge–Shrub Meadow	18	20	0	0	0	0	0	0	0	9	7	0	18	0	4	33	33	0	50	0	25	9	12	52	10
Moist Tussock Tundra	22	16	0	0	0	0	100	0	0	0	7	0	55	0	0	0	17	0	0	0	0	0	9	38	5
Riverine Low and Tall Shrub	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Riverine or Upland Shrub[b]	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Upland and Riverine Dwarf Shrub	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		
Total Nests[c]		182	46	18	1	4	1	1	3	23	14	1	11	4	28	3	6	7	2	22	8	21	406		21

[a] % habitat availability based on 31.6 km^2 of mapped habitat within the 31.9 km^2 total area searched

[b] Riverine and Upland Shrub habitat was classified only on the Colville River Delta; the road corridor extends onto the Colville River Delta to connect with CD-2

[c] Excludes 13 nests: 9 nests belonging to unknown species (3 unknown goose, 1 unknown scaup, 3 unknown duck, and 2 unknown ptarmigan), and 4 nests lacking habitat data (in unmapped area): 3 Greater White-fronted Goose nests and 1 Willow Ptarmigan nest)

species nested in Young Basin Wetland Complex and Patterned Wet Meadow and no other habitat type had >5 nesting species.

The guild of birds nesting primarily in aquatic habitats (>85% of total habitat use, nest number >5) included Canada Goose, Brant, Parasitic Jaegers, Glaucous Gulls, and Arctic Terns. The guild of birds nesting primarily in non-aquatic habitats (wet or moist meadows and tundra) included Willow Ptarmigan and Bar-tailed Godwit. Several species nested in a broad range of habitat types: Greater White-fronted Geese, Northern Pintail, King Eider, and Long-tailed Ducks. Habitat use by geese, swans, eiders, loons, and gulls are discussed in detail in their species account, below.

Sixty-five brood locations of 16 species were documented in 2003 (Figures 17 and 19, Table 15). Just over 50% of all brood locations and the highest species richness during brood-rearing occurred in open water habitats with islands: Shallow Open Water with Islands or Polygonized Margins (37% of broods, 7 species) and Deep Open Water with Islands or Polygonized Margins (15% of broods, 6 species). Only 4 species were observed in non-aquatic habitats: Greater White-fronted Goose, Canada Goose, Northern Pintail, and Willow Ptarmigan. Three habitat types were used in higher proportion than their availability: Shallow Open Water with Islands or Polygonized Margins (37% of locations, 5% of total area), Deep Open Water with Islands or Polygonized Margins (15% of locations, 3% of total area), and Shallow Open Water without Islands (6% of locations, 1% of total area). Habitat use of focal species is discussed further in their respective sections, below.

NPRA BREEDING-BIRD PLOTS

NEST DENSITIES

During 5 visits (plot marking and nest searching visits) to 24 breeding-bird plots in 2003, 199 nests were found belonging to 20 species of birds, yielding 83 nests/km² (Table 16). During nest monitoring visits, an additional 7 nests were found incidentally; inclusion of these nests yielded a total density of 86 nests/km². Nesting species included 10 species of shorebirds, 4 species of passerines, 4 species of waterfowl, plus Willow Ptarmigan and Arctic Terns. The total number of nests per plot found during these 5 visits ranged from 3–15 nests (30–150 nests/km²; Table 16). Species composition over all plots was 47% shorebirds (93 nests, 39 nests/km²), 46% passerines (92 nests, 38 nests/km²), 6% waterfowl (11 nests, 5 nests/km²), and 1% other birds (3 nests, 1 nest/km²; Table 17). Shorebirds, passerines, and waterfowl nested on at least 1 plot in all 6 plot clusters (4 plots/cluster) in 2003 (Table 17). On 4 of 6 plot clusters, passerines were the most common species group nesting. On the other 2 plot clusters, shorebirds were more abundant than passerines. The number of species per plot cluster ranged from 8 to 13 in the NPRA study area in 2003 (Appendix D1). The most common breeding birds were Lapland Longspurs (77 nests, 39% of all nests), Semipalmated Sandpipers (28 nests, 14%), and Pectoral Sandpipers (26 nests, 13%; Table 16). Lapland Longspurs were found nesting on 22 of 24 plots and the number of longspur nests per plot ranged from 0–6 nests (mean = 3 nests/plot). For both Semipalmated Sandpipers and Pectoral Sandpipers, the largest number of nests found on a plot was 4 (Table 16).

The number (197 nests) and density (82 nests/km²) in 2002 were similar to 2003, but the proportion of shorebirds and passerines differed between years. In 2002, shorebirds were twice as abundance as passerines (120 nests versus 61, respectively; Burgess et al. 2003b), while in 2003 the number of shorebirds and passerines was similar.. Many longspur nests probably were missed in 2002 because the window of opportunity to find nests was reduced compared to 2003. The nesting season for shorebirds and passerines was earlier in 2002 than in 2003 (see Conditions in the Study Area); most Lapland Longspur nests had nestlings when surveys began on 10 June in 2002, whereas in 2003, the first hatch was recorded on 20 June. In 2002, 77% of the longspur nests were inactive by the 4th nest visit, whereas in 2003, only 34% were inactive by that visit. Shorebird nesting may have been reduced in 2003 by the persistent flooding of wet habitats from snow melt. Of all shorebird species, the number of Red-necked Phalarope nests changed the most between years (from 18 nests in 2002 to 7 nests in 2003). Red-necked Phalaropes commonly nest in wet sedge meadows and many of these meadows remained flooded longer into the breeding season

Table 15. Habitat use during brood-rearing in the NPRA search areas, Alaska, 2003.

Habitat	Greater White-fronted Goose	Canada Goose	Brant	Northern Pintail	Greater Scaup	Spectacled Eider	King Eider	Long-tailed Duck	Willow Ptarmigan	Red-throated Loon	Pacific Loon	Yellow-billed Loon	Parasitic Jaeger	Glaucous Gull	Sabine's Gull	Arctic Tern	All Species	Number of Brood Locations	Number of Species
Deep Open Water without Islands	14	0	0	0	100	0	0	0	0	0	7	0	0	0	0	0	6	4	3
Deep Open Water with Islands or Polygonized Margins	43	0	50	0	0	100	0	0	0	0	21	100	0	0	0	11	15	10	6
Shallow Open Water without Islands	0	0	0	0	0	0	0	100	0	0	15	0	0	9	0	0	6	4	3
Shallow Open Water with Islands or Polygonized Margins	14	0	0	0	0	0	50	0	0	100	50	0	0	73	100	55	37	24	7
Aquatic Sedge Marsh	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	11	3	2	2
Young Basin Wetland Complex	0	0	0	0	0	0	0	0	0	0	7	0	20	9	0	0	5	3	3
Old Basin Wetland Complex	14	0	0	0	0	0	50	0	0	0	0	0	80	0	0	22	12	8	4
Riverine Complex	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
Patterned Wet Meadow	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
Moist Sedge–Shrub Meadow	0	100	0	0	0	0	0	0	80	0	0	0	0	0	0	0	8	5	2
Moist Tussock Tundra	0	0	0	50	0	0	0	0	20	0	0	0	0	0	0	0	3	2	2
Riverine Low and Tall Shrub	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1
Total %	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100		16
Total Brood Locations	7	1	2	2	2	1	2	1	5	1	14	1	5	11	1	9		65	

Table 16. Number and density of nests on 24 breeding-bird plots, NPRA study area, Alaska, 2003.

	Plot Number																								Total	Density[a]
Species	1	2	3	4	25	26	27	28	33	34	35	36	45	46	47	48	53	54	55	56	101	102	103	104	Nests	(nests/km²)
Greater White-fronted Goose	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	4	1.7
Northern Pintail	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	1.3
King Eider	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	2	0.8
Long-tailed Duck	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0.8
Willow Ptarmigan	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0.8
Black-bellied Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	3	1.3
American Golden Plover	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	3	1.3
Bar-tailed Godwit	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0.4
Semipalmated Sandpiper	1	1	0	0	1	2	1	4	3	1	0	0	2	0	3	4	0	0	0	3	2	0	0	0	28	11.7
Pectoral Sandpiper	1	0	2	2	0	1	1	0	1	2	1	0	1	0	0	0	3	2	1	4	1	1	1	1	26	10.8
Dunlin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	3	1.3
Stilt Sandpiper	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	0	0	4	1.7
Long-billed Dowitcher	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	1	8	3.3
Red-necked Phalarope	1	0	1	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	1	0	0	0	0	0	7	2.9
Red Phalarope	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	3	2	1	0	0	0	0	10	4.2
Arctic Tern	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.4
Yellow Wagtail	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.4
Savannah Sparrow	0	0	0	0	0	2	0	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	1	8	3.3
Lapland Longspur	2	5	4	3	2	5	5	4	4	6	1	2	0	4	1	0	4	1	3	2	5	5	5	4	77	32.1
Common Redpoll	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	6	2.5
Total Nests	5	9	9	6	4	14	10	10	10	11	8	3	5	4	6	6	12	8	11	15	11	8	7	7	199	
Density (nests/km²)	50	90	90	60	40	140	100	100	100	110	80	30	50	40	60	60	120	80	110	150	110	80	70	70		82.9
Number of Species	4	5	4	3	3	7	6	3	5	4	5	2	4	1	4	3	6	5	6	7	6	4	3	4	20	

[a] Each plot was 10 hectares, see Figure 5

Table 17. Number and density of nests by species group on clusters of breeding-bird plots (4 plots per cluster), NPRA study area, Alaska, 2003.

	Shorebirds		Passerines		Waterfowl		Other Birds[a]	
Plots	Number	Density[b] (nests/km²)	Number	Density[b] (nests/km²)	Number	Density[b] (nests/km²)	Number	Density[b] (nests/km²)
1–4	13	32.5	15	37.5	1	2.5	0	0
25–28	11	27.5	23	57.5	3	7.5	1	2.5
33–36	14	35.0	16	40.0	1	2.5	1	2.5
45–48	15	37.5	5	12.5	1	2.5	0	0
53–56	31	77.5	13	32.5	2	5.0	0	0
101–104	9	22.5	20	50.0	3	7.5	1	2.5
Total Nests	93	38.8	92	38.3	11	4.6	3	1.3
Number of Species	10		4		4		2	

[a] Includes ptarmigan and terns
[b] Density based on a plot cluster area of 0.4 km²

in 2003 than in 2002. The 2001 breeding season phenology was more similar to 2002, and the proportion of all shorebird to passerine nests in 2001 also was similar to 2002.

In 2003, the 5 most abundant shorebird species were Semipalmated Sandpiper (12 nests/km²), Pectoral Sandpiper (11 nests/km²), Red Phalarope (4 nests/km²), Long-billed Dowitcher (3 nests/km²), and Red-necked Phalarope (3 nests/km²). Pectoral Sandpiper nests were found on the largest number of plots (17 plots) in 2003, followed by Semipalmated Sandpiper (13 plots), Long-billed Dowitcher (7 plots), Red-necked Phalarope (5 plots), and Red Phalarope (5 plots; Table 16). These same 5 species also were the most abundant shorebird species in 2002, but the order of abundance differed (Burgess et al. 2003b). The same was true in 2001, except that Black-bellied Plovers were more common than Red Phalaropes. Shorebird species composition was similar in all 3 years, except Baird's Sandpiper (1 nest) occurred only in 2001 and Buff-breasted Sandpiper (6 nests) occurred only in 2002.

Among the 4 species of passerines nesting in the NPRA breeding-bird plots in 2003 (Yellow Wagtail, Savannah Sparrow, Lapland Longspur, and Common Redpoll), 84% of the nests (77 of 92 nests, 32 nests/km²) belonged to Lapland Longspurs (Table 16). The density of Lapland Longspur nests on plots was 40–50% higher in 2003 than it was in 2001 and 2002 (Burgess et al. 2003b). Savannah Sparrows and Common Redpolls nested in much lower densities (3 and 2 nests/km², respectively, in 2003). One additional longspur nest and two additional redpoll nests were not included in the reported density in 2003 because they were inactive when found and may have been duplicate and unused nest bowls within a single breeding territory or they may have been abandoned or failed during laying. One Yellow Wagtail nest was found in 2003 (0.4 nests/km²). Lapland Longspur nests were found on 22 of the 24 plots (Table 16). Savannah Sparrow nests were found on 5 plots, Common Redpoll nests were found on 4 plots, and a Yellow Wagtail nest was found on 1 plot.

The 4 waterfowl species that nested on breeding bird plots in 2003 were Greater White-fronted Goose, Northern Pintail, King Eider, and Long-tailed Duck (Table 16). The nest density of all waterfowl species on plots in 2003 was 5 nests/km² (11 nests; Table 17). The most abundant waterfowl species nesting in the NPRA breeding bird plots was the Greater White-fronted Goose (2 nests/km²), followed by Northern Pintail (1 nest/km²), King Eider (1 nest/km²), and Long-tailed Duck (1 nest/km²). All species, except for King Eider, also were found nesting in the NPRA breeding-bird plots in 2001 and 2002 (Burgess et al. 2003b). Additionally, 1 Greater Scaup nest was found on plot in 2002. The breeding-bird plots were not designed to census low-density waterfowl, so only the most abundant species are likely to appear in plots. Nonetheless, the breeding-bird plots do provide a reasonable estimate of the overall density of waterfowl species in the areas sampled.

Other birds occurring on the NPRA breeding bird plots in 2003 included Willow Ptarmigan (2 nests, 1 nest/km²), and Arctic Tern (1 nest, 0.4 nests/km²; Table 16). A Red-throated Loon nest was found on plot in 2003 during the nest monitoring period of the study on the same small waterbody where a nest was found in 2002. Nests of 3 additional species were found off plot in 2003—Brant, Pacific Loon, and Long-tailed Jaeger.

NESTING SUCCESS AND SURVIVAL RATES

All nests found on (206 nests, including 7 nests found during nest monitoring visits) and off (103 nests) the NPRA breeding-bird plots in 2003 were checked for nest fate. Of these 309 nests, 199 were successful, 99 failed, and 11 were unknown fate. Eggshell evidence found at successful and failed shorebird nests during this study corroborated patterns of evidence found at nests of other shorebird species (Mabee 1997). Known successful shorebird nests (those with chicks) all contained eggshell fragments in the nest scrape (Appendix D2). Also, eggshell tops or bottoms were found only near successful nests. For calculations of daily survival rate (DSR), the nests of unknown fate and nests that had insufficient data (e.g., found on the day of hatch or were found failed) were excluded. Mean DSR was calculated for each plot cluster for species with ≥4 total nests, for species groups in each plot cluster, and for all plots together.

Daily survival rates during the incubation period in 2003 were quite variable both among groups of birds (i.e., shorebirds, waterfowl, passerines) and among the species composing these groups (Table 18). Overall, shorebirds had the highest DSR, followed by passerines and waterfowl, similar to results from 2002 (Burgess et al. 2003b). By raising the DSR to the power of the average incubation period for the species of interest, one can calculate an improved estimate of nesting success (% of nests hatched). Shorebird nesting success in the NPRA study area during 2003 (using mean DSR and assuming a mean incubation period of 23 d) was 60% (0.978^{23}; Table 18), similar to the 64% nesting success in 2002 (Burgess et al. 2003b). Among shorebirds, Long-billed Dowitchers had the highest survival rates in 2003, followed by Red Phalaropes, Red-necked Phalaropes, Semipalmated Sandpipers, Pectoral Sandpipers, and Black-bellied Plovers. The differences in these survival rates resulted in substantial differences in nesting success, with 86% nesting success for Long-billed Dowitchers and 26% for Black-bellied Plovers (Table 18). Daily survival rate for each shorebird species was similar in 2002 and 2003 (Burgess et al. 2003b). Waterfowl nesting success was low overall (~26%) and ranged from 1% (plots 101–104) to 45% (plots 51–54; Table 18), slightly better than the overall success (18%) during 2002 (Burgess et al. 2003b).

Nesting success of passerines (predominantly of Lapland Longspurs) was moderate overall (68%) and ranged from 82% (plots 1–4) to 59% (in plots 21–24, 31–34; Table 18). Survival rates of passerine nestlings (throughout incubation and until birds left the nest) also were variable among clusters (again, predominantly Lapland Longspurs; Table 18). Nestling success of Lapland Longspurs was high overall in the NPRA study area (83%), ranging from 95% (plots 1–4) to a low of 73% (plots 41–44). Survival rates during the incubation and nestling periods were similar to those documented in 2002 (Burgess et al. 2003b).

NEST PREDATORS

Jaegers and gulls were the most abundant and widespread nest predators observed at breeding-bird plots. Potential nest predators seen incidentally while working on plots included Long-tailed, Parasitic and Pomarine Jaeger (61% of 650 sightings), Glaucous Gull (26%), caribou (5%), Common Raven (3%), arctic and red fox (2%), arctic ground squirrel (2%), and raptor (1%; Appendix D3). Caribou and ground squirrels were included as potential nest predators because both species are known to cause nest loss, through trampling by caribou and egg predation by ground squirrels. All predators except foxes also were seen on the timed counts and the proportion in each predator group was similar to that seen on the incidental counts, with jaegers being the most common predator (61% of 102 sightings), followed

Table 18. Mean daily survival rates for nests on breeding-bird plots, NPRA study area, Alaska, 2003.

SPECIES GROUP / Species	Mean Daily Survival Rate ± SE (Number of Nests)						
	All Plots	Plots 1–4	Plots 21–24	Plots 31–34	Plots 41–44	Plots 51–54	Plots 101–104
SHOREBIRDS[a]	0.978 ± 0.004 (125)	0.956 ± 0.016 (14)	0.983 ± 0.008 (18)	0.985 ± 0.007 (22)	0.980 ± 0.008 (21)	0.978 ± 0.006 (40)	0.977 ± 0.013 (10)
Black-bellied Plover	0.949 ± 0.019 (9)	(0)	(0)	(1)	(2)	0.957 ± 0.021 (6)	(0)
Long-billed Dowitcher	0.993 ± 0.007 (9)	1.000 ± 0.000 (4)	(0)	(0)	(0)	(3)	(2)
Pectoral Sandpiper	0.975 ± 0.007 (34)	0.952 ± 0.027 (5)	0.975 ± 0.025 (4)	0.984 ± 0.011 (8)	(1)	0.972 ± 0.014 (12)	0.983 ± 0.017 (4)
Red Phalarope	0.989 ± 0.011 (9)	(0)	(0)	(2)	(1)	0.980 ± 0.020 (6)	(0)
Red-necked Phalarope	0.987 ± 0.009 (10)	(2)	(0)	0.990 ± 0.010 (6)	(1)	(1)	(0)
Semipalmated Sandpiper	0.984 ± 0.005 (37)	(2)	0.994 ± 0.006 (11)	0.986 ± 0.014 (5)	0.981 ± 0.011 (11)	1.000 ± 0.000 (5)	(3)
WATERFOWL[b]	0.947 ± 0.014 (21)	(2)	0.874 ± 0.059 (4)	(3)	(2)	0.965 ± 0.020 (6)	0.838 ± 0.088 (4)
Greater White-fronted Goose	0.946 ± 0.018 (12)	(1)	(2)	(3)	(0)	(2)	0.838 ± 0.088 (4)
PASSERINES[c] (Incubation)	0.968 ± 0.007 (99)	0.984 ± 0.011 (17)	0.957 ± 0.019 (19)	0.957 ± 0.019 (18)	(4)	0.961 ± 0.019 (18)	0.983 ± 0.010 (23)
Common Redpoll	0.933 ± 0.029 (9)	(1)	(3)	(0)	(0)	(3)	(2)
Lapland Longspur	0.970 ± 0.007 (85)	0.982 ± 0.013 (16)	0.950 ± 0.024 (14)	0.948 ± 0.023 (16)	0.915 ± 0.058 (4)	0.988 ± 0.012 (15)	0.986 ± 0.010 (20)
PASSERINES[d] (Incubation and Nestling Periods)	0.977 ± 0.004 (132)	0.994 ± 0.004 (24)	0.965 ± 0.011 (25)	0.967 ± 0.011 (23)	0.962 ± 0.022 (8)	0.968 ± 0.011 (24)	0.988 ± 0.005 (28)
Common Redpoll	0.936 ± 0.024 (9)	(1)	(3)	(0)	(0)	(3)	(2)
Lapland Longspur	0.981 ± 0.004 (114)	0.994 ± 0.005 (23)	0.975 ± 0.011 (17)	0.965 ± 0.012 (20)	0.962 ± 0.022 (8)	0.978 ± 0.010 (21)	0.989 ± 0.006 (25)
ALL SPECIES	0.972 ± 0.003 (259)	0.963 ± 0.011 (35)	0.966 ± 0.009 (43)	0.976 ± 0.007 (44)	0.978 ± 0.007 (30)	0.973 ± 0.006 (67)	0.976 ± 0.008 (40)

[a] Also includes American Golden Plover ($n = 4$), Bar-tailed Godwit ($n = 1$), Dunlin ($n = 5$), and Stilt Sandpiper ($n = 7$)
[b] Includes Brant ($n = 1$), Greater White-fronted Goose ($n = 12$), Long-tailed Duck ($n = 2$), Northern Pintail ($n = 3$), and King Eider ($n = 3$)
[c] Incubation period; includes Lapland Longspur ($n = 85$), Common Redpoll ($n = 9$), Savannah Sparrow ($n = 4$), and Yellow Wagtail ($n = 1$)
[d] Incubation and nestling period; includes Lapland Longspurs ($n = 114$), Common Redpoll ($n = 9$), Savannah Sparrow ($n = 8$), and Yellow Wagtail ($n = 1$)
[e] Incubation period; also includes Arctic Tern ($n = 5$), Long-tailed Jaeger ($n = 1$), Pacific Loon ($n = 1$), Red-throated Loon ($n = 1$), and Willow Ptarmigan ($n = 6$)

by Glaucous Gulls (31%), caribou (3%), Common Raven (3%), arctic ground squirrel (1%), and raptor (1%; Appendix D3). Avian predators were most often seen flying over plots and only occasionally landed on plot. During timed counts, jaegers were seen on 20 of 24 plots and Glaucous Gulls were seen on 16 of 24 plots (Appendix D4).

Mean number of predators seen per hour was higher for timed counts (overall mean = 4.3 predators/hr) compared to incidental counts (overall mean = 1.2 predators/hr; Appendix D3). During timed counts observers were focused on detecting predators while during incidental counts observers were focused on other activities, and predators probably were missed. An exception was foxes, which were not observed during timed counts, probably because they occurred infrequently. However, many trends are similar between the 2 methods. The 3 plot clusters (45–48, 25–28, and 101–104) with the highest occurrence of predators were the same for each of the 2 types of counts (Appendix D3).

SPECIES ACCOUNTS

SPECTACLED EIDER

Of the 4 species of eiders that may occur on the Colville Delta and in the NPRA study area, the Spectacled Eider has received the most attention because it was listed as a threatened species under the Endangered Species Act in 1993 (58 FR 27474-27480) and because it nests in both areas. The Spectacled Eider is a common breeding bird across the outer Colville Delta but occurs only in low numbers in inland parts of the delta (such as the CD South study area) and in scattered wetland basins in the NPRA study area (Burgess et al. 2003a, 2003b; Johnson et al. 2003b).

Colville River Delta

Distribution and Abundance

Pre-nesting—The 2003 aerial survey for pre-nesting eiders on the Colville Delta was conducted on 13–15 June (Table 1), which is similar to the period flown in previous years. All sightings of Spectacled Eiders were of groups of 1–3 birds distributed across the study area in potential nesting habitat (Figure 20). During the 2003 pre-nesting survey, we recorded the smallest number of Spectacled Eiders on the Colville Delta of any previous year (Figure 21, Table 19). No Spectacled Eiders were seen in the CD South study area, whereas 17 Spectacled Eiders (14 indicated birds [USFWS 1987b]) were sighted in the CD North study area, and 7 (6 indicated birds) were sighted in the northeast delta (Table 19). The trend line for the CD North study area suggests a decline may have occurred in this area after 1998 or 1999; however the number of Spectacled Eiders across the Arctic Coastal Plain has remained relatively stable with a slightly decreasing and insignificant trend (Larned et al. 2003). The Arctic Coastal Plain survey is probably more robust to variation in timing of arrival of Spectacled Eiders than the survey of the Colville Delta, because it is conducted over a longer period of time (6–11 days) and a larger survey area (30,755 km²).

Although our 2003 survey of the Colville Delta appeared to be conducted at an appropriate time relative to the arrival and departure of male Spectacled Eiders, survey conditions were only fair, which probably reduced both the number of eiders in the study area as well as the proportion of eiders in the area that were seen from the aircraft. High winds prevented aerial surveys on most of 10–12 June, and winds remained at 10–20 mph during the eider survey period, causing the aircraft to travel at higher than normal speeds on downwind transects. High wind speeds and low ceilings with snow flurries limited the number of hours that surveys were conducted on the days that flying was attempted. Lakes refroze each night during the survey period, possibly causing eiders to move to other areas for open water, and patchy snow and ice created difficult viewing conditions for aerial observers. Surveys were flown in suboptimal viewing conditions because there were too few hours of favorable flying weather to complete all the areas that required surveys. Similar limitations encountered on the aerial survey of the Arctic Coastal Plain caused a postponement for 5 days and required use of an additional aircraft to finish the survey, which is normally completed with 1 aircraft (Larned et al. 2003).

Relative to nearby areas, the CD North study area generally supports high densities of Spectacled Eiders. The CD North study area contained higher densities of Spectacled Eiders (0.08 birds/km²) than did the more inland CD

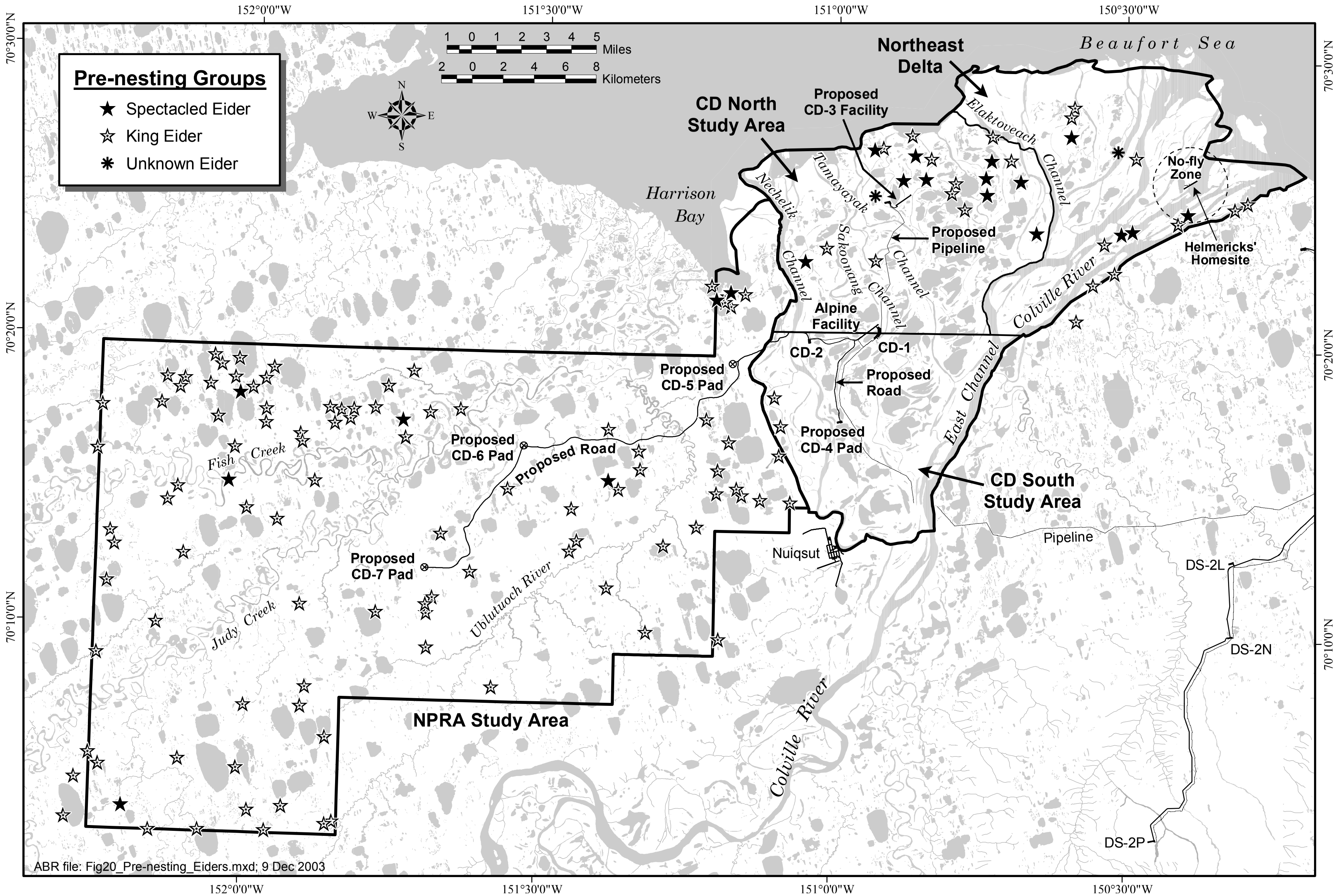

Figure 20. Spectacled, King, and unidentified eider groups (flying and on the ground) during pre-nesting aerial surveys of the CD North, CD South, and NPRA study areas, Alaska, 2003.

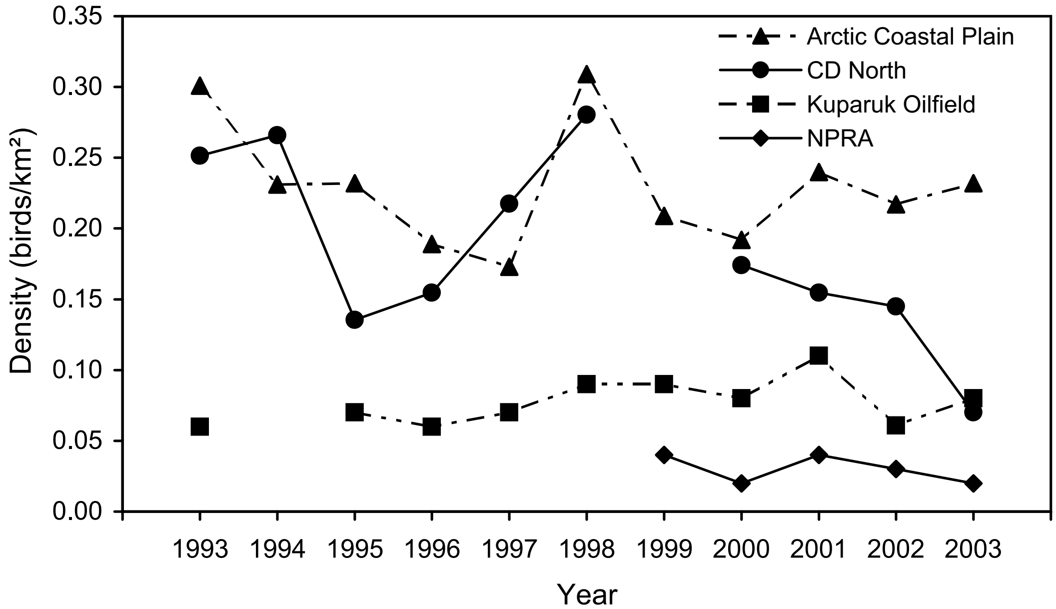

Figure 21. Trends in density of Spectacled Eiders (indicated birds; USFWS 1987a) from pre-nesting surveys in the CD North study area, NPRA, Kuparuk Oilfield, and Arctic Coastal Plain, Alaska, 1993–2003. Data are from Anderson et al. (2004), Larned et al. (2003), and this study.

South study area (0 birds) or the northeast delta (0.04 birds/km²; Figure 20, Table 19). The CD North study area also had higher densities of Spectacled Eiders than did the NPRA study area (0.02 birds/km²), immediately to the west, and the Kuparuk Oilfield (0.05 birds/km²; Anderson et al. 2004), immediately east of the delta.

Spectacled Eiders on the Colville Delta were closely associated with coastal areas in all years, and their distribution during pre-nesting in 2003 (Figure 20) was similar to that observed in previous surveys (Johnson et al. 2003b). During 2003, the mean distance of pre-nesting Spectacled Eiders from the coast was 5.0 km (n = 14 sightings), and the maximal distance was 10.3 km.

Nesting—The distribution of Spectacled Eiders during nesting is similar to the distribution observed on pre-nesting aerial surveys; more nests occur on the outer Colville Delta in the CD North study area than in the CD South study area (Burgess et al. 2003a, Johnson et al. 2003b). Nest searches of the CD North search area in 2003 produced 12 Spectacled Eider nests (0.7 nests/km²) and 1 unidentified eider nest (0.1 nests/km²), (Figure 13, Table 5). An additional nest was found outside the search-area boundary during the nest-fate visit. The density of Spectacled Eider nests was the same as the mean of 4 years that nest searches were conducted in this area.

Three of the 13 Spectacled Eider nests found in 2003 hatched (23% apparent nesting success includes 1 nest outside the search area) and mean clutch size was 4 eggs (n = 7 nests). Three Spectacled Eider nests and 1 unidentified eider nest had failed before their discovery, and their identification was based on color patterns of contour feathers (Anderson and Cooper 1994). Apparent nesting success of Spectacled Eider nests in 2003 was slightly lower than the overall success of all nests we have found on the delta (31 %, n = 55 nests of known fate), but mean clutch size in 2003 was the same as the long-term average.

Brood-rearing—Three Spectacled Eider broods were seen in the CD North search area in 2003 (Figure 15, Table 6). Broods of eiders are probably undercounted because the hens and young are cryptic and often use cover along shorelines to hide. Brood size for Spectacled Eiders in 2003

Table 19. Number and density of eiders during pre-nesting aerial surveys of the CD North and CD South study areas, the northeast delta, and the NPRA study area, Alaska, 2003.

STUDY AREA	Numbers of Eiders					Density (birds/km²)[a]	
	Observed						
Species	Males	Females	Total	Pairs	Indicated Total[b]	Observed Total	Indicated Total[b]
CD NORTH STUDY AREA[c]							
Spectacled Eider							
On Ground	7	5	12	5	14	0.06	0.07
Flying	4	1	5	1	–	0.02	–
All Birds	11	6	17	6	–	0.08	–
King Eider							
On Ground	5	2	7	2	10	0.03	0.05
Flying	5	5	10	5	–	0.05	–
All Birds	10	7	17	7	–	0.08	–
CD SOUTH STUDY AREA[d]							
King Eider							
On Ground	1	0	1	0	2	0.01	0.01
Flying	1	0	1	0	–	0.01	–
All Birds	2	0	2	0	–	0.01	–
NORTHEAST DELTA[c]							
Spectacled Eider							
On Ground	3	3	6	3	6	0.04	0.04
Flying	1	0	1	0	–	0.01	–
All Birds	4	3	7	3	–	0.04	–
King Eider							
On Ground	13	12	25	7	26	0.15	0.16
Flying	4	3	7	0	–	0.04	–
All Birds	17	15	32	7	–	0.20	–
NPRA STUDY AREA							
Spectacled Eider							
On Ground	6	1	7	1	12	0.01	0.02
Flying	2	1	3	1	–	0.01	–
All Birds	8	2	10	2	–	0.02	–
King Eider							
On Ground	64	49	113	43	128	0.20	0.23
Flying	42	36	78	26	–	0.14	–
All Birds	106	85	191	69	–	0.34	–

[a] Density in CD North, CD South, and the northeast delta was calculated for 100% coverage of 206.7 km², 137.2 km², and 163.4 km², respectively; density in NPRA was calculated for 50% coverage of 1,085.2 km² and 100% coverage of 15.1 km² (total = 557.6 km² surveyed); numbers were not corrected for sightability

[b] Total indicated birds was calculated according to standard USFWS protocol (USFWS 1987a)

averaged 2.3 young, which was less than the mean (3.3 young/brood, *n* = 33 broods) of all years combined.

Habitat Use

During pre-nesting in 2003, >50% of the Spectacled Eiders used Deep Open Water with Islands or Polygonized Margins and Nonpatterned Wet Meadow (Table 20). Six habitats were preferred (use was significantly greater than availability) by Spectacled Eiders in a selection analysis using 10 years of surveys: Brackish Water, Salt Marsh, Salt-killed Tundra, Deep Open Water with Islands or Polygonized Margins, Shallow Open Water with Islands or Polygonized Margins, and Aquatic Sedge with Deep Polygons (Appendix E1). These preferred habitats are more common on the outer Colville Delta (19% of the CD North study area) than on the southern Colville Delta (4% of the CD South study area, Table 4), which may explain the higher densities of Spectacled Eiders in the CD North study area.

Nesting Spectacled Eiders used many of the same habitats that were preferred during pre-nesting (Table 7). In 2003, 58% of the Spectacled Eider nests in the CD North search area were in Patterned Wet Meadow and 25% were in Aquatic Sedge with Deep Polygons. Among all 4 years that nest searching was conducted in CD North, Spectacled Eiders used Patterned Wet Meadow, Aquatic Sedge with Deep Polygons, and Salt-killed Tundra (each occupied by >20% of the nests) in higher proportions than their availabilities, but none of the habitats were significantly preferred with the addition of the 2003 nests (Appendix E2). Prior analyses had shown Salt-killed Tundra as the only preferred nesting habitat in the CD North search area (Johnson et al. 2002b, 2003b).

Brood-rearing Spectacled Eiders primarily used the same habitats as were used for nesting. In 2003, 1 Spectacled Eider brood each used Shallow Open Water with Islands or Polygonized Margins, Aquatic Sedge with Deep Polygons, and Patterned Wet Meadow (Table 8). Of the 37 Spectacled Eider broods seen on the delta since 1993, >50% used Deep Open Water with Islands or Polygonized Margins, Aquatic Sedge with Deep Polygons, and Salt-killed Tundra.

NPRA Study Area

The NPRA study area is used by fewer Spectacled Eiders but more King Eiders than use the Colville Delta during the breeding period. In 2003, Spectacled Eiders occurred in a few wetland basins in the northern portion of the NPRA study area (Figure 20), and this distribution was consistent with observations in past years (Burgess et al. 2003b).

In 2003, the eider pre-nesting survey in the NPRA study area was conducted on 12–13 June (Table 1), within the time-frame typically flown in previous years. Ten Spectacled Eiders were seen during the aerial survey (Figure 20, Table 19), which was a slight decline from the number seen in 2002 (12 birds, Burgess et al. 2003b). The density of Spectacled Eiders in the NPRA study area (0.02 birds/km^2) was half or less that in the CD North study area (0.08 birds/km^2) and on the northeast delta (0.04 birds/km^2; Table 19).

Three Spectacled Eider nests (0.1 nests/km^2; 1 nest identified by contour feathers [Anderson and Cooper 1994]) were found in 2003 during searches of 31.6 km^2 around proposed pad locations and road corridors (Table 13). One nest was in the Alpine West search area, and 2 were in the northern road corridor and extension buffers (Figure 16, Appendix C2). Two nests hatched and 1 nest failed. Average clutch size was 4.0 eggs, same as the long-term average on the Colville Delta.

One Spectacled Eider brood was found in a large lake in the road corridor search area between Spark and Lookout during 2003 (Figure 19). That brood contained 3 young and was the first Spectacled Eider brood we have recorded in the NPRA study area.

Habitat Use

Old Basin Wetland Complex was the most important habitat for both species of eider in the NPRA study area. Pre-nesting Spectacled Eiders in 2003 used 5 habitats equally in the NPRA study area (Table 20). Three habitats were preferred by pre-nesting Spectacled Eiders during 3 years of surveys: Salt Marsh, Shallow Open Water with Islands or Polygonized Margins, and Old Basin Wetland Complex (Appendix E3). The selection analysis was constrained by small sample size (16 groups of Spectacled Eiders), so more habitats

Table 20. Habitat use by Spectacled Eider and King Eider groups during pre-nesting in the Colville River Delta and in the NPRA study area, Alaska, 2003.

	Colville Delta			NPRA		
SPECIES Habitat	Groups	Adults	Use[a] (%)	Groups	Adults	Use[a] (%)
SPECTACLED EIDER						
Salt Marsh	1	2	11.1	1	2	20.0
Salt-killed Tundra	1	2	11.1	0	0	0
Deep Open Water with Islands or Polygonized Margins	3	7	33.3	0	0	0
River or Stream	1	2	11.1	0	0	0
Aquatic Sedge with Deep Polygons	1	1	11.1	0	0	0
Old Basin Wetland Complex	0	0	0	1	1	20.0
Nonpatterned Wet Meadow	2	4	22.2	0	0	0
Patterned Wet Meadow	0	0	0	1	1	20.0
Moist Sedge–Shrub Meadow	0	0	0	1	2	20.0
Upland Low and Tall Shrub[b]	–	–	–	1	1	20.0
Total	9	18	100	5	7	100
KING EIDER						
Open Nearshore Water	1	1	7.7	0	0	0
Brackish Water	0	0	0	3	5	8.8
Tapped Lake with Low-water Connection	1	2	7.7	0	0	0
Salt Marsh	1	4	7.7	1	2	2.9
Deep Open Water without Islands	0	0	0	4	9	11.8
Deep Open Water with Islands or Polygonized Margins	0	0	0	1	4	2.9
Shallow Open Water without Islands	0	0	0	2	3	5.9
Shallow Open Water with Islands or Polygonized Margins	0	0	0	4	7	11.8
River or Stream	4	13	30.8	0	0	0
Aquatic Sedge Marsh	0	0	0	2	3	5.9
Old Basin Wetland Complex	0	0	0	7	20	20.6
Nonpatterned Wet Meadow	1	1	7.7	2	2	5.9
Patterned Wet Meadow	2	2	15.4	2	3	5.9
Moist Sedge–Shrub Meadow	0	0	0	3	10	8.8
Moist Tussock Tundra	0	0	0	2	4	5.9
Upland and Riverine Dwarf Shrub[b]	–	–	–	1	2	2.9
Barrens	3	10	23.1	0	0	0
Total	13	33	100	34	74	100

[a] % use = (groups / total groups) × 100.
[b] Upland Low and Tall Shrub and Upland and Riverine Dwarf Shrub were mapped in NPRA but not on the Colville River Delta

likely will be designated as preferred as sample size increases with additional surveys.

In 2003, 2 Spectacled Eider nests occurred in Old Basin Wetland Complex and 1 nest occurred in Aquatic Grass Marsh in the NPRA search areas (Table 14). We have records of only 8 Spectacled Eider nests (includes historical data) in the NPRA study area and 5 (62%) of those nests were in Old Basin Wetland Complex. Sample size was too small to conduct a selection analysis.

Only 1 Spectacled Eider brood was seen in 2003 in the NPRA search areas and that brood was in Deep Open Water with Islands or Polygonized Margins (Table 15). That habitat also was the most used habitat for brood-rearing on the Colville Delta.

KING EIDER

Colville River Delta

Distribution and Abundance

Pre-nesting—Unlike Spectacled Eiders, King Eiders are widespread across the study areas and generally occur in low densities on the Colville Delta (Figure 20, Table 19). In 2003, as in the past, pre-nesting King Eiders on the delta occurred in larger groups (maximum = 6) and used marine and riverine habitats that are not used for nesting (Johnson et al. 2003b). Therefore, a larger proportion of King Eiders than Spectacled Eiders on the Colville Delta appeared to be in transit to breeding habitats in other areas. The annual trend in King Eiders on the delta has been relatively stable, compared with the fluctuations that have occurred in the Kuparuk Oilfield and on Alaska's Arctic Coastal Plain, where densities are much higher than on the Colville Delta (Figure 22).

King Eiders generally have occurred in lower numbers than Spectacled Eiders during pre-nesting aerial surveys of the Colville Delta (Johnson et al. 2003b). However, in 2003, the number of King and Spectacled eiders was the same (17 flying and non-flying combined) in CD North (Table 19). Two King Eiders were sighted in the CD South study area, and 32 King Eiders were recorded on the northeast delta, more than 4 times the number of Spectacled Eiders seen in that area (Table 19). The northeast delta is highly dissected by distributary channels and has been used by large flocks of King Eiders in past years (Johnson et al. 2003b).

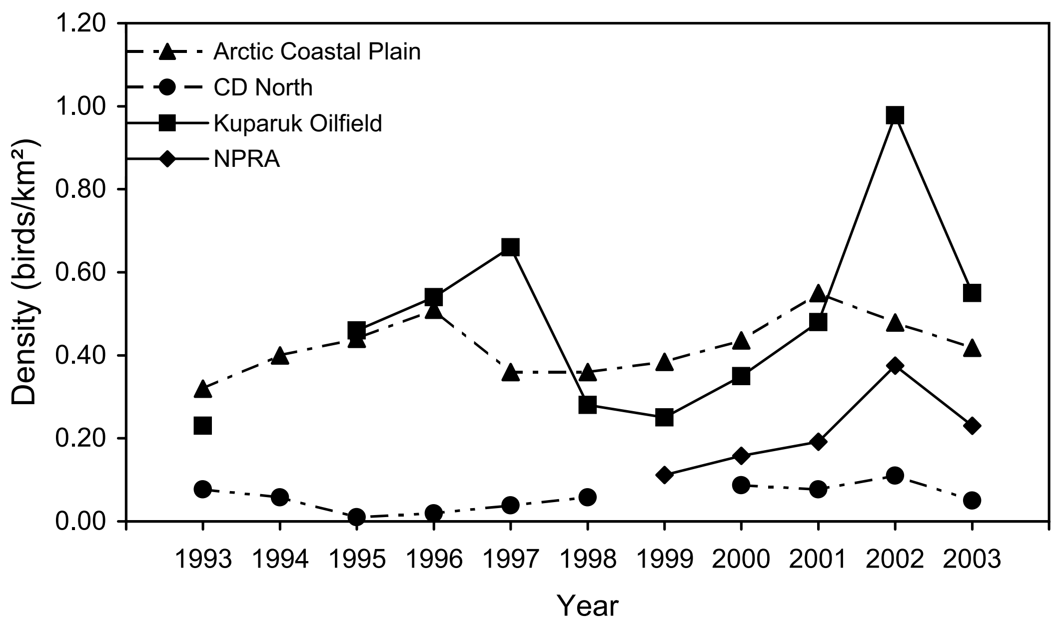

Figure 22. Trends in density of King Eiders (indicated birds, USFWS 1987a) from pre-nesting surveys in the CD North study area, NPRA, Kuparuk Oilfield, and Arctic Coastal Plain, Alaska, 1993–2003. Data are from Anderson et al. (2004), Larned et al. (2003), and this study.

The distribution of pre-nesting King Eiders relative to the coastline in 2003 (Figure 20) was similar to that observed in previous surveys (Johnson et al. 2003b). Like Spectacled Eiders, King Eiders on the Colville Delta also had an affinity for the coast: the mean distance from the coast during pre-nesting in 2003 was 5.1 km ($n = 21$ sightings), and the maximal distance was 14.2 km.

Nesting—Nest searches of the CD North search area in 2003 produced 1 King Eider nest (0.1 nests/km², Figure 13, Table 5). That nest was identified by color patterns on contour feathers (Anderson and Cooper 1994), because it had failed before it was discovered. Besides King and Spectacled eider, no other species of eider was found nesting in the CD North search area in 2003. Few nests of eider species other than Spectacled Eider have been found on the Colville Delta (Johnson et al. 2003b). Of 102 eider nests on the delta for which we have records, 10 nests (9.8%) belonged to King Eiders, 6 nests were unidentified (5.9%, all were either King or Spectacled eider), and 1 (1%) belonged to a Common Eider. The remaining 85 nests (83%) belonged to Spectacled Eiders. Although the entire delta has not been thoroughly searched for eider nests, these results, along with the results of the pre-nesting surveys, indicate the delta does not support much nesting by eider species other than the Spectacled Eider.

Brood-rearing—One King Eider brood with 4 young was found in the CD North search area in 2003 (Figure 15, Table 6,). No other species of eider broods, besides King and Spectacled eider, were seen in CD North in 2003. Since 1992, only 4 King Eider broods have been recorded on the delta, and the mean size of these broods was 4.5 young.

Habitat Use

Unlike Spectacled Eiders, King Eiders on the Colville Delta during pre-nesting often use aquatic habitats that do not provide nesting habitat. Over 50% of the King Eiders were found in River or Stream and Barrens (Table 20), neither of which is used for nesting, and is another indication that most pre-nesting King Eiders on the delta are not breeding there. The only preferred habitats for pre-nesting King Eiders on the Colville Delta were Brackish Water and River or Stream (Appendix E1).

Nesting King Eiders used similar habitats as did nesting Spectacled Eiders on the Colville Delta. The 1 King Eider nest found in CD North in 2003 was in Aquatic Sedge with Deep Polygons. Too few King Eider nests (10 nests) have been found on the delta since 1992 to conduct a selection analysis, but 50% of the nests were in Aquatic Sedge with Deep Polygons, 30% were in Salt-killed Tundra, and 20% were in Patterned Wet Meadow, all habitats frequently used or preferred by nesting Spectacled Eiders.

King Eider broods on the Colville Delta primarily used the same habitats that were used for nesting. One King Eider brood was found in 2003 in Deep Open Water with Islands or Polygonized Margins. Only 3 other broods of King Eiders have been seen on the delta, and they were in Brackish Water, Aquatic Sedge with Deep Polygons, and Patterned Wet Meadow.

NPRA Study Area

Distribution and Abundance

As mentioned previously, the NPRA study area is used during breeding by more King Eiders than use the Colville Delta, and King Eiders are about 20 times more numerous than Spectacled Eiders in this part of the NPRA. King Eiders were well-dispersed throughout aquatic habitat in the study area (Figure 20), and this distribution is consistent the distribution observed in past years (Burgess et al. 2003b).

During the pre-nesting aerial survey in 2003, 191 King Eiders (flying and non-flying birds) were recorded (Figure 20, Table 19). The number of King Eiders in the NPRA study area during 2003 declined only slightly from 2002 (208 birds). The density of King Eiders in the NPRA study area was 2–10 times the density of King Eiders in the 3 Colville Delta areas.

King Eider nests also were much more abundant than Spectacled Eider nests in the NPRA search areas (Table 13). Twenty three King Eider nests (0.7 nests/km²) were found during 2003. Nesting success was 43% and average clutch size was 4.6 eggs/nest ($n = 9$ nests). Nests were found throughout the search areas in wetland basins (Figures 16 and 18, Appendix C1), which appear to be productive nesting areas for a variety of waterbirds.

In 2003, 2 King Eider broods, each with 3 young, were seen in the northern road corridor (Appendix C3, C4). Five broods of King Eiders have been seen in nest-search areas since 2002 (when we began conducting searches during brood-rearing) with a mean brood size of 4.2 young.

Habitat Use

As was the case for Spectacled Eiders, Old Basin Wetland Complex was the most important habitat for pre-nesting King Eiders in the NPRA study area. King Eiders used 13 habitats during pre-nesting in 2003 (Table 20). The most used habitats were Old Basin Wetland Complex (21% of all groups), Deep Open Water without Islands (12%), and Shallow Open Water with Islands or Polygonized Margins (12%). However, the preferred habitats used by King Eiders during 3 years of surveys were Brackish Water and all 4 types of Deep and Shallow Open Water (Appendix E3). Old Basin Wetland Complex was the third most used habitat (14% of the King Eider groups) during these 3 years, but despite the high number of King Eiders in that habitat, it was not preferred because it was one of the more abundant habitats in the NPRA study area (9% of the area).

King Eiders in 2003 also nested most frequently in Old Basin Wetland Complex (35% of nests; Table 14). The second most used habitat was Shallow Open Water with Islands or Polygonized Margins (22%). Among 46 King Eider nests (includes historical data) in the NPRA study area, 33% of those nests were in Old Basin Wetland Complex and 24% were in Shallow Open Water with Islands or Polygonized Margins.

Two King Eider broods were seen in 2003 in the NPRA search areas. One was in Old Basin Wetland Complex and the other was in Shallow Open Water with Islands or Polygonized Margins (Table 15, Appendix C3). Three other King Eider broods were seen in previous years in Aquatic Sedge Marsh and in both types of Deep Open Water.

STELLER’S EIDER

The Steller’s Eider is the other threatened species of eider, listed under the Endangered Species Act in 1997 (62 FR 31748-31757). Steller’s Eiders occur infrequently on the Colville Delta and NPRA study area and may not breed in these areas, although both areas are within their historical range (Kertell 1991, Quakenbush and Cochrane 1993, Day et al. 1995). In 2001, a pair of Steller’s Eiders was seen during nesting in the CD North search area, but no nests or broods were ever found. A single flying male Steller’s Eider was seen during a pre-nesting aerial survey in the NPRA (Johnson and Stickney 2001; Johnson et al. 2002). Five Steller’s Eiders also were seen in early June 1995 on the outer Colville Delta (J. Bart, Boise State University, pers. comm.). No sightings of Steller’s Eiders have been recorded during aerial or ground surveys since 2001.

COMMON EIDER

Common Eiders are widespread along the Beaufort Sea coast, but are rare nesters on the Colville Delta (Johnson et al. 2003b) and absent in the NPRA study area, because it does not include coastline or offshore islands, where Common Eiders tend to nest. One nest was found on the outer Colville Delta in 1994, and 5 sightings of 1–4 birds have been made during pre-nesting aerial surveys over 11 years (Smith et al. 1993, Johnson 1994, Johnson et al. 1999b, Johnson et al. 2002). A male Common Eider carcass was found during nest searching in CD North in 2003. Otherwise, Common Eiders have not been sighted on any surveys in the Colville Delta since 2001 or any survey in NPRA since surveys began in 1999.

LONG-TAILED DUCK

Colville River Delta

Distribution and Abundance

Long-tailed Ducks were the most common nesting duck in the CD North search area (Figure 13, Table 5). Twenty-six Long-tailed Duck nests were found in CD North in 2003, and the density of Long-tailed Duck nests in the CD North search area was 1.5 nests/km², which is slightly above the mean nest density (mean = 1.3 nests/km², range 1.2–1.5) for that species in the CD North search area since 2000 (Johnson et al. 2003b). Nesting success was only 12% in 2003 (Table 5), but was within the range of the previous 3 years (0% in 2002 to 44% in 2000; Johnson et al. 2003b). Long-tailed ducks in CD North have experienced lower nesting success than in western Alaska, where the 10-year mean was 41% (Robertson and Savard 2002). Six Long-tailed Duck broods were observed in the CD North search area in 2003, which was at the high end of the range of broods observed since 2000 (2–6 broods).

Habitat Use

Long-tailed Duck nests primarily occurred in 4 habitats in the CD North search area, all of which featured polygonal surface forms: Aquatic Sedge with Deep Polygons (27% of all nests), Patterned Wet Meadow (23%), Deep Open Water with Islands or Polygonized Margins (19%), and Shallow Open Water with Islands or Polygonized Margins (12%; Table 7). The 2 aquatic habitats were preferred, as was Aquatic Sedge with Deep Polygons and Deep Open Water without Islands (Appendix F). Most nests in 2003 were found either on islands (8 nests; 31% of the total) or polygon rims (13 nests; 50%). Long-tailed Duck broods occurred in 3 habitat types: Aquatic Sedge with Deep Polygons (50% of all broods), Deep Open Water with Islands or Polygonized Margins (33%), and Deep Open Water without Islands (17%).

NPRA Study Area

Distribution and Abundance

During the pre-nesting aerial survey around the road corridor in NPRA, 143 adults, 37 pairs, and an indicated total of 205 birds were recorded in 84 observations (Figure 23, Table 21). The density of pre-nesting adults in the Long-tailed Duck survey area was 0.95 observed birds/km² or 1.36 indicated total birds/km² (Table 21). Direct comparisons with other aerial surveys would be unsuitable because of differences in methodology (i.e. fixed wing vs. helicopter). However, our results fall within the range of densities reported for fixed-wing aerial surveys for Long-tailed Ducks in Alaska on the Arctic Coastal Plain (Mallek et al. 2002), on the Yukon Delta (Hodges et al. 1996), and on the Seward Peninsula (Hodges et al. 1996). Available data suggest that the breeding population of Long-tailed Ducks is declining in Alaska (Robertson and Savard 2002), as much as 75% from 1977 to 1994 (Hodges et al. 1996), and the population has continued to decline since 1994 (Conant and Groves 2003). On the Arctic Coastal Plain, the Long-tailed Duck population has declined by 34% from 1986 to 2002 (Mallek et al. 2002).

When they are on land, Long-tailed Ducks were difficult to observe from the air due to their cryptic plumage and this probably resulted in a low bias in density estimates. In addition, many of the larger lakes in the survey area were ice-covered at the time of the survey, and this, too, may have resulted in a low bias because Long-tailed Ducks often were observed to dive below the ice as the helicopter approached. A diving response of waterfowl to fixed wing aircraft was reported in Forsell and Gould (1980), but observations of ducks on the Colville Delta suggest that this behavior is less pronounced during helicopter transect surveys than during similar fixed-wing transect surveys (C. Johnson, personal observation).

Long-tailed Duck nests occurred in all 3 pad search areas in the NPRA study area and in the NPRA road corridor in 2003 (Figures 16 and 18, Appendix C1). The density of Long-tailed Duck nests ranged from 0.2 nests/km² in the Lookout search area to 0.6 nests/km² in the Alpine West search area (Table 9). Nesting density appeared particularly high in the NPRA road corridor (1.0 nests/km² in the extended buffer; Table 12), but these estimates were inflated by the concentration of effort in wet and aquatic habitats. When all NPRA search areas are combined (pads and corridor), the density of Long-tailed Duck nests was 0.4 nests/km² in 2003 (Table 13). Nest success for Long-tailed ducks was 38% (5 successful of 13 known-fate nests) in the 2003 NPRA search areas (Table 13). Only 1 Long-tailed Duck brood was observed in the NPRA study area in 2003, in the extended buffer of the NPRA road corridor (Figure 19, Table 10).

Habitat use

During pre-nesting in the NPRA study area, Long-tailed Ducks were found in 10 of 12 aquatic habitats (only aquatic habitats were surveyed; Table 22). Fifteen additional groups were observed in 6 terrestrial habitats that bordered aquatic habitats. Pre-nesting Long-tailed Ducks were observed most frequently in Deep Open Water without Islands (37.7%), Deep Open Water with Islands or Polygonized Margins (17.4%), and Old Basin Wetland Complex (15.9%). In the analysis of

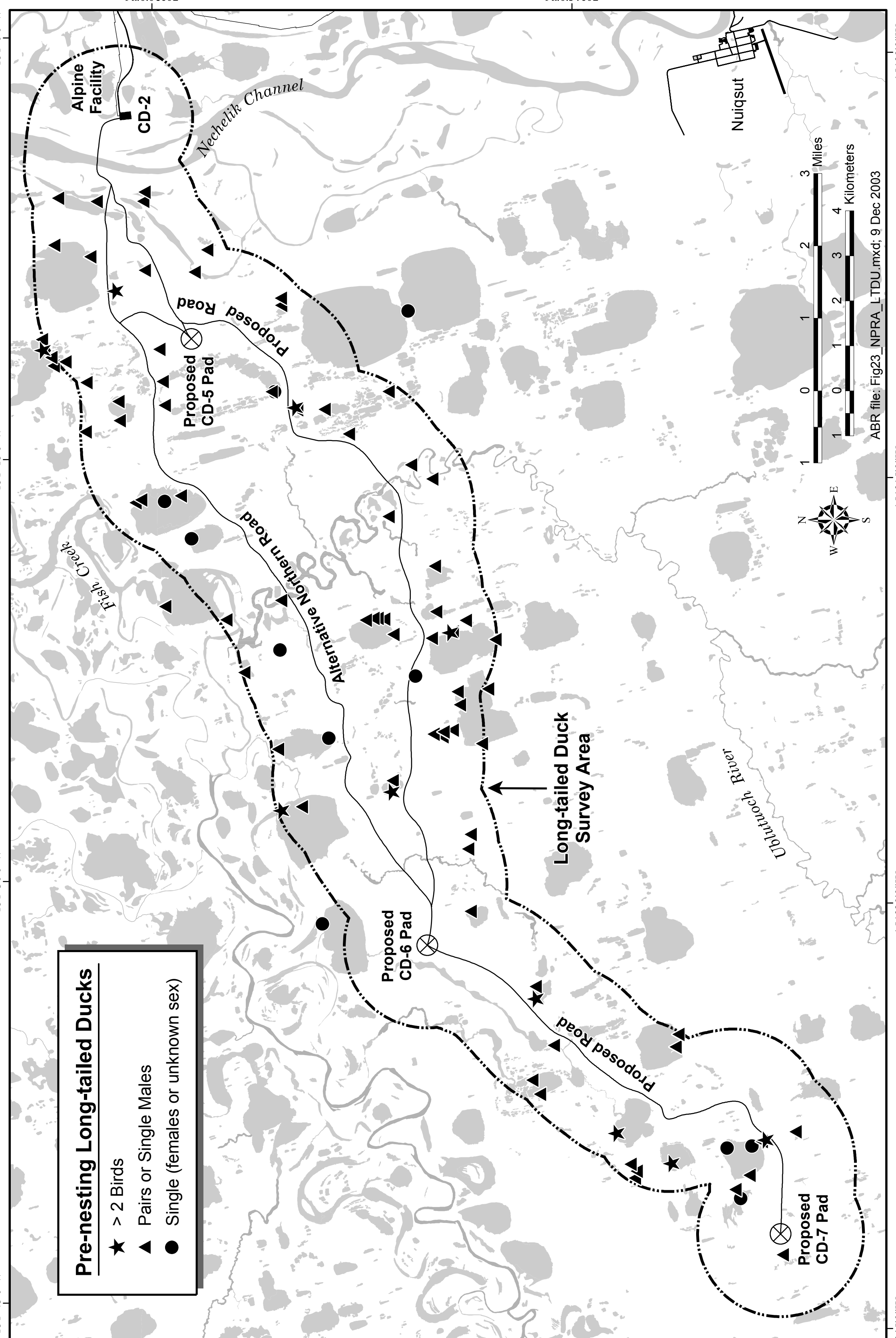

Figure 23. Long-tailed Duck locations during a pre-nesting aerial survey of the NPRA road corridor, Alaska, June 2003.

habitat selection, 3 habitats were preferred: Deep Open Water without Islands, Deep Open Water with Islands or Polygonized Margins, and Shallow Open Water without Islands (Table 22).

During ground searches in the NPRA study area, 14 Long-tailed Duck nests were found in 7 habitat types (Table 14). The habitats most used for nesting were Old Basin Complex (29%), Patterned Wet Meadow (21%), Aquatic Sedge Marsh (21%), and Shallow Open Water with Islands or Polygonized Margins (14%). Most nests (76%) were located within 1 m of a waterbody. The single Long-tailed Duck brood observed in the NPRA study area in 2003 was located in Shallow Open Water without Islands (Table 15).

Table 21. Number and density of Long-tailed Ducks during a pre-nesting aerial survey of the NPRA road corridor, Alaska, June 2003.

	Number		Density[a] (birds/km²)	
	Observed	Indicated[b]	Observed	Indicated[b]
Males[c]	97	–	–	–
Females[c]	46	–	–	–
Pairs	37	97	0.25	0.64
Total Birds	143	205	0.95	1.36

[a] Area surveyed = 150.7 km² (see Figure 8)
[b] Indicated total and pairs calculated according to standard USFWS protocol (USFWS 1987a)
[c] Includes males and females from pairs

Table 22. Habitat use and selection by pre-nesting Long-tailed Ducks in the NPRA study area, Alaska, 2003.

Habitat[a]	Area (km²)	Adults	Groups	Use (%)	Availability (%)	Monte Carlo Results[b]
Brackish Water	0.08	0	0	0	0.2	ns
Tapped Lake with Low-water Connection	0.89	1	1	1.4	2.0	ns
Tapped Lake with High-water Connection	0.05	0	0	0	0.1	ns
Deep Open Water without Islands	11.49	39	26	37.7	25.2	prefer
Deep Open Water with Islands or Polygonized Margins	4.59	26	12	17.4	10.1	prefer
Shallow Open Water without Islands	1.45	10	7	10.1	3.2	prefer
Shallow Open Water with Islands or Polygonized Margins	3.33	8	5	7.2	7.3	ns
River or Stream	2.27	1	1	1.4	5.0	ns
Aquatic Sedge Marsh	2.82	4	3	4.3	6.2	ns
Aquatic Grass Marsh	0.53	2	2	2.9	1.2	ns
Young Basin Wetland Complex	1.58	2	1	1.4	3.5	ns
Old Basin Wetland Complex	16.44	17	11	15.9	36.1	avoid
Total	45.52	110	69	100	100	

[a] Only aquatic habitats were included in survey
[b] Significance calculated from 1,000 simulations at alpha = 0.05; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability; % use = (groups / total groups) × 100

YELLOW-BILLED LOON

Colville River Delta

Distribution and Abundance

During nesting in 2003, 29 Yellow-billed Loons were observed in the CD North study area and 23 loons were observed in the CD South study area (Table 23, Figure 24). The number of loons recorded in each survey area was within the range reported in each study area during 8 previous years of surveys (17–34 in CD North and 15–26 in CD South) (Burgess et al. 2003a, Johnson et al. 2003b). The density of Yellow-billed Loons was 0.14 birds/km² in the CD North study area and 0.15 birds/km² in the CD South study area in 2003 (Table 23), which was slightly higher than the mean of 9 years (0.13 birds/km² in each study area). Other studies have reported similar densities for Yellow-billed Loon nesting areas on the Arctic Coastal Plain of Alaska: Square Lake in the NPRA (0.14 birds/km²; Derksen et al. 1981) and the Alaktak region south of Smith Bay (0.16 birds/km²; McIntyre 1990).

Sixteen Yellow-billed Loon nests were found in the CD North study area and 8 nests were found in the CD South study area during the aerial survey in 2003 (Figure 24, Table 23). Nest density in 2003 in the CD North study area (0.08 nests/km²) was higher than any previously recorded density (0.05 nests/km²) for that study area since delta-wide aerial surveys began in 1993. Nest density in the CD South study area in 2003 (0.05 nests/km²) was slightly higher than the mean of 9 years (0.04 nests/km²). In 2003, 1 additional nest was found just outside the CD North study area east of the Elaktoveach channel (Figure 24) and that nesting lake has been used in previous years (Johnson et al. 2003b). Also, 1 brood was observed in the northeastern part of the CD North study area during the brood-rearing aerial survey in a traditional nest lake where a nest was not found in 2003, suggesting that an additional nest was active there but missed during the nesting survey (Figure 24). The total count of 26 nests (including the nest indicated by a brood location) for the Colville Delta in 2003 is the highest that has been reported from aerial surveys (23 nests was the previous high count in 1998; Johnson et al. 1999) or from intensive ground surveys by North (1986) in 1983 (19 nests) and 1984 (20 nests).

Table 23. Number and density of loons and their nests, broods, and young during aerial surveys in the CD North, CD South, and NPRA study areas, Alaska, 2003.

	Yellow-billed Loons					Pacific Loons[a]			Red-throated Loons[a]		
	Number			Density (number/km²)		Number			Number		
SURVEY AREA[b] Survey Type	Adults	Nests/ Broods	Young	Adults	Nests/ Broods	Adults	Nests/ Broods	Young	Adults	Nests/ Broods	Young
CD NORTH											
Nesting	29	16	–	0.14	0.08	25	9	–	2	0	–
Brood-rearing[c]	26	10	12	0.13	0.05	26	1	1	0	0	0
CD SOUTH											
Nesting	23	8	–	0.15	0.05	37	10	–	1	0	–
Brood-rearing[c]	20	4	4	0.13	0.03	59	5	7	4	2	2
NPRA											
Nesting	53	26	–	0.06	0.03	486	96	–	3	0	–
Brood-rearing[c]	54	16	18	0.06	0.02	52	8	10	5	2	4

[a] Densities of Pacific and Red-throated loons were not calculated because detectability differed from that of Yellow-billed Loons and surveys did not include smaller lakes (<10 ha) where those species commonly nest

[b] CD North = 206.9 km², CD South = 155.7 km², NPRA = 878.2 km²

[c] Only lakes known to have Yellow-billed Loon nests were surveyed during brood-rearing

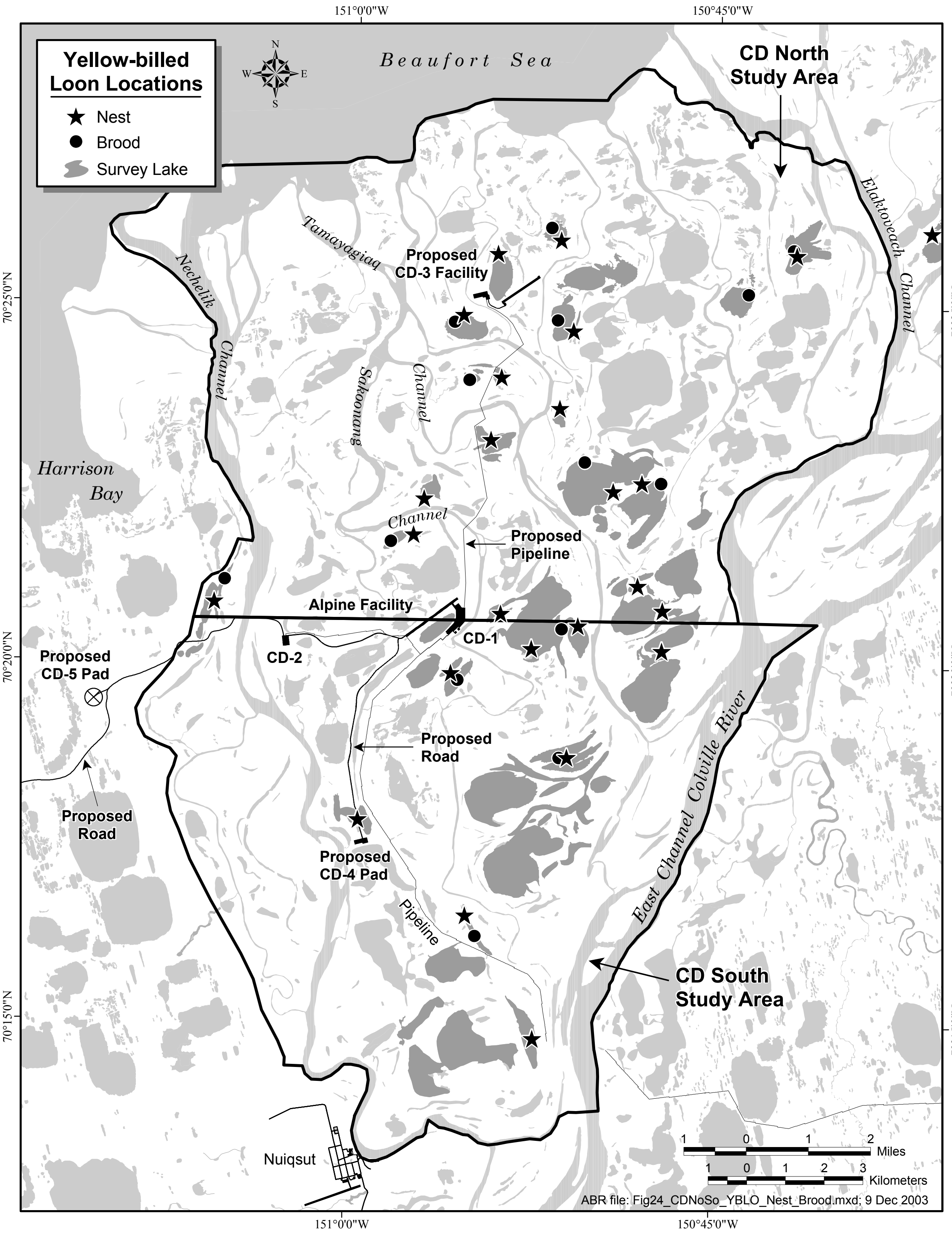

Figure 24. Yellow-billed Loon nests and brood locations in the CD North and CD South study areas, Colville River Delta, Alaska, 2003.

As in previous years, Yellow-billed Loon nests in 2003 were concentrated in the central part of the delta (Figure 24; Rothe et al. 1983, North 1986, Burgess et al. 2003a, Johnson et al. 2003b). All nests but one were on lakes where Yellow-billed Loons have nested in previous years (Burgess et al. 2003a, Johnson et al. 2003b). The new nest location in 2003 was on a lake in the southwestern corner of the CD North study area west of the Nechelik channel (Figure 24). This lake was first surveyed in 2002, when a single adult Yellow-billed Loon was observed on that lake during the nesting survey.

Twenty-six adult Yellow-billed Loons and 10 broods were observed during the brood-rearing aerial survey in the CD North study area in 2003, and 20 adults and 4 broods were observed in the CD South study area (Figure 24, Table 23). The distribution and density of adult loons in both study areas during brood-rearing (0.13 birds/km² in both areas) was similar to that during nesting (Table 23) and similar to the mean of 9 years (0.13 birds/km² and 0.12 birds/km² in the CD North and CD South study areas, respectively; Burgess et al. 2003a, Johnson et al. 2003b). However, brood density in both study areas in 2003 (0.05 broods/km² in CD North and 0.03 broods/km² in CD South) was higher than the mean of 9 years (0.02 broods/km² for both areas; Burgess et al. 2003a, Johnson et al. 2003b). The total count of 14 Yellow-billed Loon broods for the Colville Delta is the highest number recorded during 9 years of surveys.

Habitat Use

During aerial surveys of the Colville Delta in 2003, a total of 25 Yellow-billed Loon nests were observed in 7 habitats (Table 24). The 2 habitats most frequently used for nesting were Patterned Wet Meadow (32% of all nests) and Deep Open Water with Islands or Polygonized Margins (32%). The remaining 9 nests were found in Deep Open Water without Islands (16%), Nonpatterned Wet Meadow (8%), Tapped Lake with High-water Connection (4%), Shallow Open Water without Islands (4%), and Aquatic Sedge Marsh (4%; Table 24). Within these areas, nests were built on peninsulas, shorelines, islands, or in emergent vegetation; the latter 2 types could be classified as part of a waterbody at the scale of our habitat map.

Because Yellow-billed Loons typically raise broods on the lakes where they nest, forage in lakes within their territories, and use lakes for escape habitat, the waterbody type (or aquatic habitat) adjacent to the nest site is more indicative of habitat selection than the terrestrial habitat on which the nest is actually built. Five types of waterbodies were associated with Yellow-billed Loon nests in 2003: Deep Open Water without Islands (44% of all nests), Deep Open Water with Islands or Polygonized Margins (40%), Tapped Lake with High-water Connection (8%), Shallow Open Water without Islands (4%), and Aquatic Sedge Marsh (4%; Table 24). We did not measure the distance to water for nests recorded during aerial surveys, but all were close (<5 m) to water. Previous investigators have reported that Yellow-billed Loons on the Arctic Coastal Plain nest within 2 m of water (Sage 1971, Sjolander and Agren 1976, North and Ryan 1989).

During 9 years of nesting aerial surveys on the Colville Delta, 147 Yellow-billed Loon nests were found in 9 of 24 available habitats (Appendix G1). Ninety-five nests (65%) were located in the 3 preferred habitats: Patterned Wet Meadow (56 nests), Deep Open Water with Islands or Polygonized Margins (37 nests), and Aquatic Sedge Marsh (2 nests). Patterned Wet Meadow was the most frequently used habitat for nesting (38% of all nests), and it was the most abundant habitat on the delta (25% of the loon survey area; Appendix G1). Nesting Yellow-billed Loons avoided 7 habitats, all of which were unused—Tapped Lake with Low-water Connection, Tidal Flat, Salt-killed Tundra, River or Stream, Moist Sedge–Shrub Meadow, Riverine or Upland Shrub, and Barrens. Together these 7 habitat types occupied a large portion of the CD North and CD South study areas (44%).

On the Colville Delta in 2003, 14 Yellow-billed Loon broods were found in 3 habitats: Tapped Lake with High-water Connection and both types of Deep Open Water (Table 24). During 9 years of aerial surveys on the Colville Delta, 60 Yellow-billed Loon broods were found in the same 3 habitats, all of which were preferred (Appendix G1). Deep Open Water without Islands was used by most broods (60% of total), followed by Tapped Lake with High-water Connection (20%), and Deep Open Water with Islands or

Table 24. Habitat use by nesting and brood-rearing Yellow-billed Loons on the Colville River Delta and in the NPRA study area, Alaska, 2003.

	Colville River Delta				NPRA Study Area			
	Nests[a]		Broods		Nests		Broods	
Habitat	Number	Use (%)	Number	Use (%)	Number	Use (%)	Number	Use (%)
HABITAT USED								
Tapped Lake with High-water Connection	1	4.0	2	14.3	0	0	0	0
Deep Open Water without Islands	4	16.0	9	64.3	2	8.3	4	25.0
Deep Open Water with Islands or Polygonized Margins	8	32.0	3	21.4	10	41.7	12	75.0
Shallow Open Water without Islands	1	4.0	0	0	0	0	0	0
Aquatic Sedge Marsh	1	4.0	0	0	4	16.7	0	0
Aquatic Grass Marsh	0	0	0	0	1	4.2	0	0
Nonpatterned Wet Meadow	2	8.0	0	0	2	8.3	0	0
Patterned Wet Meadow	8	32.0	0	0	2	8.3	0	0
Moist Sedge–Shrub Meadow	0	0	0	0	3	12.5	0	0
Total	25	100	14	100	24	100	16	100
NEAREST WATERBODY								
Tapped Lake with High-water Connection	2	8.0	–	–	0	0	–	–
Deep Open Water without Islands	11	44.0	–	–	4	16.7	–	–
Deep Open Water with Islands or Polygonized Margins	10	40.0	–	–	14	58.3	–	–
Shallow Open Water without Islands	1	4.0	–	–	1	4.2	–	–
Aquatic Sedge Marsh	1	4.0	–	–	4	16.7	–	–
Aquatic Grass Marsh	0	0	–	–	1	4.2	–	–
Total	25	100	–	–	24	100	–	–

[a] Includes 1 nest in the Northeast Delta, the remainder are in the CD North and CD South study areas

Polygonized Margins (20%). No shallow-water habitats were used during brood-rearing. The concurrence of selection analyses for nesting and brood-rearing reaffirms the importance of large, deep waterbodies to breeding Yellow-billed Loons.

NPRA Study Area

Distribution and Abundance

During the nesting aerial survey in 2003, 53 Yellow-billed Loons and 26 nests were recorded in the NPRA study area (Figure 25, Table 23). One brood was seen in the NPRA study area during the brood-rearing aerial survey in a lake where a nest was not found, suggesting that 1 additional nest was active there (Figure 25). Both loons and nests were concentrated in lakes adjacent to Fish and Judy creeks, leaving much of the northwestern and southeastern portions of the study area unoccupied by Yellow-billed Loons (Figure 25). The density of loons was 0.06 birds/km² in the NPRA study area in 2003. A similar distribution and density was found in the same study area in 2002 and in a slightly smaller study area in 2001 (Burgess et al. 2002b). One additional nest was found during ground searches in 2003 whose egg measurements matched that of a Yellow-billed Loon (Appendix C1, C2). This nest had 1 egg in mid-June and was assumed to have been found during laying. During nest fate checks in July, the nest was inactive. We believe the pair renested at a site on the northern part of the same lake by the time of the aerial survey on 26 June (Figure 25). The latter nest site, which was used in 2002 by Yellow-billed Loons, was flooded in early June 2003 due to unusually high water in the NPRA study area and was probably not available when the loons were prospecting for a nest site.

In 2003, the density of Yellow-billed Loon nests was 0.03 nests/km² in the NPRA study area (Table 23), the same density found during 2001 and 2002 (Burgess et al. 2003b). Although the NPRA study area supports a lower overall density of nesting Yellow-billed Loons than the Colville Delta, the concentration of nests in lakes adjacent to Fish and Judy creeks (25 of 27 nests in 2003) comprises a larger number of nests than typically occurs on the entire Colville Delta (mean = 19.0 nests, range 13–25 nests, n = 9 years). The concentration of nests in the Fish and Judy creek area suggests that this area is a regionally important breeding area for the species on the same scale as the Colville Delta (see Johnson et al. 2003b).

During the brood-rearing aerial survey in 2003, 54 adult Yellow-billed Loons and 16 broods were observed in the NPRA study area (Figure 25, Table 23). Both the number of adults and the number of broods in the NPRA study area in 2003 were higher than in 2001 or 2002. The density of adult loons observed during brood-rearing (0.06 loons/km²) was the same as the density of adult loons observed during nesting. The density of Yellow-billed Loon broods in the NPRA study area in 2003 was 0.02 broods/km², which was over twice the density observed in either 2001 or 2002 (Burgess et al. 2003b).

Habitat Use

During aerial surveys in 2003, a total of 24 Yellow-billed Loon nests occurred in the part of the NPRA study area covered by the habitat map (Table 24). Nests were found in 7 habitats. The 3 habitats most frequently used for nesting were Deep Open Water with Islands or Polygonized Margins (42% of all nests), Aquatic Sedge Marsh (17%), and Moist Shrub–Sedge Meadow (13%). Five types of waterbodies were associated with Yellow-billed Loon nests in the NPRA study area in 2003: Deep Open Water with Islands or Polygonized Margins (58%), Deep Open Water without Islands (17%), Aquatic Sedge Marsh (17%), Shallow Open Water without Islands (4%), and Aquatic Grass Marsh (4%; Table 24). As in the Colville Delta, most nests were located within several meters of a lake shore.

Sixty-three Yellow-billed Loon nests found in the NPRA study area in 2001–2003 were included in the analysis of habitat selection. These 63 Yellow-billed Loon nests occurred in 8 of 27 available habitats (Appendix G2). Three habitats were preferred for nesting: Deep Open Water with Islands or Polygonized Margins (49% of all nests), Aquatic Sedge Marsh (11%), and Aquatic Grass Marsh (3%). Three habitats were avoided by nesting Yellow-billed Loons: Old Basin Wetland Complex and Moist Tussock Tundra (both of which were unused) and Moist Sedge–Shrub Tundra (the second most abundant habitat in the NPRA study area) in which 5 nests were located.

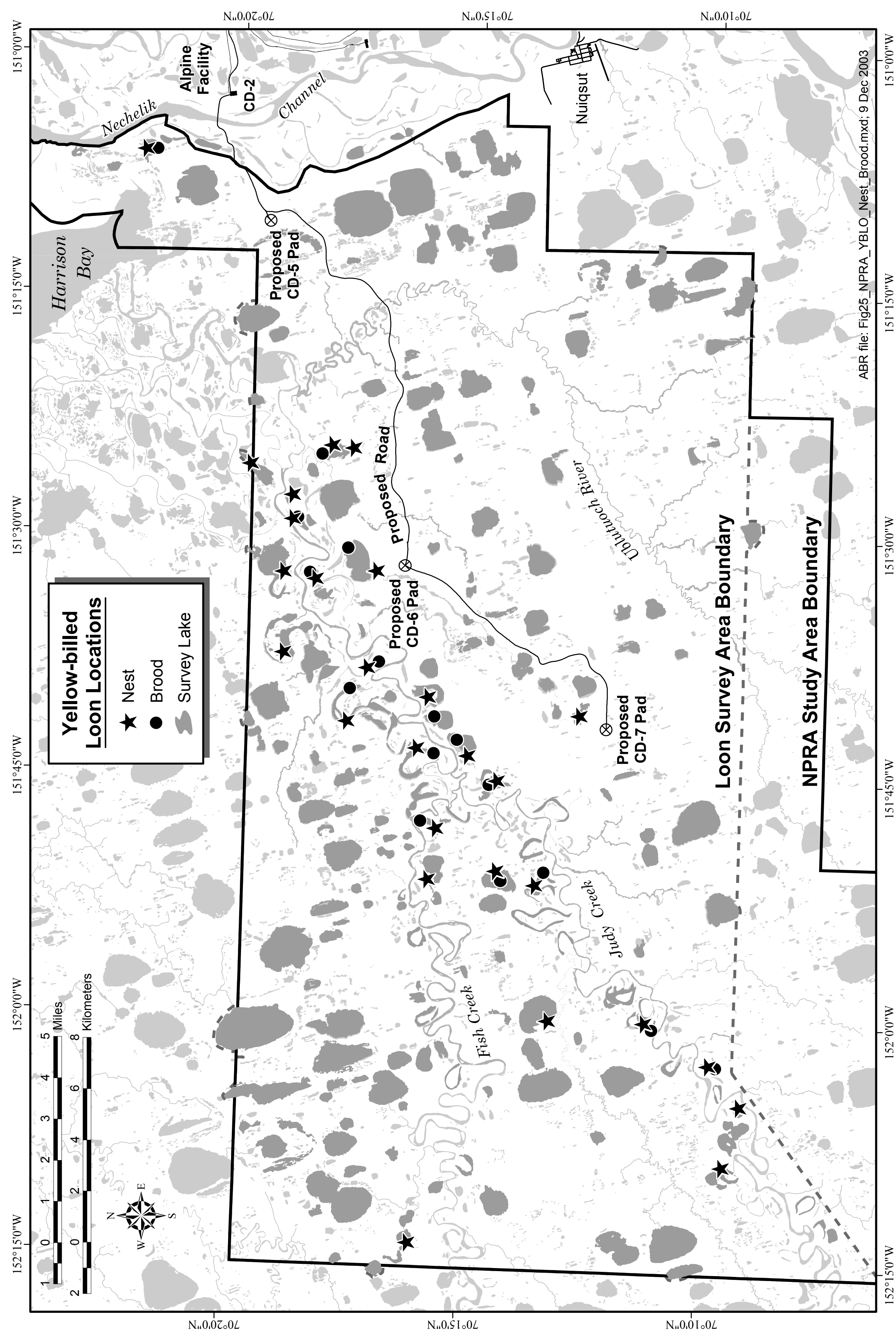

Figure 25. Yellow-billed Loon nests and brood locations in the NPRA study area, Alaska, 2003.

Yellow-billed Loon broods were observed in 2 habitat types in 2003: Deep Open Water with Islands or Polygonized Margins (12 broods) and Deep Open Water without Islands (4 broods; Table 24). Over all 3 years of surveys, all broods occurred in these same 2 habitat types and both were identified as preferred by the habitat selection analysis in NPRA (Appendix G3) as they also were for the Colville Delta. Deep Open Water with Islands or Polygonized Margins was used by most broods (69% of total).

The mean distance of Yellow-billed Loon nests to either Fish or Judy creek was 1.1 km (range 0.2–3.6 km) and the mean distance of nest lakes to either creek was 0.5 km (range 0.05–3.3 km). Each nest lake in 2003 contained at most 1 pair of Yellow-billed Loons, and most nests were locations known to have been used in either or both 2001 and 2002 (Burgess et al. 2003b). Most Yellow-billed Loon nests in the NPRA study area in 2003 were located on islands (20 of 27 nests, 74%). Other nests were built on peninsulas or shorelines. All but 2 pairs of Yellow-billed Loons in the NPRA study area in 2003 nested on large lakes (>10 ha).

OTHER LOONS

Colville River Delta

Distribution and Abundance

Nine nests of Pacific Loons were located opportunistically in the CD North study area and 10 nests were found in the CD South study area during the Yellow-billed Loon nest aerial survey in 2003 (Figure 26, Table 23). No nests of Red-throated Loons were seen in either study area on that survey. Opportunistic counts of Pacific and Red-throated loons reflect their general distribution in the CD North and CD South study areas in lakes ≥10 ha but are not indicative of the relative abundance of these species (due to differences in species detectability) or annual changes in abundance (because of annual variation in survey intensity) (Burgess et al. 2003a, Johnson et al. 2003b). Because the survey focused on lakes larger than those typically occupied by Pacific and Red-throated loons for nesting, densities have not been calculated from aerial survey data for these 2 species. Nonetheless, it is clear that Pacific Loons were the most abundant loon in both study areas in 2003 (and previous years).

In the CD North search area, 19 Pacific and 6 Red-throated loon nests were found during ground searches in 2003 (Figure 14, Table 5). We assumed from the number and locations of Red-throated Loon broods found during the brood search that 2 additional Red-throated Loon nests were in the area but not detected (Figure 15). The densities of Pacific and Red-throated loon nests in the CD North search area in 2003 were 1.1 and 0.5 nests/km², respectively (Table 5). Nest densities of Pacific Loons in 2000–2002 (0.6–1.0 nests/km²) were slightly lower than in 2003, while nest densities of Red-throated Loons in 2000–2002 (0.5–0.8 nests/km²; Johnson et al. 2003b) were the same or slightly higher than in 2003. Summarizing ground-based surveys on the delta, Rothe et al. (1983) reported similar findings and suggested that Pacific and Red-throated loon densities on the Colville Delta were comparable to other areas on the Arctic Coastal Plain.

During the brood-rearing aerial survey in 2003, 26 Pacific Loons and 1 brood were observed in the CD North study area and 59 adults and 5 broods were observed in the CD South study area (Figure 26, Table 23). Red-throated Loons were not observed in the CD North study area during the aerial survey but 4 Red-throated Loons and 2 broods were observed in the CD South study area. As mentioned above, our aerial surveys greatly underestimate the actual number of Pacific and Red-throated loons with broods, and therefore, densities and comparisons among years are not presented.

During ground searches in 2003, 5 Pacific Loon broods and 5 Red-throated Loon broods were observed in the CD North search area (Figure 15, Table 6). The density of Pacific Loon broods in the CD North search areas in 2003 (0.3 broods/km²) was in the middle of the range observed in 2000–2002 (0.2–0.4 broods/km²), while the density of Red-throated Loon broods in 2003 (0.3 broods/km²) was at the low end of the range observed in 2000–2002 (0.2–0.6 broods/km²).

Habitat Use

In the CD North search area in 2003, 19 Pacific Loon nests were found in 9 habitat types (Table 7). The most frequently used habitats were

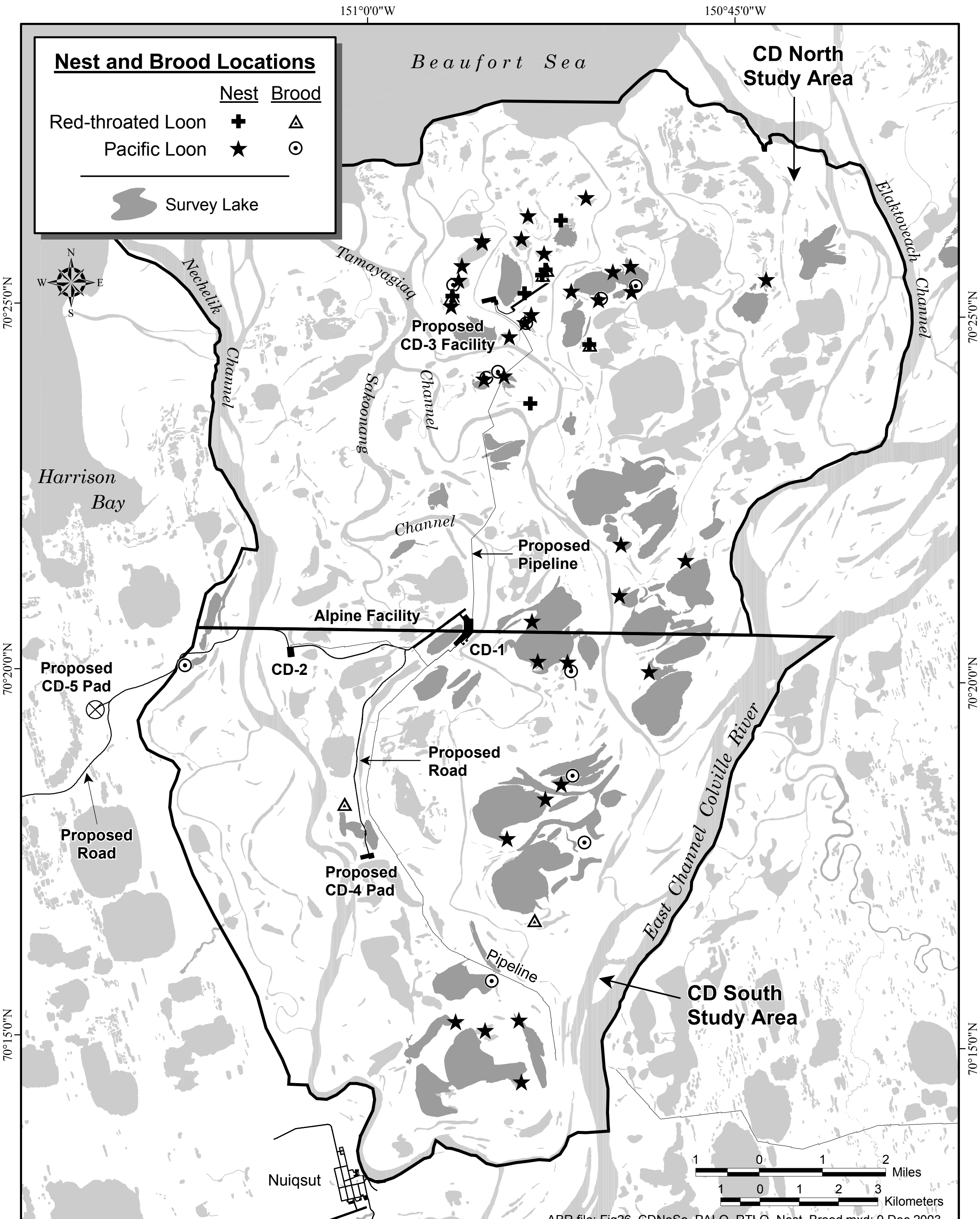

Figure 26. Pacific and Red-throated loon nests and brood locations in the CD North and CD South study areas, Colville River Delta, Alaska, 2003.

Brackish Water (21% of all nests), Tapped Lake with High-water Connection (21%), Deep Open Water with Islands or Polygonized Margins (21%), and Patterned Wet Meadow (11%). Red-throated Loons were found nesting in 3 habitat types in the CD North search area in 2003: Aquatic Sedge with Deep Polygons (50% of all nests), Shallow Open Water with Islands or Polygonized Margins (33%), and Brackish Water (17%; Table 7).

During 4 years of ground searches in the CD North search area, 55 Pacific Loon nests were found in 11 of 18 available habitats (Appendix G4). Four habitats were preferred: Deep Open Water with Islands or Polygonized Margins (26%), Tapped Lake with High-water Connection (22%), Brackish Water (16%), and Shallow Open Water with Islands or Polygonized Margins (7%). Four habitats were avoided although all 4 habitats were used for nesting: Patterned Wet Meadow (5 nests), Salt-killed Tundra (2 nests), Aquatic Sedge with Deep Polygons (2 nests), and Nonpatterned Wet Meadow (1 nest). These 4 habitats were the 4 most abundant habitats available in the CD North search area and together accounted for 65% of the area (Table 4). (A similar analysis was not possible for Red-throated Loons because of small sample size.)

In the CD North search area in 2003, 5 Pacific Loons broods were found in 3 aquatic habitats: Deep Open Water without Islands (60% of broods), Deep Open Water with Islands or Polygonized Margins (20%) and Shallow Open Water with Islands or Polygonized Margins (20%; Table 8). Five Red-throated Loons broods were found in the same habitats that were used for nesting: Shallow Open Water with Islands or Polygonized Margins (60% of broods) and Aquatic Sedge with Deep Polygons (40%; Table 8).

NPRA Study Area

Distribution and Abundance

In 2003, Pacific and Red-throated loons were recorded incidentally during the Yellow-billed Loon aerial surveys (Figure 27, Table 23). As described above, the Yellow-billed Loon surveys were incomplete for other loons and densities are not presented. However, Pacific Loons were the most abundant and widespread loon species breeding in the NPRA study area (Figure 27). On the nesting aerial survey in 2003, 486 adult Pacific Loons and 96 nests were found (Table 23). Pacific Loons occupied small and large lakes, sometimes nesting on the same lakes as Yellow-billed Loons. Three Red-throated Loon adults were seen on the aerial survey in 2003 and no nests were found. Nests of Red-throated Loons are not easily detected from the air.

During ground searches in the NPRA study area in 2003, 28 Pacific Loon and 4 Red-throated Loon nests were found (Figures 16 and 18; Tables 9, 12 and 13; Appendices C1 and C2). Over all search areas combined, the density of Pacific Loon nests in the NPRA study area was 0.9 nests/km^2 and the density of Red-throated Loon nests was 0.1 nests/km^2. These estimates may be somewhat inflated because search effort was not equal across habitats, particular in the NPRA road corridor where wet and aquatic habitats were searched preferentially. Among the 3 pad search areas in the NPRA study area in 2003, nest densities ranged from 0–1.4 nests/km^2 for Pacific Loons and from 0–0.2 nests/km^2 for Red-throated Loons (Table 9).

During the brood-rearing aerial survey for Yellow-billed Loons in 2003, 52 adult Pacific Loons and 8 broods and 5 Red-throated Loons and 2 broods were counted (Figure 27, Table 23). Again, these observations were collected incidentally and densities are not presented.

In the NPRA ground-search areas, 14 Pacific Loon broods and 1 Red-throated Loon brood were observed (Figures 17 and 19; Table 10; Appendices C3 and C4).

Habitat Use

In the NPRA ground-search areas in 2003, 28 Pacific Loon nests were found in 9 habitat types (Table 14). The most frequently used habitats were Shallow Open Water with Islands or Polygonized Margins (32% of all nests), Aquatic Sedge Marsh (21%), and Deep Open Water with Islands or Polygonized Margins (11%). Red-throated Loons were found nesting in 3 habitat types: Old Basin Wetland Complex (50% of 4 nests), Shallow Open Water with Islands or Polygonized Margins (25%, 1 nest), and Riverine Complex (25%, 1 nest; Table 14).

Pacific Loon broods occurred in 5 habitat types in the NPRA ground-search areas in 2003: Shallow Open Water with Islands or Polygonized Margins (50% of 14 broods), Deep Open Water with Islands or Polygonized Margins (21%),

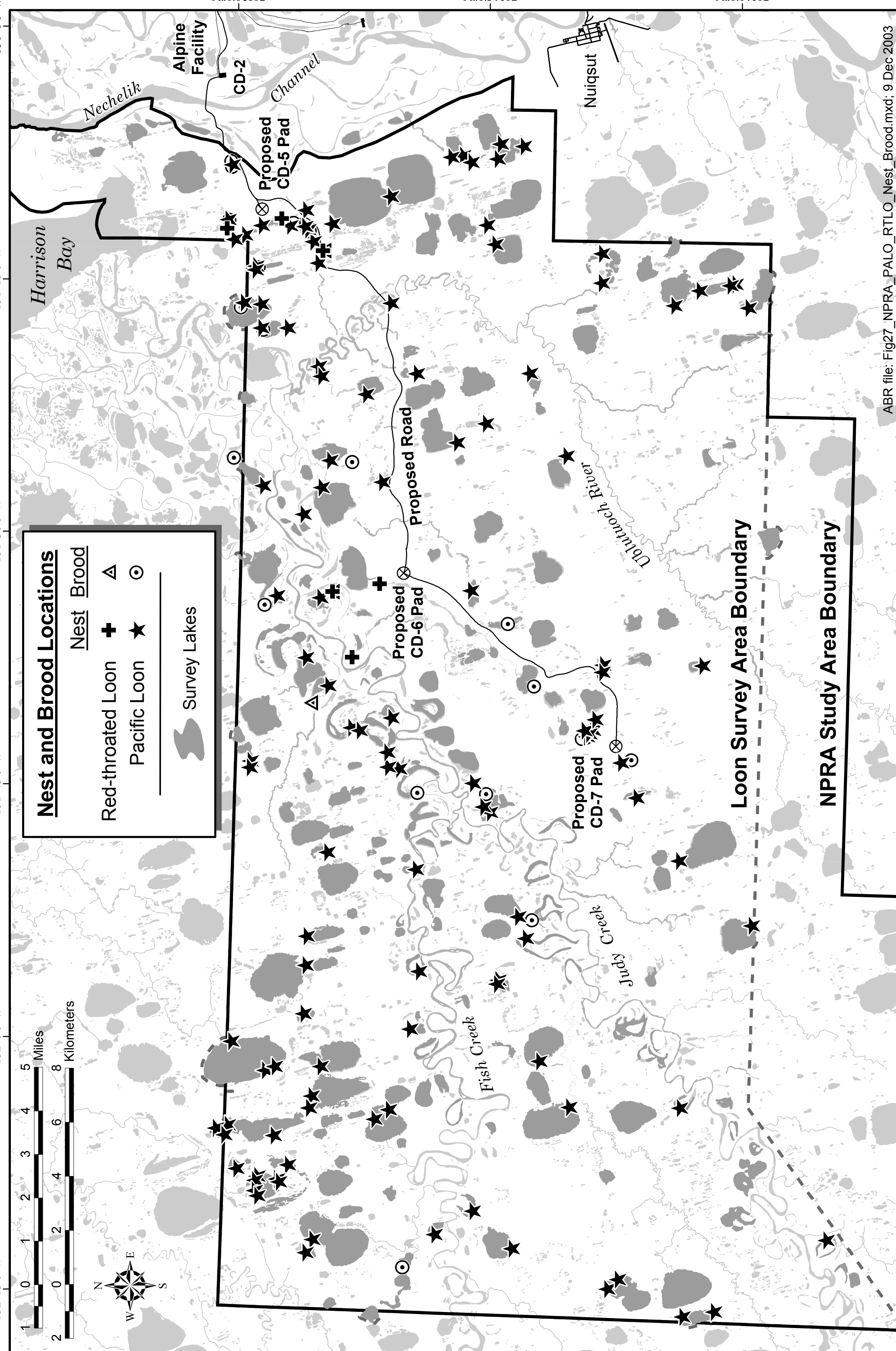

Figure 27. Pacific Loon and Red-throated Loon nests and brood locations in the NPRA study area, Alaska, 2003.

Shallow Open Water without Islands (15%), Deep Open Water without Islands (7%), and Young Basin Wetland Complex (7%; Table 15). The single Red-throated Loon brood observed in the NPRA ground-search areas was located in Shallow Open Water with Islands or Polygonized Margins (Table 15).

TUNDRA SWAN

Colville River Delta

Distribution and Abundance

A total of 354 swans including 87 pairs were counted on the Colville Delta during the 2003 nesting aerial survey. Although the number of adults observed was less than the 10-year mean of 405 swans per nest survey, the number of pairs was the second highest counted since 1992 (Johnson et. al. 2003b). The number of nests found on the nesting aerial survey of the entire Colville Delta was 43 nests or 0.08 nests/km² (Table 25), which was higher than the 10-year average of 0.06 nests/km² (range 0.03–0.10 nests/km²).

Of the 43 Tundra Swan nests counted during the aerial survey in 2003, 23 were located in CD North, 7 were located in CD South, and 13 were on the northeast delta (Figure 28, Table 25). An additional 9 nests not observed during the aerial survey were found during ground-searches in the CD North search area (2 nests) and during helicopter-based surveys for loon nests (7 nests). The number of Tundra Swan nests in the CD North study area in 2003 was the second highest number since 1992; the highest count, 31 nests, was recorded in 2002 (Johnson et al. 2003b). In 2003, the density of swan nests in CD North was 0.11 nests/km² (Table 25), which is within the range that has been observed in CD North since 1992 (0.04 to 0.15 nests/km²; Johnson et al. 2003b).

Seven nests were found on the aerial survey in the CD South study area in 2003 (Figure 28, Table 25). An additional 5 nests were found in CD South during helicopter-based loon surveys. (Ground-searches were not undertaken in CD South in 2003.) Nest density in CD South in 2003 was 0.04 nests/km², which was within the range of densities that were observed there during the previous 9 years (0.02–0.11 nests/km²). The number and density of swan nests in the CD South study area has decreased annually since 1998, although the total number of swan nests on the delta as a whole has remained constant or increased.

Sixteen of the 27 swan broods (59%) found on the Colville Delta in 2003 were located in CD North (Figure 28; Table 25). Nesting success in CD North, estimated by dividing numbers of broods by the number of nests (data from aerial surveys only), was 70% in 2003 (Table 25). The density of swan broods in the CD North study area in 2003 was 0.08 broods/km², which is the highest density

Table 25. Number and density of Tundra Swan nests and broods during aerial surveys of the CD North and CD South study areas, the northeast delta, and NPRA study areas Alaska, 2003.

Area	Nests: Number	Nests: Density (nests/km²)	Nesting Success (%)[a]	Broods: Number	Broods: Density (broods/km²)	Mean Brood Size
COLVILLE RIVER DELTA[b]						
CD North	23	0.11	70	16	0.08	2.6
CD South	7	0.04	57	4	0.03	1.8
Northeast Delta	13	0.07	54	7	0.04	2.6
Total	43	0.08	63	27	0.05	2.4
NPRA STUDY AREA[c]	43	0.04	42	18	0.02	2.3

[a] Nest success = (nests / broods) × 100
[b] Colville River Delta = 551.6 km², CD North = 206.9 km², CD South = 155.7 km², Northeast Delta = 189.0 km²
[c] NPRA study area = 1,092 km²

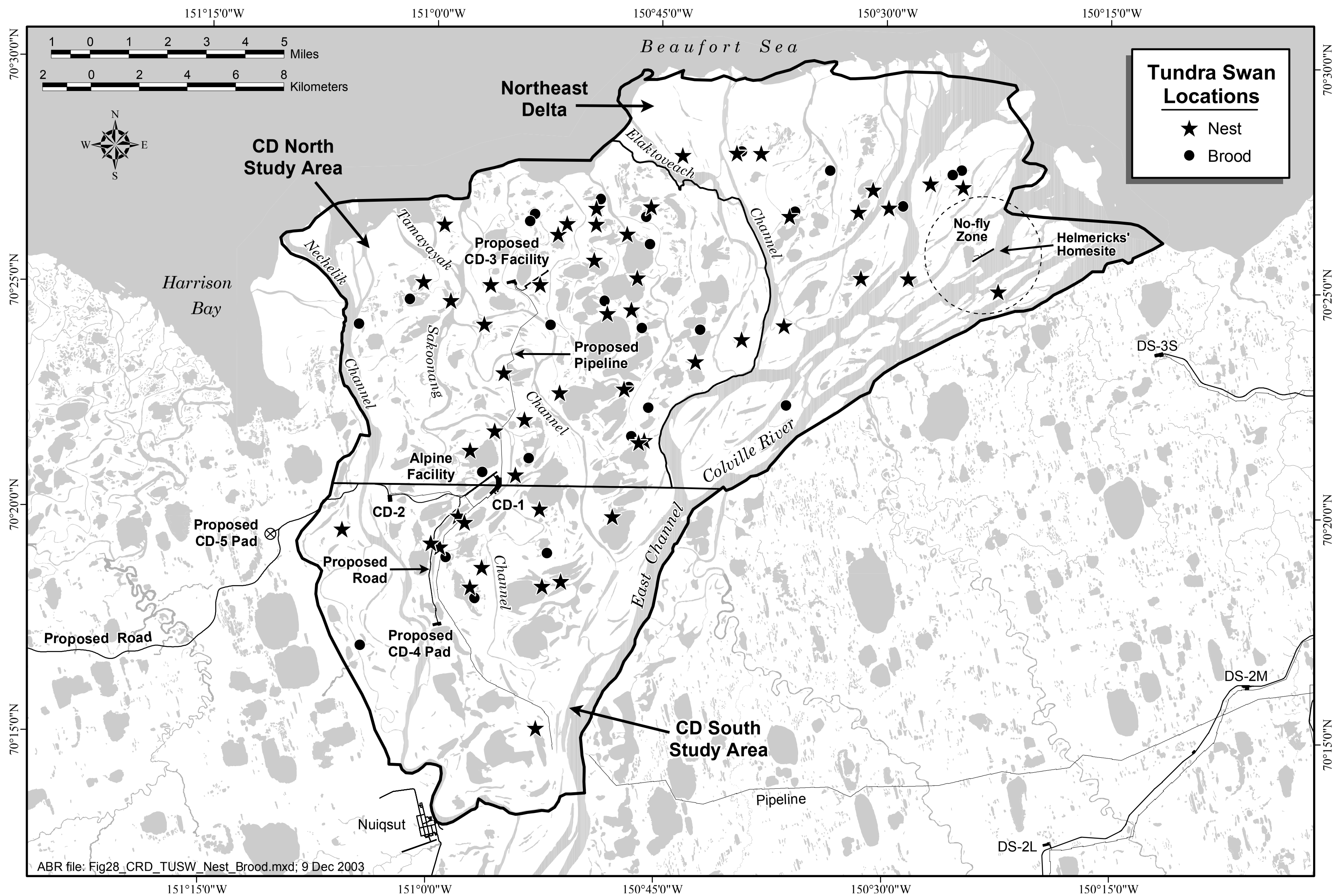

Figure 28. Tundra Swan nests and brood locations in the CD North and CD South study areas, Colville River Delta, Alaska, 2003.

of broods that has been recorded in CD North since 1992 (range 0.02–0.07 broods/km²). The mean brood size in the CD North study area in 2003 was 2.6 young (*n* = 16 broods), somewhat less than the 10-year average of 2.9.

In 2003, 4 swan broods were observed in the CD South study area, yielding an estimated 57% nesting success (Figure 28, Table 25). The density of swan broods in the CD South study area was 0.03 broods/km² in 2003. The mean brood size of 1.8 young was the lowest mean brood size recorded for CD South since 1992 (2.5 young/brood; range 1.8–3.4 young/brood) (Burgess et al. 2003).

The 27 Tundra Swan broods observed across the entire Colville Delta (CD North, CD South, and the northeast delta) in 2003 yielded an estimated nesting success of 63%, slightly less than the 10-year mean of 65% (range 31–114%). The density of broods across the entire delta in 2003 was 0.04 broods/km². Swan nest and brood densities were above average for the Colville Delta in 2003, while nesting success and mean brood size were slightly below average. The mean brood size of 2.4 in 2003 was below the 10 year mean of 2.7 but the total of 66 young on the delta was the highest since 1996, and the third highest of the 10 years of surveys.

Habitat Use

In 2003, 52 Tundra Swan nests were found in 11 habitat types (Table 26). Patterned Wet Meadow was used by the largest percentage (37%) of the swans nesting on the Colville Delta, followed by Salt-killed Tundra (17%) and Aquatic Sedge with Deep Polygons (13%) (Table 26).

Habitat selection was evaluated for 337 Tundra Swan nests recorded on the Colville Delta since 1992 (Appendix H1). Although some nest sites were used in multiple years (and thus not annually independent locations), we were not able to distinguish these sites objectively from others where nests were close, but not in exactly the same location, in consecutive years. None of the nest sites was used in all the years that surveys were conducted. Previous investigations have reported that 21–49% of swan nests are located on mounds used during the previous year (Hawkins 1983, Monda et al. 1994) and that nest sites reused from previous years were slightly more successful than new nest sites (Monda et al. 1994). Therefore, deletion of multi-year nest sites from selection analysis could bias the results towards habitats used by less experienced or less successful pairs. Instead, we have chosen to include all nest sites, while recognizing that all locations may not be annually independent.

Tundra Swans on the Colville Delta used a wide range of habitats for nesting. Over 10 years of surveys on the Colville Delta, Tundra Swans nested in 20 of 24 available habitats, of which 6 habitats were preferred and 7 were avoided (Appendix H1). Eighty-five percent of the nests were found in 6 preferred habitats: Salt Marsh, Salt-killed Tundra, Deep Open Water with Islands or Polygonized Margins, Aquatic Sedge with Deep Polygons, Patterned Wet Meadow, and Moist Sedge–Shrub Meadow. Nests occurred most frequently in Patterned Wet Meadow (38% of all nests), Salt-killed Tundra (13%), and Nonpatterned Wet Meadow (10%).

Tundra Swan broods on the Colville Delta in 2003 were observed in 13 of 20 available habitats (Table 26). The largest proportion of broods was observed in Salt-killed Tundra (19% of 27 broods), followed by Tapped Lake with Low-water Connection (15%), Brackish Water (11%), and Barrens (11%). Habitat selection was evaluated for 219 Tundra Swan broods recorded on the Colville Delta since 1992 (Appendix H1). Seven habitats were preferred: Brackish Water, both types of Tapped Lakes, both types of Deep Open Water, and Aquatic Grass Marsh. Broods were seen most frequently in Tapped Lake with Low-water Connections (16% of all broods) and Patterned Wet Meadow (16%).

The use of salt-affected habitats (e.g., Brackish Water, Salt Marsh, Salt-killed Tundra, Tidal Flat, and Tapped Lake with Low-water Connection) by brood-rearing swans reflects an apparent seasonal change in distribution or habitat preference, in that 38% of all swan broods on the delta were in salt-affected habitats, compared with only 20% of all nests (Appendix H1). Similar patterns have been reported by previous investigations (Monda et al. 1994, Spindler and Hall 1991).

Table 26. Habitat use by nesting and brood-rearing Tundra Swans in the Colville River Delta and in the NPRA study area, Alaska, 2003.

	Colville River Delta				NPRA Study Area			
	Nests[a]		Broods[b]		Nests[a]		Broods[b]	
Habitat	Number	Use (%)	Number	Use (%)	Number	Use (%)	Number	Use (%)
Brackish Water	0	0	3	11.1	0	0	0	0
Tapped Lake with Low-water Connection	0	0	4	14.8	0	0	3	23.1
Tapped Lake with High-water Connection	1	1.9	2	7.4	0	0	0	0
Salt Marsh	4	7.7	0	0	1	2.8	0	0
Tidal Flat	1	1.9	1	3.7	0	0	0	0
Salt-killed Tundra	9	17.3	5	18.5	0	0	0	0
Deep Open Water without Islands	1	1.9	1	3.7	0	0	6	46.2
Deep Open Water with Islands or Polygonized Margins	1	1.9	0	0	4	11.1	1	7.7
Shallow Open Water without Islands	0	0	1	3.7	0	0	0	0
Shallow Open Water with Islands or Polygonized Margins	0	0	0	0	4	11.1	1	7.7
River or Stream	0	0	1	3.7	0	0	0	0
Aquatic Sedge with Deep Polygons	7	13.5	0	0	0	0	0	0
Aquatic Grass Marsh	1	1.9	0	0	2	5.6	1	7.7
Old Basin Wetland Complex	0	0	0	0	4	11.1	0	0
Nonpatterned Wet Meadow	4	7.7	2	7.4	1	2.78	0	0
Patterned Wet Meadow	19	36.5	2	7.4	3	8.3	0	0
Moist Sedge-Shrub Meadow	4	7.7	0	0	9	25.0	0	0
Moist Tussock Tundra	0	0	1	3.7	8	22.2	0	0
Riverine or Upland Shrub[c]	0	0	1	3.7	–	–	–	–
Barrens	0	0	3	11.1	0	0	1	7.7
Total	52	100	27	100	36	100	13	100

[a] Includes nests found during both aerial and ground surveys
[b] Includes broods found during aerial surveys only
[c] Riverine or Upland Shrub was classified into 3 habitats in NPRA, but no nests or broods were found in those habitats

NPRA Study Area

Distribution and Abundance

In 2003, 43 nests were found during the aerial survey of the NPRA study area (Figure 29, Table 25), the same number found in 2002 (Burgess et al. 2003b). An additional 7 nests were found by ground searchers and helicopter-based surveys for nesting Yellow-billed Loons and Brant. Nest density in the NPRA study area was 0.04 nests/km². Swan nesting density in the NPRA study area was the same as the 15-year mean density in the Kuparuk Oilfield (Anderson et al. 2004) but below the 10-year mean nest density recorded on the Colville Delta (0.06 nests/km²). Nesting density of swans in the NPRA study area also was within the range of nest densities recorded on the eastern Arctic Coastal Plain (0.04–0.06 nests/km²; Platte and Brackney 1987).

Eighteen Tundra Swan broods (0.02 broods/km²) were observed in the NPRA study area in 2003 (Figure 29, Table 25). Estimated nesting success was 42% (18 of 43 nests successful) in the NPRA study area in 2003, down from 63% in 2002. Comparable brood-rearing surveys in the Kuparuk Oilfield and on the Colville Delta in 2003 indicated estimated nesting success of 79% and 63%, respectively, in 2003 (Anderson et al. 2004). The mean brood size in the NPRA study area in 2003 was 2.3 young (n = 18 broods; range 1–4 young) (Table 25).

Habitat Use

Tundra Swan nests occurred in 9 of 27 available habitats in the NPRA study area in 2003 (Table 26). Nests occurred most frequently in Moist Sedge–Shrub Meadow (25% of all nests), Moist Tussock Tundra (22%), Deep Open Water with Islands or Polygonized Margins (11%), Shallow Open Water with Islands or Polygonized Margins (11%), and Old Basin Wetland Complex (11%).

Habitat selection was calculated for 77 Tundra Swan nests recorded in the NPRA study area since 2001 (Appendix H2). Tundra Swans nested in 13 of 27 available habitats, but preferred only 2 habitats (Shallow Open Water with Islands or Polygonized Margins and Aquatic Grass Marsh) that were used by only 8 nests. One nest occurred in the single avoided habitat (Deep Open Water without Islands). All other nests were located in habitats that were neither preferred nor avoided (i.e., they were used in proportion to their relative availability).

Similar to swan broods on the Colville Delta, broods in NPRA were attracted to large, deep waterbodies. Thirteen swan broods used 6 of 27 available habitats in the NPRA study area in 2003 (Table 26). The 2 habitats used most frequently by brood-rearing swans were Deep Open Water without Islands (46%) and Tapped Lake with Low-water Connection (23%).

Habitat selection was evaluated for 46 Tundra Swan broods recorded in the NPRA study area since 2001 (Appendix H3). Tundra Swan broods used 13 of 27 available habitats. Thirty-one broods were located in the 3 preferred habitats: Deep Open Water without Islands (35% of all broods), Deep Open Water with Islands or Polygonized Margins (26%), and Tapped Lake with Low-water Connection (7%). Four broods occurred in the 4 avoided habitats (Old Basin Wetland Complex, Patterned Wet Meadow, Moist Sedge-Shrub Tundra, Moist Tussock Tundra).

GREATER WHITE-FRONTED GOOSE

Colville River Delta

Distribution and Abundance

Greater White-fronted Geese are by far the most abundant large bird nesting in the CD North search area. The 264 nests (14.7 nests/km²) of Greater White-fronted Geese accounted for 65% of all nests found in the CD North search area in 2003 (Figure 13, Table 5). More nests of Greater White-fronted Geese were found in the CD North search area in 2003 than in any previous year (previous high was 213 in 2001). The annual nest densities of this goose in CD North (≥9.8 nests/km²) were greater than any density reported previously elsewhere on the Colville Delta (Simpson and Pogson 1982, Rothe et al. 1983, Simpson 1983, Burgess et al. 2003a, Johnson et al. 2003a) or in the NPRA (Derksen et al. 1981, Burgess et al. 2003b). Nesting success of White-fronted Geese in the CD North search area was 73% in 2003, which was similar to nesting success in 2000–2002 (range 62–75%).

In contrast, only 1 brood of Greater White-fronted Geese was observed in the CD North search area in 2003 (Table 6). Greater

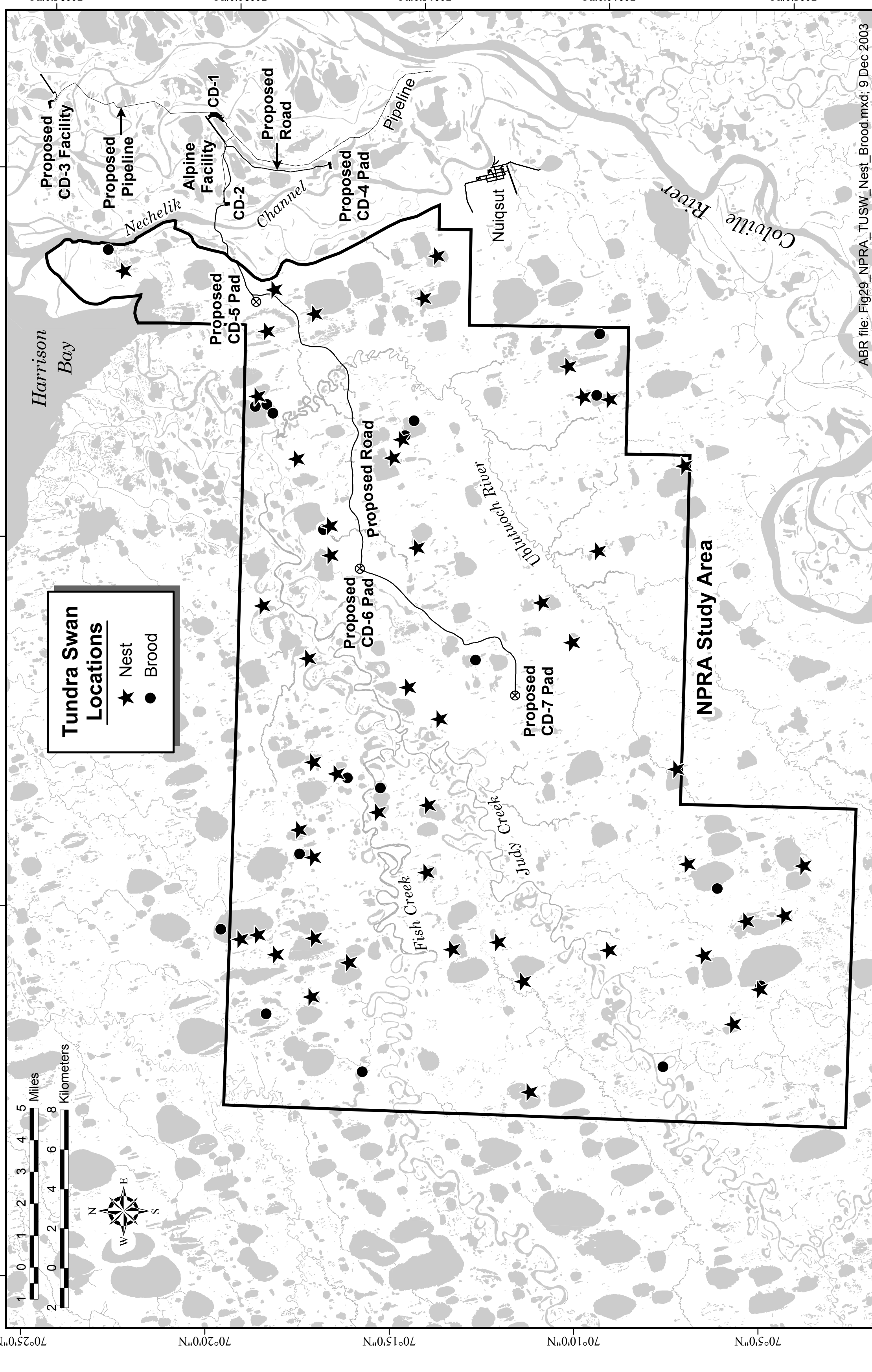

Figure 29. Tundra Swan nests and brood locations in the NPRA study area, Alaska, 2003.

White-fronted Geese are wary and highly mobile during the brood-rearing period and this probably accounts for the scarcity of sightings during brood-rearing. The maximum number of broods of Greater White-fronted Geese that has been observed in the CD North search area since 2000 is 11 (Johnson et al. 2003b).

Habitat Use

Greater White-fronted Geese nested in a variety of habitats in 2003 (Table 7), but 2 habitats with polygonal surfaces accounted for >60% of all nests: Patterned Wet Meadow (41% of all nests) and Aquatic Sedge with Deep Polygons (26%). Nonpatterned Wet Meadow was the only other habitat that accounted for >10% of nests. Most (79%) Greater White-fronted Goose nests in 2003 were on slightly elevated landforms—polygon rims, low ridges, or small hummocks—that were similar to the nesting sites reported for other areas of the delta (Simpson et al. 1982, Johnson et al. 2003a). Nests ranged from <1 to 296 m (mean = 82.7 m, n = 264 nests) from the nearest waterbody.

Habitat selection was analyzed for 774 Greater White-fronted Goose nests from 4 years of surveys in the CD North search area (Appendix I1). The 2 most-frequently used habitats were identified as preferred for nesting: Patterned Wet Meadow (39% of nests) and Aquatic Sedge with Deep Polygons (29%). Ten habitat types were “avoided” (used significantly less than their availability), although 136 nests occurred in these avoided habitats. One avoided habitat, Salt-killed Tundra, occupied 15% of the search area and contained 11% of the nests (85 nests), suggesting that it was an important nesting habitat for Greater White-fronted Geese, despite its being used less than its availability.

The single group of brood-rearing Greater White-fronted Geese observed in the CD North search area in 2003 was located in Patterned Wet Meadow (Table 8). In previous years, when more broods have been seen, they have occurred in a variety of terrestrial and aquatic habitats (Johnson et al. 2003b).

NPRA Study Area

Distribution and Abundance

With 185 total nests, Greater White-fronted Geese also were the most abundant large birds nesting in ground-search areas in the NPRA study area (Figures 16 and 18, Table 13). Overall nest density was 5.8 nests/km², with densities in the Alpine West search areas reaching 11.8 nests/km² (Table 9). The nest density of Greater White-fronted Geese at Alpine West in 2003 was only slightly less than the density in the CD North search area (14.7 nests/km²). The overall nesting success for Greater White-Fronted Geese in the NPRA search areas in 2003 was 66% (Table 13).

Only 5 broods of Greater White-fronted Geese were observed in the NPRA pad and road corridor search areas in 2003 (Table 10). However, during brood-rearing and fall-staging aerial surveys in 2003, Greater White-fronted Geese were the most abundant species observed in the NPRA study area. During brood-rearing, 1,547 geese were observed in 45 groups (mean = 34.4 geese/group, range 1–170) (Figure 30, Table 27). Juvenile geese comprised only 21% (321 young) of the total. The density of brood-rearing Greater White-fronted Geese was 2.8 geese/km², which was slightly higher than in previous years.

During the fall-staging survey in 2003, 188 Greater White-fronted Geese were observed in 10 groups (mean = 18.8 geese/group, range 4–40, density = 0.4 birds/km²) (Figure 30, Table 27), which was much lower than during brood-rearing and lower than in previous years. Weather conditions were poor for flying at the time of the surveys, with low ceilings, fog and low temperatures, and rain mixed with occasional snow. These conditions could have affected the visibility of geese; alternatively, these conditions also could have persuaded the geese to move to other staging areas.

Habitat Use

Greater White-fronted Geese nested in a wide range of habitat types in the NPRA search areas, and unlike other waterfowl in the region, the majority of nests were in terrestrial habitats (Table 14). Four habitats accounted for 91% of nests: Patterned Wet Meadow (29%), Old Basin Wetland Complex (26%), Moist Sedge–Shrub Meadow (20%), and Moist Tussock Tundra (16%). These

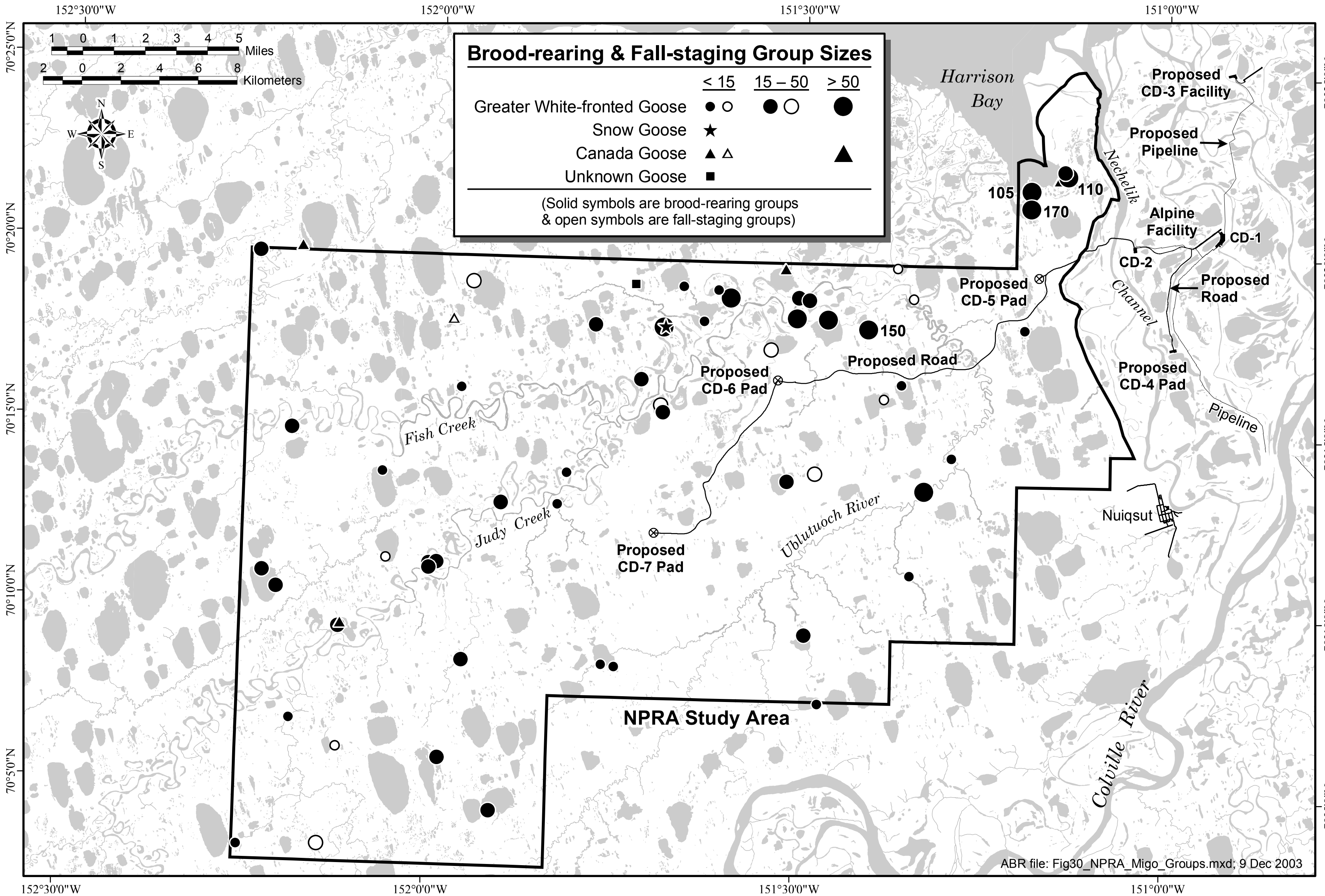

Figure 30. Greater White-fronted Goose, Canada Goose, and Snow Goose brood-rearing and fall-staging groups in the NPRA study area, Alaska, 2003. Groups >100 birds are indicated.

Table 27. Number and density of brood-rearing and fall-staging geese during aerial surveys of the NPRA study area, Alaska, 2003.

Species	Brood-rearing Adults	Brood-rearing Young	Brood-rearing Density[a] (total birds/km²)	Fall-staging Number	Fall-staging Density[a] (birds/km²)
Greater White-fronted Goose	1,226	321	2.85	188	0.35
Canada Goose	62	20	0.15	4	0.01
Snow Goose	1	0	<0.01	0	0
Unknown Goose	4	0	0.01	0	0
Total	1,293	341	3.01	192	0.36

[a] Density based on a 50% survey of 1,087 km² (543.5 km²) during brood-rearing and 1,072 km² (536 km²) during staging

habitat types in the NPRA study area all are characterized by inclusion of drier microsites and a juxtaposition of wet and moist terrain. Only Patterned Wet Meadow and Old Basin Wetland Complex were preferred habitats for nesting (Appendix I2). Despite the occurrence in Moist Tussock Tundra of 29 of 182 nests, this habitat was considered avoided, because use (16% of all nests) was significantly less than availability (22% of the area). Over 80% of nests in 2003 were on slightly elevated landforms—polygon rims, low ridges, or small hummocks—similar to what was observed on the Colville Delta. Nests ranged from <1 to 421 m (mean = 76.0 m, n = 185 nests) from the nearest waterbody.

Broods of Greater White-fronted Geese were observed in 5 habitat types during ground searches in the NPRA study area in 2003 (Table 15). Most brood-rearing groups were located in Deep Open Water with Islands or Polygonized Margins (3 groups), and 1 group each was observed in Deep Open Water without Islands, Shallow Open Water with Islands or Polygonized Margins, Old Basin Wetland Complex, and Riverine Low and Tall Shrub.

During the brood-rearing aerial survey, Greater White-fronted Geese were located in or near lakes, rivers, streams, and marshes (Figure 30, Table 28). More than 68% of all Greater White-fronted Goose sightings were in aquatic habitats, usually near creek or river drainages. The terrestrial habitats in which Greater White-fronted Geese were observed were those associated with lakes or the streams in the study area. It should be noted that the high use of lakes by geese that was observed during the aerial surveys was possibly an escape response to the aircraft, and may not represent use of foraging habitat.

BRANT

Colville River Delta

Distribution and Abundance

Nesting Brant are abundant on the Colville Delta, but the largest colonies lie outside of the CD North search area (see Johnson et al. 1999). In 2003, only 12 Brant nests were found in the CD North search area (Figure 13, Table 5), which was less than half of the number found in previous years (range 23–40 in 2000–2002; Johnson et al. 2003b). However, the number of nests in 2003 was a minimal estimate for the CD North search area, because many Brant nests failed before nests searches were conducted in 2003. In particular, one Brant nest colony on a lake that normally supports up to 13 nests had experienced complete nest failure by the time nest searches began in 2003. It was impossible to determine during the nest search exactly how many nests had been initiated or why the colony failed. Consequently, the nest success of 42% calculated for the remaining nests is an overestimate. The estimated nest density for Brant was 0.7 nests/km², compared with 1.2–2.5 nests/km² in previous years.

No brood-rearing Brant were observed in the CD North search area in 2003. The lack of Brant broods in most years was probably due to low to moderate nest success and the tendency of Brant to move out to coastal salt marshes for brood-rearing (see Johnson et al. 2003b).

Table 28. Habitat use by brood-rearing/molting groups and fall staging groups of Greater White-fronted, Canada, and Snow geese in the NPRA study area, Alaska, 2003.

SEASON Habitat	Greater White-fronted Goose Groups	Greater White-fronted Goose Use (%)	Canada Goose Groups	Canada Goose Use (%)	Snow Goose Groups	Snow Goose Use (%)
BROOD-REARING						
Open Nearshore Water	1	3.1	0	0	0	0
Salt Marsh	2	6.3	0	0	0	0
Tidal Flat	1	3.1	1	50.0	0	0
Deep Open Water without Islands	8	25.0	0	0	0	0
Deep Open Water with Islands or Polygonized Margins	10	31.3	1	50.0	1	50.0
Shallow Open Water without Islands	2	6.3	0	0	0	0
Aquatic Grass Marsh	1	3.1	0	0	0	0
Old Basin Wetland Complex	3	9.4	0	0	0	0
Riverine Complex	1	3.1	0	0	0	0
Patterned Wet Meadow	2	6.3	0	0	0	0
Moist Sedge–Shrub Meadow	1	3.1	0	0	0	0
Total	32[a]	100	2[b]	100	1	100
STAGING						
Deep Open Water without Islands	3	42.9	0	0	0	0
Deep Open Water with Islands or Polygonized Margins	1	14.3	0	0	0	0
River or Stream	1	14.3	0	0	0	0
Aquatic Sedge Marsh	1	14.3	0	0	0	0
Old Basin Wetland Complex	1	14.3	0	0	0	0
Patterned Wet Meadow	0	0	1	100	0	0
Total	7[c]	100	1	100	0	0

[a] 13 groups of Greater White-fronted Geese occurred outside the area mapped for habitat
[b] 1 group of Canada Geese occurred outside the area mapped for habitat
[c] 3 groups of Greater White-fronted Geese occurred outside the area mapped for habitat

Habitat Use

Brant nests in 2003 were found primarily within the colonies that were identified in previous years and mostly were located on islands or peninsulas in Deep Open Water with Islands or Polygonized Margins (58% of all known nests) and Aquatic Sedge with Deep Polygons (17%) (Table 7). All Brant nests were <1m from water.

NPRA Study Area

Distribution and Abundance

Eighteen Brant nests were found in the various ground-search areas in the NPRA study area in 2003, yielding 0.6 nests/km² (Figure 16, Table 13). Most Brant nests were within 2.5 km of the proposed Alpine West pad. Overall nesting success for Brant was poor (28%). The abundance of Brant in proximity to Alpine West in the NPRA study area is consistent with their tendency to nest close to the coast and deltas. Although suitable habitats for nesting Brant exist in the vicinity of Fish Creek and the Ublutuoch River, much of the remainder of the NPRA lacks suitable habitats and is farther inland than Brant typically are found nesting (Anderson et al. 1999, Johnson et al. 1999, Ritchie and Wildman 2000).

During the aerial nesting survey in 2003, 55 Brant and 11 nests were recorded at 20 locations within the NPRA study area (Figure 31). The majority of the nesting locations were in the northeastern section of the study area in the vicinity of Fish Creek and the Ublutuoch River. In addition, 97 Brant and 23 nests were observed at 10 locations immediately north of the study area

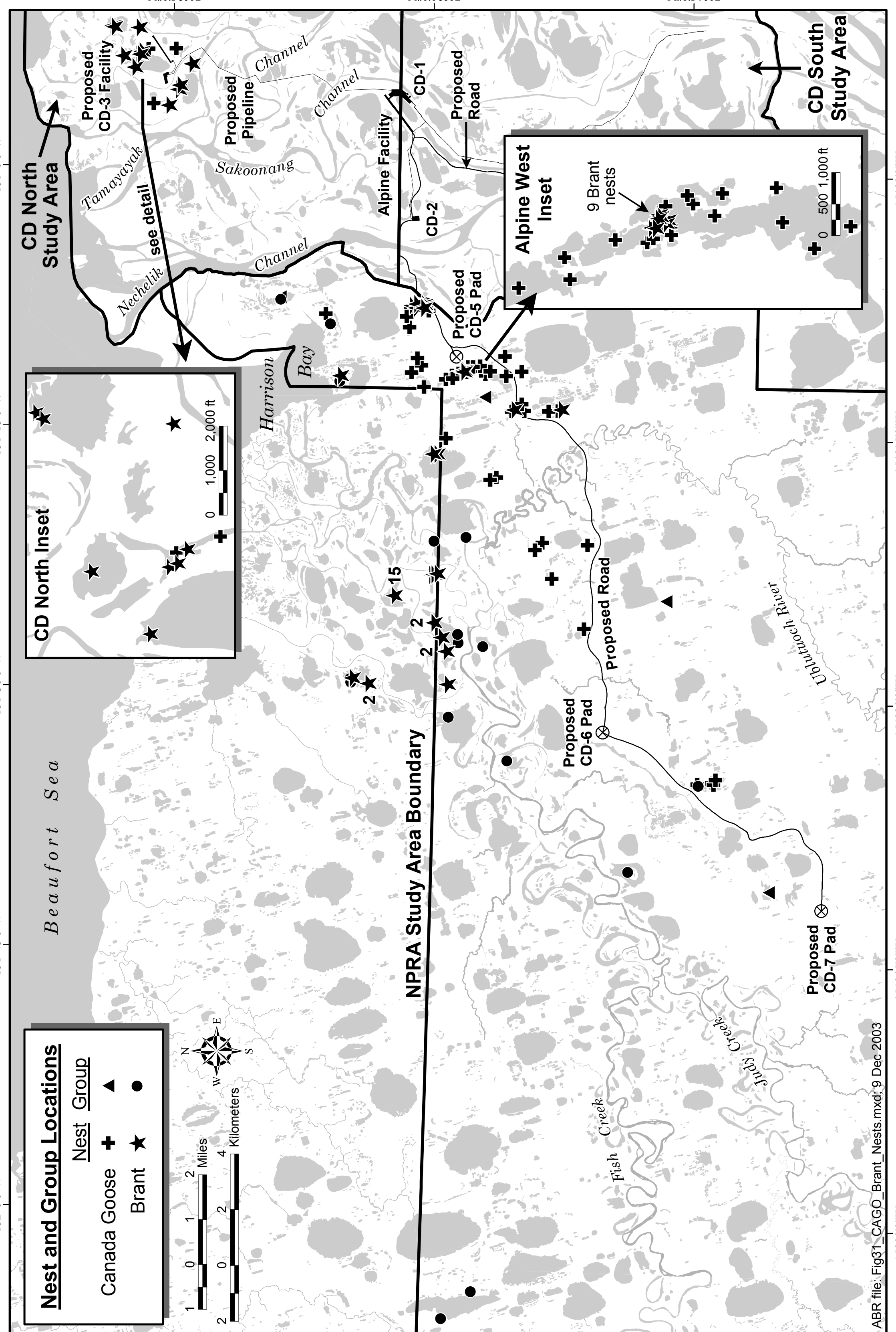

Figure 31. Brant and Canada Goose nests and group locations in the CD North and NPRA study areas, Alaska, 2003. Data from aerial and ground surveys in NPRA, ground surveys only in CD North. Locations with >1 nest are indicated.

(Figure 31), one of which had an estimated 67 adults and ≥15 nests. The number of Brant and nests observed during the aerial survey in 2003 was greater than in previous years, but still represents a minimal estimate, because of the difficulty of seeing these geese and their nests from the air.

Only 2 Brant broods were observed in the NPRA ground-search areas in 2003 (Figure 19, Table 10). Both were located just northeast of the Spark search area, farther south than any of the known Brant nests in the NPRA study area. In 2003, Brant were not observed in the NPRA study area during the brood-rearing aerial survey, which is conducted after most Brant move to coastal areas.

Habitat Use

Brant typically nest on small islands in lakes, often in small groups or colonies, and often in association with other geese. All Brant nests in the combined search areas in the NPRA study area were located in 2 habitats: Shallow Open Water with Islands or Polygonized Margins (56% of all nests) and Young Basin Wetland Complex (44%) (Table 14). Additionally, Brant observed during the aerial survey also nested in Deep Open Water with Islands or Polygonized Margins (3 nests), and on islands in Brackish Water (1 nest). Aquatic Sedge with Deep Polygons was a preferred nesting habitat in the Colville Delta (Johnson et al. 2003b), but in the NPRA this habitat represented <0.1% of the total mapped area. Another preferred nesting habitat for Brant on the Colville Delta was Salt-killed Tundra, which did not occur in the ground-search areas in the NPRA.

Although Brant were not seen during the brood-rearing aerial survey, 2 brood groups were observed during ground visits to the NPRA search areas. One group was observed in Deep Open Water with Islands or Polygonized Margins and 1 was in Riverine Complex (Table 15).

CANADA GOOSE

Colville River Delta

Distribution and Abundance

Canada Geese are relatively uncommon in the Colville Delta and only 4 nests were found in the CD North search area in 2003 (Table 5). Nest density was 0.2 nests/km² and nesting success was 75%. No brood-rearing Canada Geese were observed in the CD North search area in 2003. Aerial surveys for nesting, brood-rearing, and fall-staging geese were not conducted in the Colville Delta in 2003.

Habitat Use

Canada Geese nested in 2 habitat types in the CD North search area: Deep Open Water with Islands or Polygonized Margins (3 nests) and Deep Open Water without Islands (1 nest) (Table 7). All 4 nests were located on small islands, some of which were too small to register on our habitat mapping.

NPRA Study Area

Distribution and Abundance

Nesting Canada Geese were abundant in the NPRA pad and corridor search areas in 2003. Forty-six Canada Goose nests (1.4 nests/km²) were found in the various ground-search areas (Table 13). One additional Canada Goose nest was found during the aerial survey for Brant (Figure 31), bringing the total number of known Canada Goose nests in the NPRA study area to 47. Nesting success in the NPRA study area in 2003 was 53%. Seventeen Canada Goose nests occurred in the Alpine West search area, and the density of nests (3.6 nests/km²) in this search area was the highest of any area searched in 2003 (Table 9).

During brood-rearing aerial surveys, 82 Canada Geese (including 20 young) were observed at 3 locations in the NPRA study area (Figure 30, Table 27). In 2003, brood-rearing groups were observed primarily in lakes and ponds associated with the creeks in the study area. During fall-staging surveys, only 4 Canada Geese were observed at 1 location in the NPRA study area (Figure 30, Table 27).

Habitat Use

All Canada Goose nests found in the NPRA search areas in 2003 were in aquatic habitats (Table 14). Of forty-six Canada Goose nests for which habitat information was available, 89% were in Shallow Open Water with Islands or Polygonized Margins (59% of nests) and Old Basin Wetland Complex (30%) (Table 14). Nests were located primarily on islands (76%) or on shoreline features (15%), within 1 m from water.

The single brood-rearing group of Canada Geese observed during ground visits was located in

Moist Sedge–Shrub Meadow (Figure 17, Table 15). During the brood-rearing aerial survey, Canada Geese occurred in or near lakes, rivers, streams, and marshes (Figure 30, Table 28). The 2 groups of Canada Geese for which habitat data were available occurred in Tidal Flat and in Deep Open Water with Islands or Polygonized Margins.

SNOW GOOSE

Colville River Delta

Distribution and Abundance

Snow Geese nest in small numbers and scattered locations on the Colville Delta. In 2003, 3 Snow Goose nests were found in the CD North search area (Table 5). All 3 nests appeared successful, and the nest density was 0.2 nests/km². Another successful nest was found west of the ground search area near an arctic fox natal den (den 62). Previously, 1–2 Snow Goose nests were recorded in the CD North search area in 1994, 1997, and 2002 (Johnson et al. 2003b).

During brood-rearing, 35 adult Snow Geese and 38 young were observed in a single group in the CD North search area (Figure 15, Table 6). Snow Goose broods were not recorded in the CD North search area in previous years, but the larger CD North study area has had Snow Goose broods (range 0–72 geese) in 5 out of 6 years of aerial surveys. No aerial surveys were conducted in the Colville Delta for brood-rearing or staging geese in 2003.

Habitat Use

Snow Geese in the CD North search area in 2003 nested only in Deep Open Water with Islands or Polygonized Margins (2 nests) and Patterned Wet Meadow (1 nest). The single brood-rearing group observed in the CD North search area in 2003 was located in Nonpatterned Wet Meadow (Table 8).

NPRA Study Area

No Snow Goose nests or brood-rearing groups were observed in the various search areas in the NPRA study area in 2003. During the brood-rearing aerial survey, a single Snow Goose was observed in the NPRA study area just north of the confluence of Fish and Judy creeks (Figure 30) in Deep Open Water with Islands or Polygonized Margins (Table 28).

GLAUCOUS GULL

Colville River Delta

Distribution and Abundance

Eight Glaucous Gull nests were counted in the CD North study area and 18 nests were counted in the CD South study area during aerial surveys for eiders, swans, and loons in 2003 (Figure 32; Table 29). An additional 5 nests were found by ground searchers in the CD North search area, 1 of which was outside the search area (Figure 14). The apparent concentration of Glaucous Gull nests in the northern half of the CD North study area (Figure 32) may be an artifact of the intensive ground searches in that area (i.e., fewer nests were missed by ground search than by aerial survey). In the CD South study area, 14 of the 18 nests were part of a Glaucous Gull colony located ~5 km southeast of the Alpine project area (Figure 32). Counts at this colony have ranged from 10 to 18 nests during 5 years of surveys (1998, 2000–2003). No colonies were found in the CD North study area, but 2 locations had 2 nests each. Most nests in both study areas were in the same locations used previously in 2000–2002 (Burgess et al. 2003a, Johnson et al. 2003b). An additional 7 nests were observed in 2003 in the northeast delta, 6 of which were in a Glaucous Gull colony (Figure 32). Five nests also were observed at this colony in 2002 (Johnson et al. 2003b).

The density of Glaucous Gull nests in 2003 was 0.06 nests/km² in the CD North study area and 0.12 nests/km² in the CD South study area (Table 29). The density of Glaucous Gull nests for both study areas were within the range of densities reported in 2000–2002 (CD North, 0.04–0.10 nests/km²; CD South, 0.09–0.17 nests/km²). Because Glaucous Gulls were counted on aerial surveys designed to survey other species, some nests probably were missed. The density of Glaucous Gull nests estimated from ground searches in the CD North search area was 0.2 nests/km² in 2003 (Table 5). In 2000–2002, nest density ranged from 0.2 to 0.8 nests/km² in the CD North search area (Johnson et al. 2003b).

Glaucous Gull broods were recorded incidentally in 2003 during the aerial survey for brood-rearing loons. Two Glaucous Gull broods were recorded, 1 each in the CD North and CD South study areas (Figure 32). Two additional

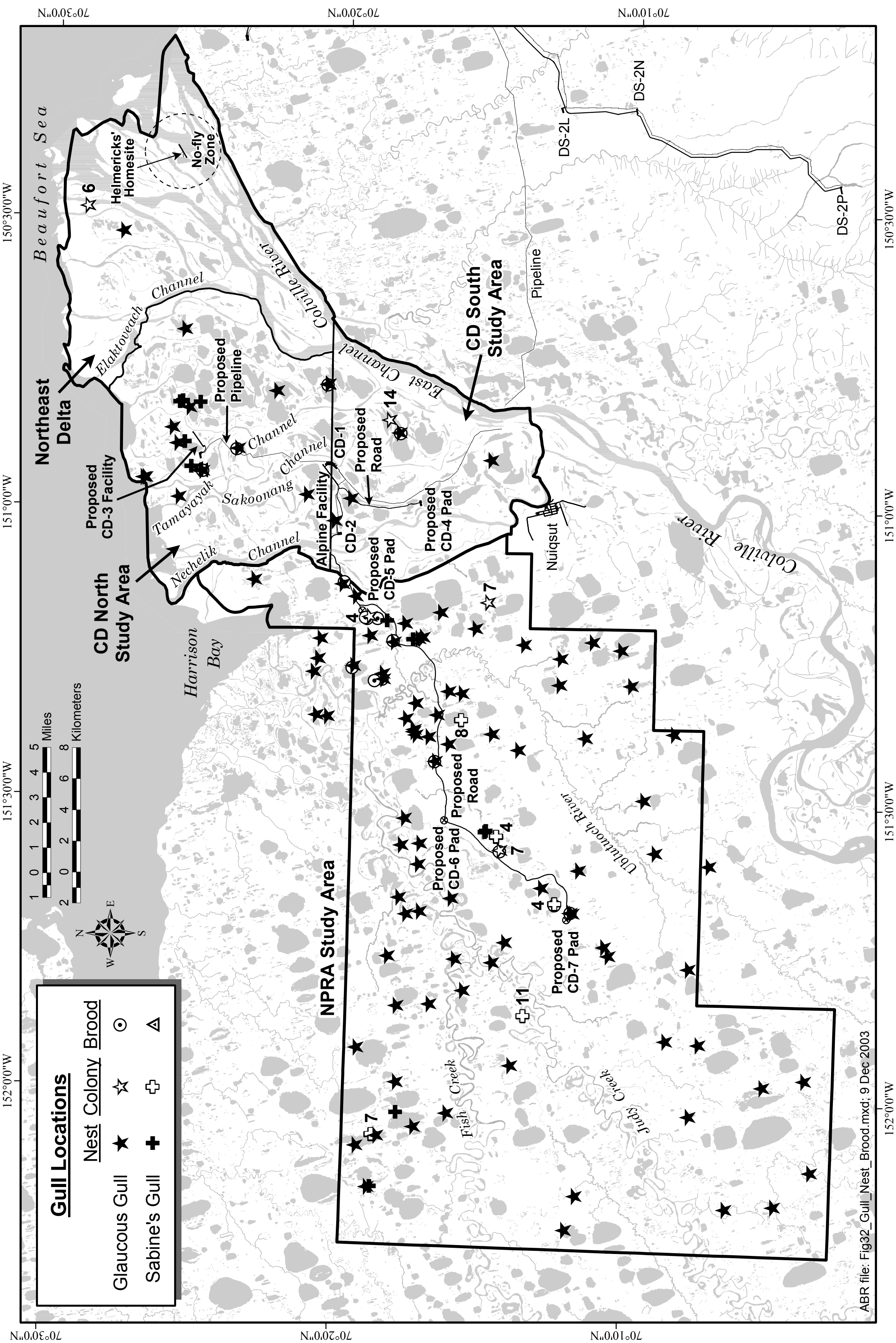

Figure 32. Glaucous Gull and Sabine's Gull nests and broods in the CD North, CD South, and NPRA study areas, Alaska, 2003. Labels indicate the number of nests if >2 nests were present.

Table 29. Number and density of Glaucous Gull and Sabine's Gull nests in the CD North, CD South, and NPRA study areas, Alaska, 2003.

SURVEY AREA[a] Species	Number of Nests			Nest Density[d] (nests/km²)
	Aerial Surveys[b]	Ground-searches[c]	Total	
CD NORTH				
Glaucous Gull	8	5[e]	13	0.06
Sabine's Gull	0	6	6	–
CD SOUTH[f]				
Glaucous Gull	18	–	18	0.12
Sabine's Gull	0	–	0	–
NPRA				
Glaucous Gull	93	18[g]	93	0.09
Sabine's Gull	34	7	41	–

[a] CD North = 206.9 km², CD South = 155.7 km², NPRA = 1091.6 km²
[b] Data were collected during aerial surveys for pre-nesting eiders and Long-tailed Ducks, and for nesting Brant, Tundra Swans, and Yellow-billed Loons
[c] Data were collected in large waterbird ground-search areas (see Figures 4 and 5); CD South was not searched on the ground
[d] Nest density not calculated for Sabine's Gulls because detectability of nesting pairs on aerial survey is low and surveys were not comprehensive
[e] One nest included was found on ground-search but was outside the CD North search area
[f] No ground search was conducted in CD South in 2003
[g] All nests found during ground searches also were found on aerial survey

broods were observed in the CD North study area during ground searches, 1 of which was outside the ground-search area (Figures 15 and 32, Table 6). All Glaucous Gull broods were located near known nest locations. No young were observed at the colony site in the CD South study area during the aerial survey in 2003, and we suspect that young may have fledged prior to that survey, as was suspected in 2002 (Burgess et al. 2003a). Twelve young were observed at that site in 2000 and 7 young were observed in 2001.

Habitat Use

Fourteen of the 38 Glaucous Gull nests (37%) found on the Colville Delta in 2003 were from the colony in the CD South study area, which is a large island classified as Patterned Wet Meadow (Figure 32, Table 30) in Deep Open Water with Islands or Polygonized Margins. The colony of 6 nests (16% of all nests) in the northeast delta was located in a raised area in Tidal Flat. The remaining nests were located on islands in Deep Open Water with Islands or Polygonized Margins (7 nests, 18%), Tapped Lake with High-water Connection (4 nests, 10%), Brackish Water (3 nests, 8%), Aquatic Sedge with Deep Polygons (3 nests, 8%), and Shallow Open Water without Islands (1 nest, 3%) (Table 30). Within the CD North search area, Glaucous Gull nests were found only in Deep Open Water with Islands or Polygonized Margins (3 nests) and Tapped Lake with High-water Connection (1 nest) (Table 7). Glaucous Gull broods observed during aerial and ground surveys were located near nests in the same habitats as the nests (Table 8).

NPRA Study Area

Distribution and Abundance

Ninety-three Glaucous Gull nests were counted in the NPRA study area in 2003 during aerial surveys for eiders, Brant, Long-tailed Ducks, Tundra Swans and Yellow-billed Loons (Figure 32, Table 29). Eighteen nests found during ground searches in the NPRA study area also were found during aerial surveys. Of the 93 nests found in the study area, 18 nests were in 3 colonies—1 colony in the Alpine West search area had 4 nests, 1 colony in the extended buffer of the road corridor

Table 30. Habitat use by nesting Glaucous Gulls in the Colville River Delta and in the NPRA study area, Alaska, 2003.

Habitat	Colville River Delta Nests[a]	Colville River Delta Use (%)	NPRA Study Area Nests	NPRA Study Area Use (%)
Brackish Water	3	7.9	1	1.3
Tapped Lake with High-water Connection	4	10.5	0	0
Tidal Flat	6	15.8	0	0
Deep Open Water with Islands or Polygonized Margins	7	18.4	7	9.2
Shallow Open Water without Islands	1	2.6	6	7.9
Shallow Open Water with Islands or Polygonized Margins	0	0	50	65.8
Aquatic Sedge Marsh	0	0	3	3.9
Aquatic Sedge with Deep Polygons	3	7.9	0	0
Aquatic Grass Marsh	0	0	1	1.3
Young Basin Wetland Complex	0	0	1	1.3
Old Basin Wetland Complex	0	0	4	5.3
Nonpatterned Wet Meadow	0	0	1	1.3
Patterned Wet Meadow	14	36.8	2	2.6
Total	38	100	76	100

[a] Includes 7 nests on the northeast delta, the remainder were in the CD North and CD South study areas

south of the Lookout search area had 7 nests, and another in the eastern part of the study area had 7 nests (Figures 16, 18, and 32). These colonies also were active in 2002, when 4–6 nests were found at each site (Burgess et al. 2003b). Most other Glaucous Gull nests found in 2003 were individual nest locations (Figure 32).

Glaucous Gull nests were distributed throughout the NPRA study area in 2003 (Figure 32), and many were in the same locations as in 2001 or 2002 (Burgess et al. 2003b). Nest density in 2003 in the NPRA study area was 0.09 nests/km² (Table 29). On similar aerial and ground surveys conducted in 2002, nest density for Glaucous Gulls was 0.08 nests/km² (Burgess et al. 2003b). Nest density in the 2001 NPRA study area (615 km²) was 0.05 nests/km², but nests were recorded only during the nesting survey for Yellow-billed Loons, which focused on larger lakes and, therefore, the survey was not as comprehensive for Glaucous Gulls (Burgess et al. 2002b). The density of Glaucous Gull nests found on ground searches in the combined search areas in the NPRA study area was 0.7 nests/km² (Table 13), but we caution that the search areas were not representative of the entire study area.

No Glaucous Gull broods were observed during the brood-rearing aerial survey for Yellow-billed Loons in 2003. During ground searches, 11 Glaucous Gull broods were observed near known nest locations; 9 broods were in the search areas of Alpine West, Lookout, and the extended buffer of the road corridor (Figures 17, 19, and 32; Table 10) and 2 were in the northern road corridor and its extended buffer (Appendix C3).

Habitat Use

Glaucous Gulls nested primarily on islands in lakes. Habitat information is available for 76 Glaucous Gull nests in the NPRA study area in 2003 (Table 30). Glaucous Gulls were found nesting in 10 of 27 available habitats. Most nests were located on islands in Shallow Open Water with Islands or Polygonized Margins (66% of all nests) and Deep Open Water with Islands or Polygonized Margins (9%). The remaining 19 nests were found on islands or complex shorelines of 8 other habitats. Glaucous Gull broods were found in aquatic habitats near nest locations, often in the same habitat as the nest (Table 15).

SABINE'S GULL

Colville River Delta

Distribution and Abundance

No Sabine's Gull nests were observed during the aerial survey for nesting loons on the Colville Delta in 2003. Sabine's Gulls are difficult to detect from the air and nest in a wider variety of habitats than are included in the loon survey, which focused on large (≥10 ha) waterbodies. Six Sabine's Gull nests were found during ground searches in the CD North search area in 2003, and the density was 0.3 nests/km² for that area (Figure 14 and 31; Table 5). Two Sabine's Gull broods were found during nest fate checks in July in the CD North search area (Figures 15 and 32; Table 6).

Habitat Use

All Sabine's Gull nests on the Colville Delta were single-nest locations on islands or along complex shorelines in Deep Open Water with Islands or Polygonized Margins (3 nests, 50% of all nests), Salt-killed Tundra (1 nest, 17%), Aquatic Sedge with Deep Polygons (1 nest, 17%), and Riverine or Upland Shrub (1 nest, 17%) (Table 7). Sabine's Gull broods were located in aquatic habitats near nest locations (Table 8).

NPRA Study Area

Distribution and Abundance

During the nesting survey in 2003 for loons, 34 Sabine's Gull nests were found in the NPRA study area, either as single nests, pairs of nests, or colonies (Figure 32, Table 29). An additional 7 nests were found during ground searches—3 nests in the extended buffer of the road corridor and a colony of 4 nests in the Spark search area (Figures 16 and 18, Tables 9 and 12). One nest found during the aerial survey was in the extended buffer of the road corridor. Thirty-four of the 41 Sabine's Gull nests in the study area were located in 5 nesting colonies (Figure 32). The number of nests in each colony ranged from 4–11. Three of these colony sites were occupied in 2002, including the colony in the Spark search area; the other 2 colony sites were not checked in 2002 (Burgess et al. 2003b).

Both Sabine's Gull colonies and nests were located in the northern half of the study area, but that may be because the Yellow-billed Loon aerial survey and the ground searches were concentrated there. Sabine's Gull densities were not calculated for the NPRA study area because our sightings are opportunistic and not comprehensive for that area. However, nest densities were calculated for the combined ground-search areas in the NPRA study area and Sabine's Gulls nested at a density of 0.3 nests/km² (Table 13).

One Sabine's Gull brood with 1 young was observed during ground searches in the extended buffer of the road corridor (Figure 17, Table 10).

Habitat Use

Habitat information is available for 4 of the 5 Sabine's Gull nest colonies in the NPRA study area in 2003 (Table 14). Each colony location was found in a different habitat: Shallow Open Water with Islands or Polygonized Margins, Aquatic Sedge Marsh, Aquatic Grass Marsh, and Moist Shrub–Sedge Meadow. The colony found in Moist Shrub–Sedge Meadow was on a low-lying part of a complex shoreline. Singles and pairs of nests were found in Deep Open Water with Islands or Polygonized Margins, Shallow Open Water with Islands or Polygonized Margins, Aquatic Sedge Marsh, Old Basin Wetland Complex, and Moist Shrub–Sedge Meadow (Table 14). Sabine's Gull broods were seen in aquatic habitats near nest locations (Table 15).

CARIBOU

Caribou from 2 adjacent herds use the ASDP area: the Teshekpuk Herd (TH) and the Central Arctic Herd (CAH). The 2 herds are roughly similar in size, although the TH has grown at a faster rate in recent years. The latest ADFG photocensuses in July 2002 counted 45,166 caribou in the TH (G. Carroll, ADFG, pers. comm.) and 31,857 caribou in the CAH (Arthur and Del Vecchio 2003). Although the degree of use of the ASDP area by each herd varies by season and year, telemetry data indicate consistent use of the northeastern NPRA area by TH caribou and of the Colville Delta by CAH caribou. The TH typically calves and summers in a core area surrounding Teshekpuk Lake in the NPRA, about 50 km northwest of our study area, and disperses across the coastal plain in winter, traveling south of the Brooks Range in some years (Silva 1985, Carroll 1995, Philo et al. 1993, Prichard et al. 2001). The nearest high-density calving area used by CAH caribou lies south and southwest of the Kuparuk

Oilfield, ~35 km east of the Colville River Delta; the herd summers on the coastal plain between the Colville Delta and the Canning River and winters in the foothills of the Brooks Range (Murphy and Lawhead 2000, Lawhead and Prichard 2003b). For both herds, however, unusual movements outside of normal herd ranges have been recorded in recent years, including a westward movement of at least 6,000 CAH caribou through the NPRA study area in July 2001 (Lawhead and Prichard 2002, Arthur and Del Vecchio 2003) and a large eastward movement of an estimated 5–10,000 TH caribou to ANWR in October 2003 (G. Carroll, ADFG, pers. comm.).

Colville River Delta

Distribution and Abundance

Caribou density was low on the Colville Delta (mean = 0.05 caribou/km²; range 0.01–0.13) during all 4 aerial surveys in summer and fall 2003 (Table 31, Figure 33). The western segment of the CAH remained well east of the delta, mostly between the Kuparuk and Prudhoe Bay oilfields (>45 km east of the delta) during the insect season in 2003 (Lawhead and Prichard 2003b). The

Table 31. Number and density of caribou observed during systematic aerial strip-transect surveys of the NPRA and Colville Delta survey areas, Alaska, April–October 2003.

AREA Date	Large Caribou[a, b]	Calves[b]	Total Caribou	Estimated Total[c]	S.E.[d]	Density (caribou/km²)[e]	Mean Group Size
NPRA (1,310 km²)[f]							
24 April	1,565	0	1,565	3,130	263.0	2.39	5.0
20 May	46	0	46	92	25.5	0.07	3.5
30 May[g]	81	2	83	166	53.1	0.13	2.3
8 June	225	0	225	450	78.1	0.34	2.7
16 June	401	7	408	816	129.9	0.62	3.0
24 June	521	9	530	1,060	130.6	0.81	3.8
7 July	1	1	2	4	2.8	0.00	2.0
20 July	0	0	0	0	–	–	–
4 August	296	23	319	638	144.4	0.49	2.8
3 September	nr	nr	108	216	39.5	0.17	2.9
16 September	nr	nr	565	1,130	204.8	0.86	6.7
29 September	nr	nr	2,262	4,524	756.9	3.46	7.0
28 October	nr	nr	176	352	75.4	0.27	7.0
Total			6,289	12,578	–	0.74	4.9
COLVILLE DELTA (494 km²)[f]							
28 June	31	0	31	62	22.4	0.13	4.4
7 July	1	1	2	4	2.8	0.01	2.0
20 July	3	0	3	6	2.2	0.01	1.0
16 September	nr	nr	13	26	14.2	0.05	6.5
Total			49	98	–	0.05	3.8

[a] Adults + yearlings
[b] nr = not recorded; calves not reliably differentiated due to large size
[c] Estimated total = total caribou × 2, to adjust for 50% coverage
[d] Standard error of total caribou calculated as described by Gasaway et al. (1986), using transects as sample units
[e] Density = estimated caribou / survey area
[f] Survey coverage was 50% of the survey areas (654 km² in NPRA and 247 km² on the Colville River Delta were surveyed)
[g] Sightability correction factor of 1.88 applied due to patchy snow cover (Lawhead et al. 1994)

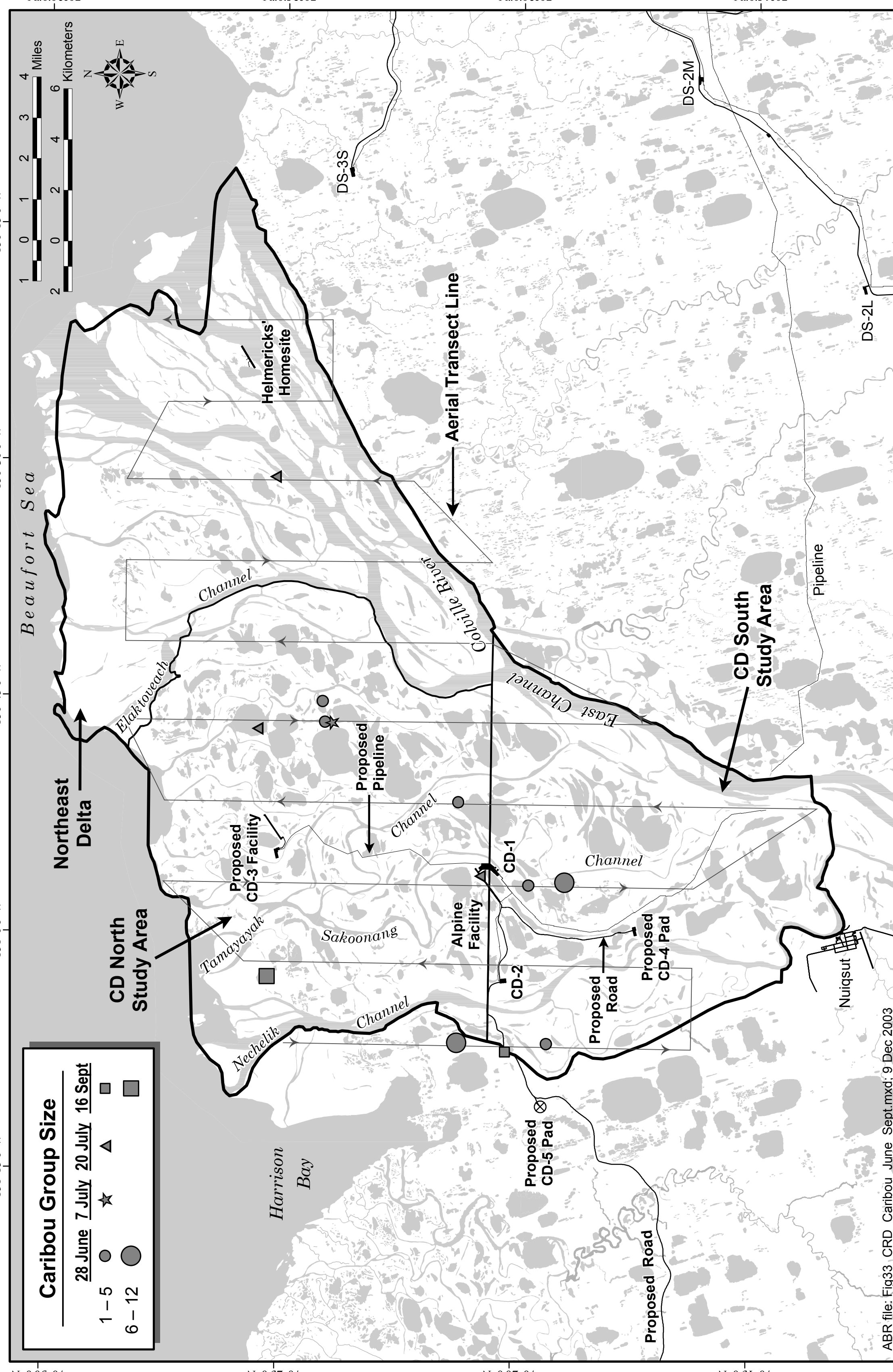

Figure 33. Distribution and group size of caribou in the Colville Delta survey area, Alaska, late June–mid-September 2003.

highest count in the Colville Delta caribou survey area in 2003 was 31 caribou on 28 June, and no large aggregations were seen on the delta during 2003.

The number of caribou using the Colville Delta in 2003 was low compared with most previous years. Surveys in the 1990s found that very few caribou used the Colville Delta during calving season (Smith et al. 1993, 1994; Johnson et al. 1996, 1997, 1998), a time when low-lying habitats on the delta frequently are flooded and river channels are difficult for calves to cross because of high water. After calving, caribou numbers usually increase on the delta, which is used most heavily during the insect season between late June and late July when large groups form in response to mosquito harassment. Surveys in the 1990s recorded movements onto the delta by up to 3,300 or more animals, usually from the CAH but also from the TH in at least one year (Smith et al. 1994; Johnson et al. 1996, 1997, 1998). In 2001, at least 10,000 CAH caribou moved onto the delta from the east during the third week of July (Lawhead and Prichard 2002). Large-scale movements of caribou onto the delta do not occur every year, however, because the size and timing of these events depends on the interaction of wind, temperature, and insect conditions (Johnson et al. 1998, Lawhead and Prichard 2002).

NPRA Study Area

Distribution and Abundance

Caribou use of the NPRA study area appears to peak during fall and winter (Burgess et al. 2002, 2003b), in contrast to the neighboring Colville Delta, where the greatest use occurs during the insect season (see above). Caribou numbers were high during the late winter survey on 24 April 2003 (Figure 34), when 1,565 caribou were observed and >3,100 were estimated in the survey area (Table 31).

The number of caribou using the study area dropped sharply by the next pre-calving survey on 20 May 2003 (Figure 34), when only 92 large caribou were estimated in the area (Table 31). Calving had begun by 30 May (Figure 34), when 43 large caribou and 1 calf were seen. We applied a sightability correction factor to that survey (SCF = 1.88; Lawhead et al. 1994) due to patchy snow cover, resulting in an estimated 166 caribou (Table 31). The numbers observed in May 2003 were lower than those in May 2002 and May 2001 (Burgess et al. 2002; Burgess et al. 2003b).

The NPRA study area was not an important calving area in 2003, similar to previous years (Burgess et al. 2002, 2003b). Results of other surveys have demonstrated that our NPRA study area is at the southeastern periphery of the TH calving grounds and is used for calving by CAH animals only rarely (Philo et al. 1993; Noel 1999, 2000; Prichard et al. 2001; Jensen and Noel 2002; Arthur and Del Vecchio 2003; G. Carroll and E. Lenart, ADFG, pers. comm.; Noel and George, in press). The calving survey on 8 June and the post-calving surveys on 16 and 24 June (Figure 35) found little use of the study area by calving females, even though the number of animals counted was moderately high, ranging from 225 to 530 caribou (450–1,060 estimated; Table 31). No calves were seen on the first calving-season survey and only 16 total were seen on the 2 other June surveys. The total numbers counted on June 2003 surveys peaked on 24 June (Table 31), shortly before the emergence of mosquitoes.

The beginning of mosquito harassment in the last 2–3 days of June caused caribou to move toward the coast, and only a few scattered individuals were seen in the NPRA study area during fox den checks on 30 June and 1 July. During insect-season aerial surveys in 2003, only 2 caribou were seen in the study area on 7 July and none were seen on 20 July (Figure 36, Table 31). No insect harassment was noted east of the Colville River in the Kuparuk Oilfield on 7 July, while severe harassment occurred on 20 July (Lawhead and Prichard 2003b), and we surmise that similar conditions occurred in the NPRA study area. The NPRA study area is inland from the coastal habitats typically used for relief from mosquitoes, so caribou numbers in the study area would be expected to be low during warm, calm weather in the insect season. It is likely, however, that caribou moved inland into the study area when insect harassment subsided during cool, windy periods, but our periodic aerial surveys in 2003 were too infrequent to detect such movements (which were noted in 2002; Burgess et al. 2003b).

The number of caribou increased in the study area by early August, after the seasonal decline in mosquito abundance, although oestrid flies were

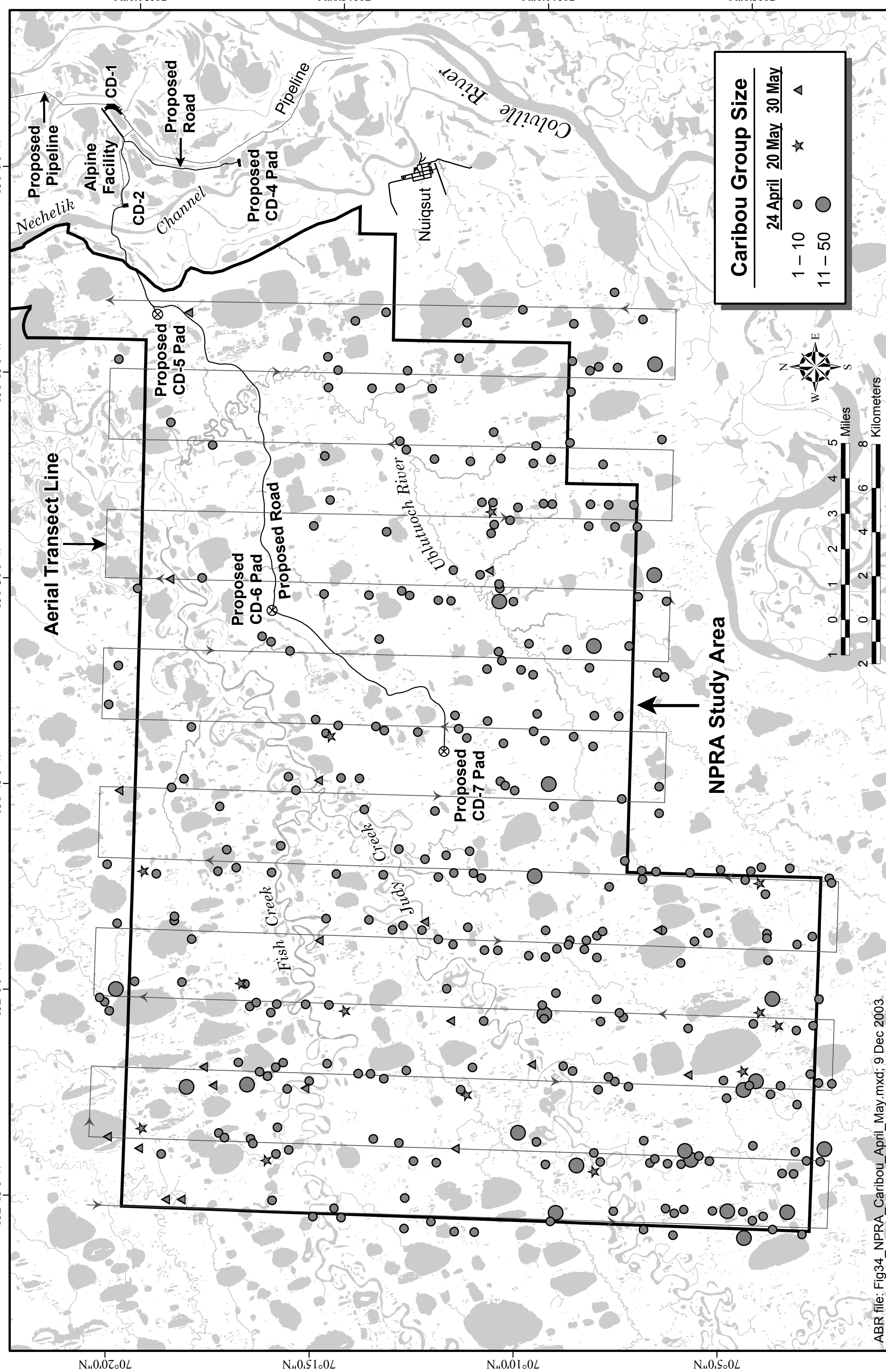

Figure 34. Distribution and group size of caribou in the NPRA survey area, Alaska, April–May 2003.

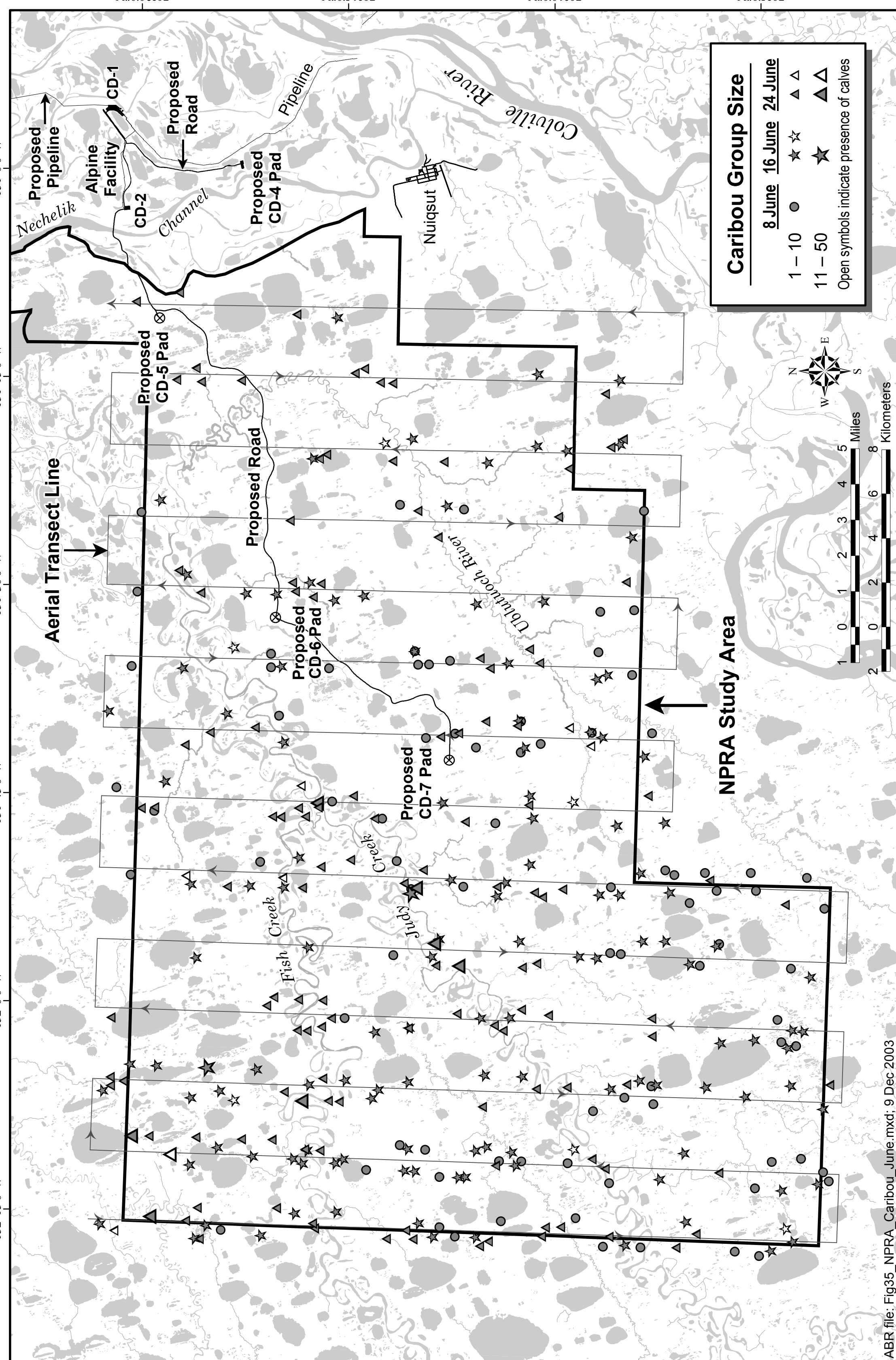

Figure 35. Distribution and group size of caribou in the NPRA survey area, Alaska, June 2003.

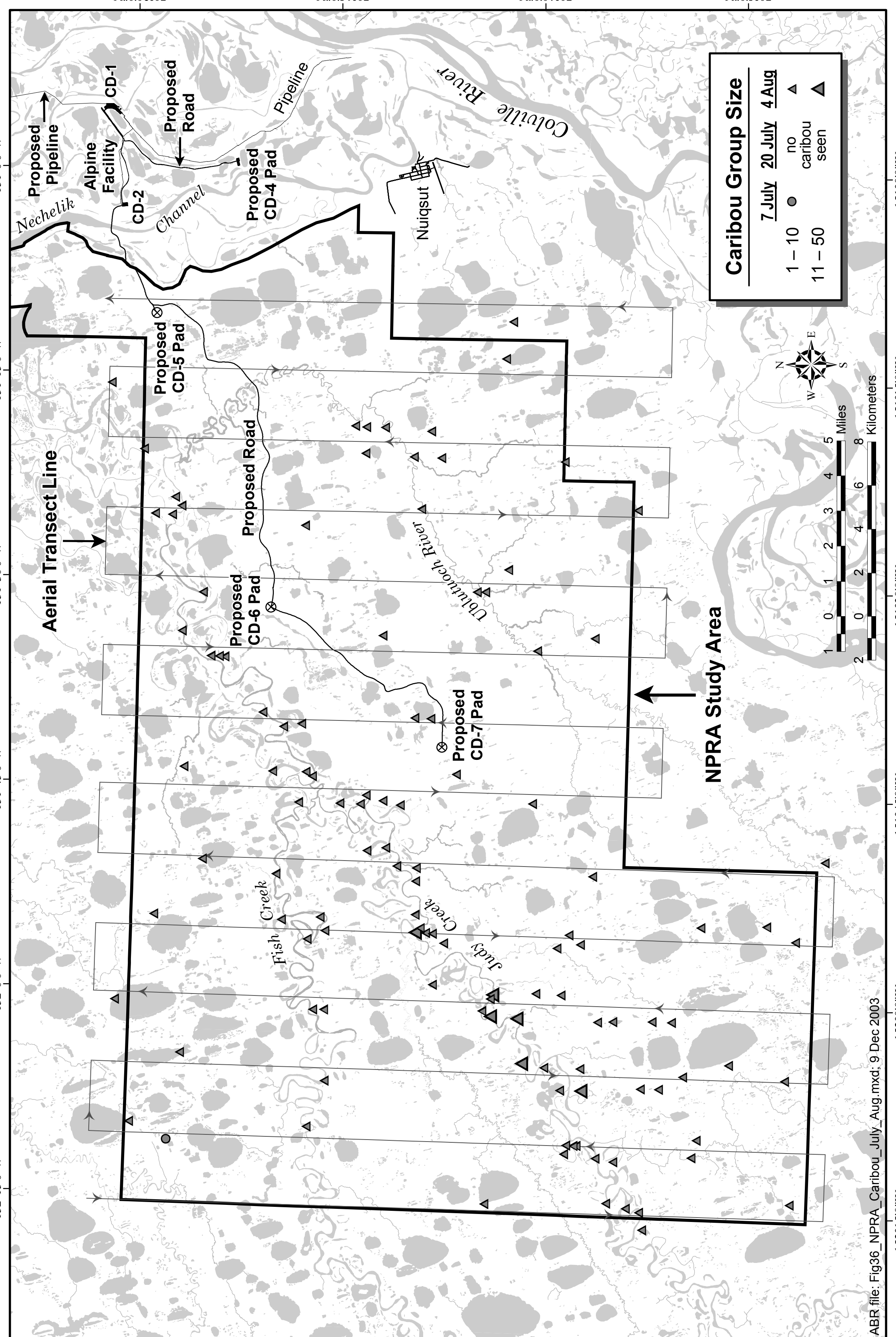

Figure 36. Distribution and group size of caribou in the NPRA survey area, Alaska, July–August 2003.

still present. On 4 August, 638 caribou were estimated in the survey area (Table 31), many of which were feeding in riparian shrub habitats or standing on sand bars along Fish and Judy creeks (Figure 36). A strong association of caribou with riparian habitats also was noted in August 2002 (Burgess et al. 2003b), but not in August 2001 (Burgess et al. 2002).

Caribou numbers in the study area increased dramatically during September 2003, from an estimated total of 216 on 3 September to 1,130 on 16 September and the peak of 4,524 on 29 September (Figure 37, Table 31). The latter estimate represents ~10% of the July 2002 (most current) population estimate for this herd. The late September 2003 estimate and corresponding density of 3.46 caribou/km² (Table 31) were the highest recorded among our 3 years of surveys in the study area (Figure 38). Although the timing has varied annually, the number of caribou in the study area has increased in the fall in all 3 years (Figure 38). In contrast, satellite telemetry data for TH caribou suggested little use of the study area in October during 1990–2001 (Prichard et al. 2001). Based on those telemetry data, most TH caribou were south or southeast of Teshekpuk Lake in October 2002 during the rut (G. Carroll, ADFG, pers. comm.). In early October 2003, most collared TH animals were just west of the study area in the upper Fish Creek drainage, but then moved south and east, including a highly unusual movement of an estimated 5–10,000 TH caribou far east of the NPRA into the Arctic National Wildlife Refuge, an area not known to have been used before by this herd (G. Carroll, ADFG, pers. comm.). The migratory movements of TH caribou out of the study area resulted in a sharp decline in numbers by the end of October, when only 352 caribou were estimated on the 28 October survey (Table 31).

ARCTIC FOX

Colville River Delta

Distribution and Abundance

Since 1992, 23 dens of arctic and red foxes have been found on the Colville Delta (Figure 39, Table 32; Johnson et al. 2003a); no new dens have been found since 2001. In 2003, 16 (70%) of the delta sites were classified as arctic fox dens, including 10 (83%) of the 12 dens in the CD North study area, 5 (56%) of the 9 dens in the CD South study area, and 1 (50%) of the 2 dens in the northeast delta area. The total density of arctic fox dens (occupied and inactive) on the entire delta (551 km²) was 1 den/34 km², identical to that reported by Eberhardt et al. (1983) for their 1,700-km² Colville study area (which extended farther east and west than ours, but not as far inland). The density of arctic fox dens in the CD North study area (207 km²) was 1 den/21 km² and the density in the CD South study area was 1 den/31 km².

Based on brief visits on 27 June at all but 1 of the 16 arctic fox sites on the delta and longer observations at 7 of those dens during 8–11 July, we concluded that pups were present at a minimum of 5 dens and suspected that pups may have been present at the other 2 active dens (Table 32). The total count among the 5 sites where pups were confirmed was 16 pups, 13 of which were at dens in the CD North study area and 3 of which were at a den in the CD South study area. Estimates of pup production are minimal figures because pups often remain underground for extended periods, making it difficult to reliably obtain complete counts, but this litter size is comparable with those calculated in most recent years when small mammals were not particularly abundant (Johnson et al. 2003a).

Estimates of pup production also can be confounded by the use of secondary dens, which may result in splitting of litters among several dens by one family (Garrott 1980, Eberhardt et al. 1983). We suspected, but could not confirm, that one litter was split between 2 dens at the time of our observations in July 2003: Den 45 (CD North) had 2 pups and Den 61 (CD South) had 3 pups (Table 32). Therefore, these pups were not included in the litter size calculation. These same 2 dens have been used in the past as a natal–secondary pair (Johnson et al. 2003a). Using only litters from the 3 confirmed natal dens, all of which were in the CD North study area, the mean litter size was 3.7 pups, which was identical to the average litter size for arctic foxes in CD North in 2002 (Johnson et al. 2003b) and near the lower end of the range observed annually on the Colville Delta and adjacent coastal plain tundra to the east of the delta during 1993–2001 (3.2–6.1 pups/litter; Johnson et al. 2003a).

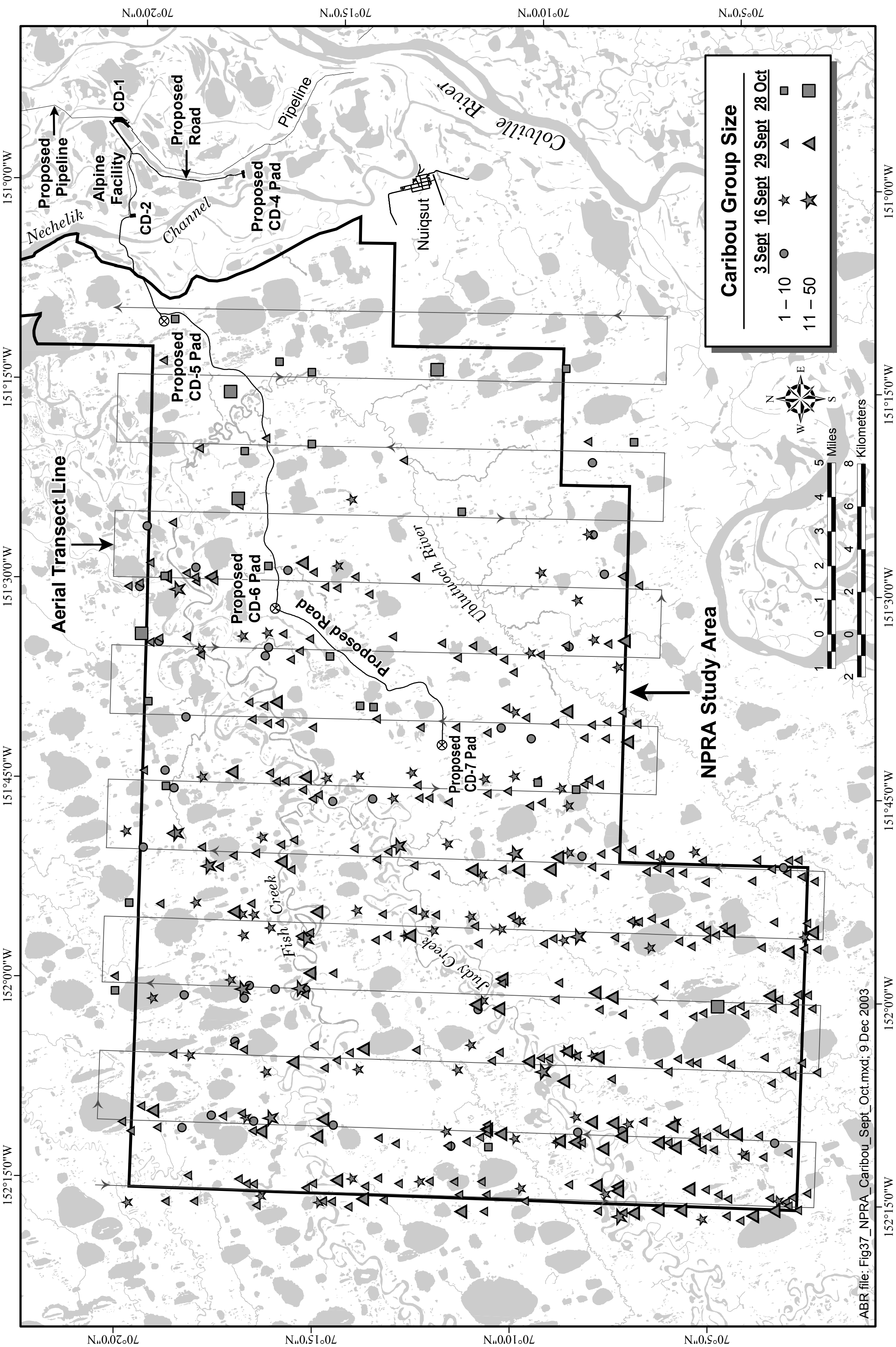

Figure 37. Distribution and group size of caribou in the NPRA survey area, Alaska, September–October 2003.

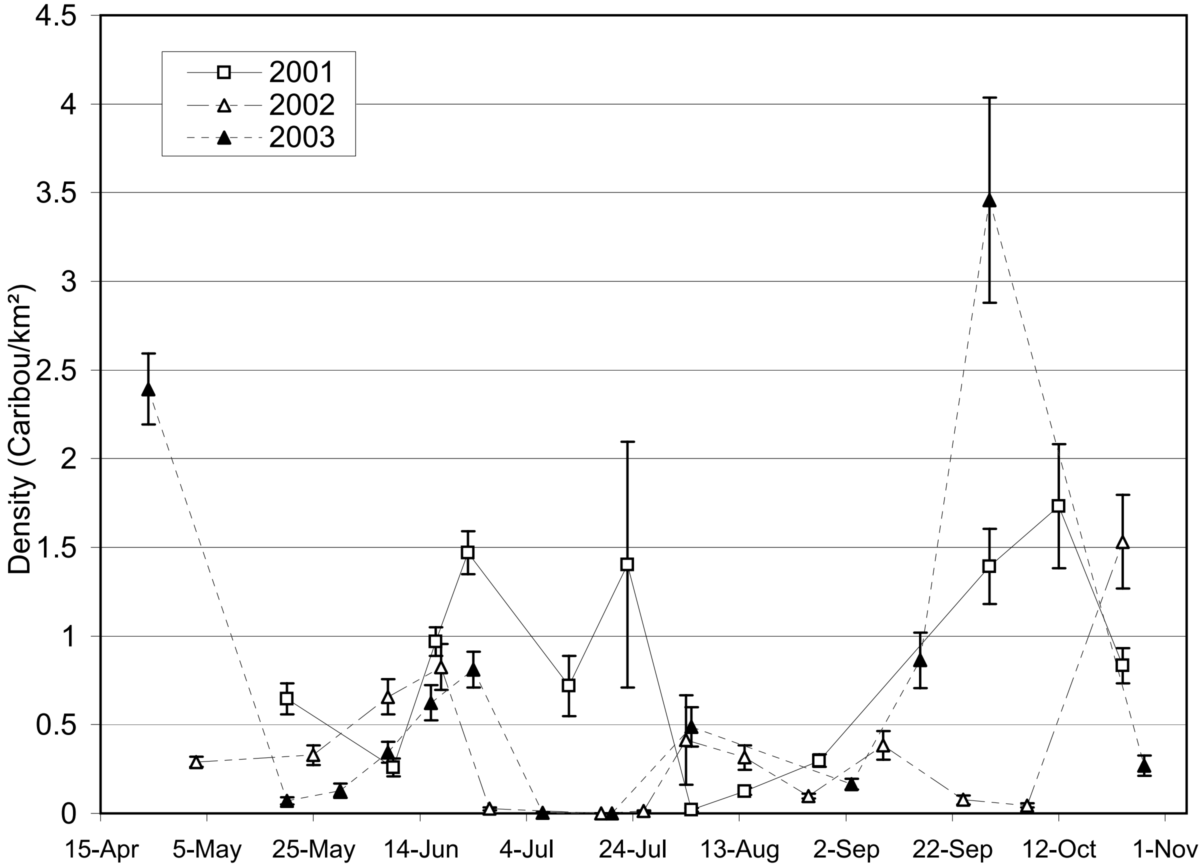

Figure 38. Caribou density (mean number/km² ± SE) during aerial surveys in the NPRA survey area, Alaska, April–October 2001–2003.

The estimated occupancy rate by litters (natal and active categories combined) at the 15 arctic fox dens checked on the Colville Delta in 2003 was 47%, near the lower end of the range observed since 1993 (40–89% occupied; Johnson et al. 2003a). This figure is substantially less than the maximal occupancy rate of 89% recorded in 1996 when microtine rodent populations peaked, which was the highest on record for the Colville Delta region (Johnson et al. 2003b). In the last decade, the occupancy rate at arctic fox dens in the CD North study area generally has been greater than the overall range of 24–67% for the delta and adjacent coastal plain tundra to the east (Johnson et al. 2003a).

Habitat Use

Because both arctic and red foxes have similar denning requirements and sometimes use the same den sites in different years, we included dens used by both species to analyze habitat selection across the entire Colville Delta. We recalculated the habitat selection analysis for the Colville Delta because the availability of certain habitats was adjusted slightly due to map refinements in 2003, but the results did not change significantly from those reported previously (Burgess et al. 2002, Johnson et al. 2002). Sixteen dens (70% of 23 total) were located in Riverine or Upland Shrub (upland shrub subtype), the only habitat that was preferred. Dens in the other 4 habitat types that were used—Barrens (eolian subtype), Moist Sedge–Shrub Meadow, Patterned Wet Meadow, and Nonpatterned Wet Meadow—actually were located in small patches of higher microrelief that were smaller than the minimal mapping size of habitat areas. Foxes did not den in the extensive river bars and mudflats on the delta. The 2 most abundant terrestrial habitats on the delta—Patterned Wet Meadow (formerly Wet

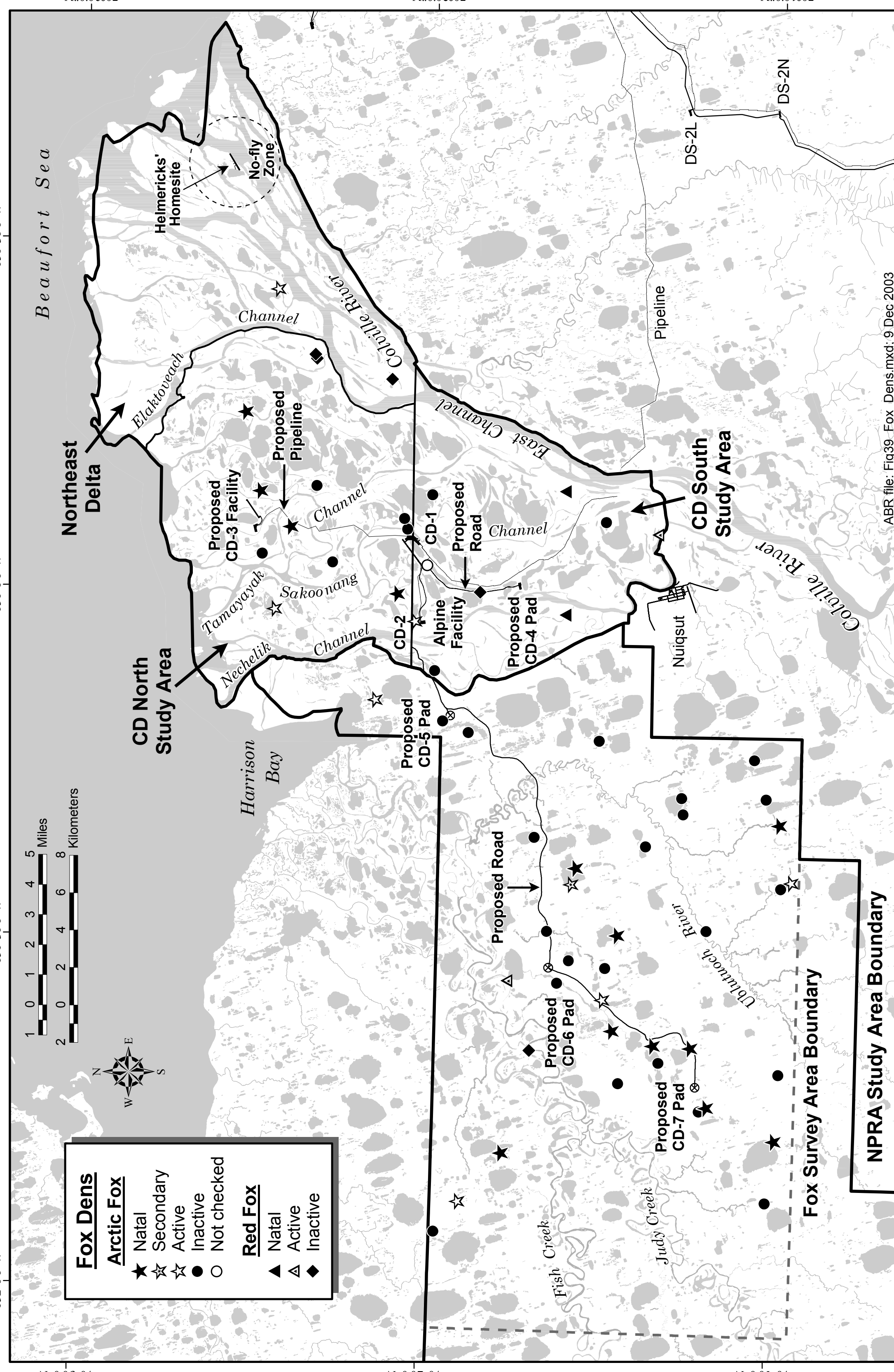

Figure 39. Distribution and status of arctic and red fox dens on the Colville River Delta and in the NPRA study area, Alaska, June–July 2003. Survey coverage (since 1992 on Colville River Delta and 2001 in NPRA) was not uniform over the area portrayed.

Table 32. Landforms, activity status, and number of pups counted (in parentheses) at arctic and red fox den sites in the Colville River Delta and in the NPRA study area, Alaska, June–July 2001–2003.

Species	Area[a]	Site No.	Landform[b]	2003 Status[c]	2002 Status[c]	2001 Status[c]
Arctic Fox	CD North	1	Old dune	Inactive	Inactive (0)	Inactive
		10	Dune/lake bank	Inactive	Inactive (0)	Inactive
		11	Lake bank	Natal (6)	Natal (2)	Natal (2)
		33	Dune/lake bank	Active (0)	Active (0)	Natal (3)
		34	Dune/lake bank	Natal (3)	Natal (6)	Inactive
		45	Dune ridge	Natal (2)	Natal (3)	Inactive
		58	Dune/riverbank	Inactive	Inactive	Active (0)
		59	Dune/lake bank	Inactive	Inactive	Inactive
		62	Low dune ridge	Natal (2)	Inactive (0)	Active (1?)
		102	Polygon rim	Inactive	Inactive	Inactive
	CD South	2	Old dune	Inactive	Inactive	Inactive
		54	Dune mound	Inactive	Active	Inactive
		61	Low ridge	Active (3)	Inactive	Natal (4)
		76	Low mound	Inactive	Active	Inactive
		103	Old channel bank	Not checked	Inactive	Active
	Northeast Delta	73[d]	Sand dune	Active (1?)	Active (0)	Inactive
	NPRA	200	DLB bank	Natal (1 dead)	Inactive	Inactive
		201	DLB bank	Inactive	Inactive	Inactive
		202	Lake bank	Inactive	Active (0)	Natal (2)
		203	Low ridge	Inactive	Inactive	Inactive
		204	Lake bank	Inactive	Active (0)	Inactive
		205	River bank	Inactive	Inactive	Inactive
		206	Stream bank	Active (0)	Active (0)	Inactive
		207	DLB bank	Inactive	Inactive	Inactive
		208	Lake bank	Natal (3)	Active (0)	Natal (2)
		209	Low mound	Inactive	Inactive	Inactive (0)
		210	Pingo	Inactive	Inactive	Inactive
		211	Lake bank	Inactive	Active (0)	Inactive
		212	Lake bank	Natal (2)	Inactive	Inactive
		213	Lake bank	Secondary (2)	Inactive	Inactive
		214	DLB bank	Inactive	Inactive	Inactive
		215	Lake bank	Natal (3)	Inactive (0)	Natal (5)
		216	Stream bank	Inactive	Active (0)	Inactive (0)
		218	Low ridge	Inactive	Inactive	Inactive (0)
		219	DLB bank	Inactive	Inactive	Inactive
		220	Low ridge	Natal (3)	Inactive	Active (0)
		221	Low ridge	Inactive	Active (0)	Inactive
		222	DLB bank	Inactive	Inactive	Active (0)
		223	Lake bank	Natal (0)	Natal (1 dead)	Inactive
		225	DLB bank	Active (0)	Inactive	–
		226	Low mound	Inactive	Inactive	–
		227	Low mound	Inactive	Inactive	–
		228	DLB bank	Inactive	Inactive	–
		229	Lake bank	Natal (2)	Active (0)	–

Table 32. (Continued).

Species	Area[a]	Site No.	Landform[b]	2003 Status[c]	2002 Status[c]	2001 Status[c]
Arctic Fox	NPRA	230	Old beach ridge	Natal (2)	Inactive (0)	–
		231	Stream bank	Inactive	Inactive	–
		232	Low ridge	Natal (0)	Inactive	–
		233	Lake bank	Inactive	Inactive	–
		235	Stream terrace	Inactive	Inactive	–
		236	Polygon rim	Active (1)	–	–
		237	Low mound	Active (1)	–	–
Red Fox	CD North	82	Sand dune	Inactive	Inactive (0)	Active (0)
		87	Sand dune	Inactive	Inactive (0)	Inactive
	CD South	26	Dune/lake bank	Inactive	Inactive	Inactive
		49	Sand dune	Natal (1)	Natal (1)	Natal (3)
		55	Dune/riverbank	Active (1)	Inactive (0)	Active (0)
		60	Sand dune	Natal (5)	Inactive (0)	Inactive (0)
	Northeast Delta	48	Sand dune	Inactive (0)	Inactive	Natal (2)
	NPRA	217	Sand dune	Inactive	Inactive	Inactive
		234[e]	Sand dune	Inactive	Inactive	–

[a] CD North, CD South, and Northeast Delta are on Colville River Delta (see Figure 38)
[b] DLB = drained-lake basin
[c] Zero indicates that no pups were seen during den observation; ? indicates that pups were suspected but not confirmed at de dash indicates that den had not yet been found
[d] Site was classified as an inactive red fox den in 2001
[e] Site was classified as an inactive arctic fox den in 2002

Sedge–Willow Meadow with Low-relief Polygons) and Barrens—were avoided by denning foxes.

The presence of permafrost in arctic tundra forces foxes to dig dens in locations that have relatively deep seasonal thaw layers. Foxes locate dens on raised landforms with well-drained soil; typical locations on the Arctic Coastal Plain include ridges, dunes, lake and stream shorelines, pingos, and low mounds (Chesemore 1969, Eberhardt et al. 1983, Burgess et al. 1993). In general, arctic foxes use a wider variety of denning habitats and substrates than do red foxes; on the Colville River Delta, red foxes dens almost exclusively in sand dunes. On the Colville Delta and adjacent coastal plain to the east, foxes den in sand dunes (mostly those stabilized by vegetation), banks of streams and lakes (including banks of drained-lake basins), ridges, and pingos (Table 32; Garrott 1980, Eberhardt et al. 1983). These observations all confirm that the primary requirement for denning habitat is well-drained soil with a texture conducive to burrowing, conditions that occur on elevated microsites within a variety of larger habitat types.

NPRA Study Area

Distribution and Abundance

In 2003, we found 2 more fox dens in the NPRA study area, giving a 3-year total of 37 dens (active and inactive) of both species (Figure 39, Table 32). Arctic foxes were much more abundant than red foxes and all but two of the 37 sites were arctic fox dens (95% of the total).

The presence of 35 arctic fox dens in our 681-km² fox survey area (Figure 39) produces a density of 1 den/19 km² for the species. This density is higher than the 1 den/34 km² on the Colville River Delta (551 km²) but similar to the 1 den/17 km² in the Alpine Transportation Corridor area (343 km²) studied by Johnson et al. (2003a) east of the delta. The density of arctic fox dens in the NPRA study area is higher than the 1 den/34 km² reported by Eberhardt et al. (1983) for their 1,700-km² Colville study area, which included parts of our NPRA study area and the adjacent Colville Delta/Alpine Transportation Corridor study areas of Johnson et al. (2003a).

Based on brief visits at all 35 arctic fox dens on 30 June–1 July and 9 July 2003 and longer observations at 14 of those dens during 8–11 July, we classified 14 dens as occupied sites, including 9 natal dens, 1 secondary den, and 4 active dens for which natal or secondary status could not be confirmed (Table 32). The remaining 21 dens (60%) showed signs of occasional use by adults only or were completely inactive. Pups were seen at 7 natal dens, the single secondary den, and 2 active dens, and were suspected to be present at the other 4 sites classified as natal or active. An adult, but no pups, was seen at one of the active dens.

The occupancy rate of dens (natal, secondary, and active categories combined) in the NPRA study area in 2003 was 40%, nearly double that observed in 2001 (22%; Burgess et al. 2002) and 2002 (26%; Burgess et al. 2003b) and similar to the 8-year (1993–2001) mean reported for the area between the western Colville Delta and the Kuparuk Oilfield (mean = 38%; SD = 15%; range 24–67%) (Johnson et al. 2003a). In comparison, Eberhardt et al. (1983) reported that the percentage of dens containing pups in their Colville study area ranged from 6% to 55% in a 5-year period, whereas 56–67% showed signs of activity by adults alone.

During 8–11 July 2003, we expended ~60 h in 21 observation bouts at 14 arctic fox dens that were known or suspected to be active on our 30 June–1 July status check, and counted 20 pups (including the remains of at least 1 pup evidently killed by a Golden Eagle) at 10 sites (Table 32). Estimates of pup production also can be confounded by the use of secondary dens, which may result in splitting of litters among several dens by one family (Garrott 1980, Eberhardt et al. 1983). We concluded that Den 213 was a secondary site for Den 212 (Table 32) in 2003, implying that a single litter of at least 4 pups was split between those 2 sites at the time of our observations there on 9 July. We also suspected that Den 236, newly found in 2003, was a secondary site for Den 220, but were unable to confirm that suspicion.

The mean litter size in 2003 was calculated to be 2.8 pups (SD = 0.75, n = 6 litters), using counts from sites where observers were reasonably confident that they observed the complete litter and combining the counts at Dens 212 and 213 as a single litter. Den observations in 2003 were much more productive than in 2002, indicating that the productivity of the population was higher. After 40 h of observation at 11 sites in 2002, the presence of pups (remains of 1 dead pup) could only be confirmed at a single den and only adults were seen at 8 dens (Burgess et al. 2003b). In 2001, after 23 h of observation at 8 sites, 9 pups were counted at 3 arctic fox dens for a mean litter size of 3 pups (SD = 1.7, n = 3 litters), and pups were suspected to be present at 2 other dens (Burgess et al. 2002). The variation in mean litter size documented for arctic foxes in the Colville Delta region since 1993 (Johnson et al. 2003a) ranged from a low of 3.2 pups in 1998 and 2001 (n = 6 and 11, respectively) to highs of 5.4 and 6.1 pups in the high-production years of 1999 and 1996 (n = 13 and 15, respectively). These figures were nearly identical to those reported by Garrott (1980) for years of low and high pup production in his Colville study area. In 1978, when small mammals (the principal prey of arctic foxes) were abundant, Garrott (1980) closely observed 7 litters from a total of 23 active dens, which averaged 6.1 pups (range 2–8). In contrast, he observed only one litter the year before (from 2 active dens), when small mammals were scarce, and was unable to obtain a complete count of that litter.

The lower occupancy rates and pup counts at arctic fox dens in 2001 and 2002 led us to infer that the density of small mammal prey in the NPRA study area was low, although we have no rodent population sampling data to support this inference directly. It appeared that small mammals may have been more abundant in 2003, judging from the higher occupancy rate and pup counts. It is also likely that, by 2003, the arctic fox population had recovered from the rabies epizootic noted in the region in winter 2001–2002 (Burgess et al. 2003b).

Habitat Use

Because arctic and red foxes both have similar denning requirements and may use the same den sites in different years, we included dens used by either species in the statistical analysis of habitat selection in the survey area (Appendix J). Foxes tend to den in bank habitats in the study area, including banks of lakes, streams, and drained-lake basins (Table 32). The habitat types used most often for denning by foxes in the NPRA study area were the 2 most abundant types mapped: Moist

Tussock Tundra and Moist Sedge–Shrub Meadow (11 and 12 dens, respectively) (Appendix J). Two other common habitat types—Patterned Wet Meadow and Upland and Riverine Dwarf Shrub—were used to a lesser extent (5 dens each) and 1 or 2 dens also were located in each of 3 other habitat types (Appendix J). The only habitat that was preferred for denning was Upland and Riverine Dwarf Shrub, which constituted 1.6% of the area mapped but had 13.5% of the fox dens. Dens in wet habitats such as Patterned Wet Meadow and Salt Marsh were located in small patches of higher microrelief that were smaller than the minimum-sized habitat mapping unit.

RED FOX

Colville River Delta

Distribution and Abundance

The red fox is much less abundant than the arctic fox on the outer coastal plain, where its distribution is restricted largely to major drainages such as the Colville and Sagavanirktok rivers (Eberhardt 1977, Johnson et al. 2003a). Red foxes are aggressive toward arctic foxes and will displace them from feeding areas and den sites (Schamel and Tracy 1986, Hersteinsson and Macdonald 1992). Since 1992, red foxes have occupied at least 4 den sites formerly used by arctic foxes on the Colville River Delta and adjacent coastal plain tundra (Johnson et al. 2003a) and a long-inactive den formerly used by red foxes in the northeast delta area has been used recently by arctic foxes (ABR, unpublished data).

Seven red fox dens were known on the Colville River Delta in 2003, all of which were located in upland sandy soils (mostly stabilized dunes; Table 32) in the Riverine or Upland Shrub habitat type. Of these, 2–4 dens have been active annually in recent years (Johnson et al. 2003a). The density of red fox dens across the entire Colville Delta was 1 den/79 km² in 2003. Comparative data are unavailable for this species from other arctic tundra areas of Alaska and Canada, but this is apparently a locally high density. The 2 red fox dens in the CD North study area, which are located within 200 m of each other on an island in the Elaktoveach Channel (Figure 38), are alternative sites that have been used in the past by a single denning pair (Johnson et al. 2000a). Red fox den density in CD North was 1 den/104 km², but because both sites are unlikely to be used simultaneously, the effective density is 1 den/207 km². Four of the 9 fox dens in the CD South study area were red fox sites in 2003, and one of these was an arctic fox den before 1998. In marked contrast to other areas on the outer coastal plain, red fox dens are as common as arctic fox dens in the CD South study area. At 1 den/39 km², the density of red fox dens in CD South is substantially higher than elsewhere on the delta.

Based on brief visits at each fox den on 27 June 2003 and longer observations at 4 red fox dens on the delta during 8–11 July, we concluded that 3 sites (43%) were occupied and counted a total of 7 pups at those sites. We were confident of a complete count of pups for only one litter of 5 pups and were unable to obtain complete litter counts at the 2 other occupied sites (Table 32). Red fox dens are more difficult to observe than arctic fox dens because they tend to be located in sand dunes having high topographic relief and tall shrubs that obscure the den entrances and activity areas. The red fox dens in the CD South study area have had higher occupancy rates each year than have the arctic fox dens there (Burgess et al. 2003a). No adults or pups were observed in 2003 at the red fox dens in the CD North study area or the northeast delta, and no sign was found to indicate that any were used as natal dens.

NPRA Study Area

Distribution and Abundance

Of the 37 fox dens known in the NPRA study area in 2003, only 2 (5%) were red fox dens, both of which were located on sand dunes bordering Fish Creek (Figure 39, Table 32). In comparison, 10 (13%) of 75 fox dens examined in 2001 between the western edge of the Colville River Delta and the Kuparuk Oilfield were classified as red fox dens (Johnson et al. 2003a).

The density of red fox dens in the NPRA study area was very low, at 1 den/340 km². In contrast, the density of red fox dens on the Colville Delta was 1 den/79 km² in 2003, reflecting the greater use of major river systems by this species. It should be noted that our den surveys to date have been biased toward detection of arctic fox dens, which are easier to find in tundra habitats away from the complex riparian habitats along Fish and

Judy creeks, which contain the majority of habitat suitable for denning by red foxes in the NPRA study area. Although we expect more red fox dens to be found in the NPRA study area in the future, we do not expect the density to reach that found on the Colville River Delta.

Den 217 was the only red fox den known in the study area in 2001 and 2002 (Table 32). Den 234 was classified as an arctic fox site when first found in 2002, but had been enlarged by red foxes by late June 2003 and was considered to possibly be active, although the presence of pups was not confirmed. A pair of red foxes was seen repeatedly along Fish Creek in the general area of this den. The pair may have not had pups or may have lost them early in the denning season, judging from frequent observations of the pair sleeping side by side in different locations, none of which was a den. It is also possible that another den went undetected in the area, despite the high levels of observer effort.

MUSKOX

Colville River Delta

Fewer muskoxen were seen in 2003 and 2002 than in 2001 in the Colville–Kuparuk region (Lawhead and Prichard 2003a, 2003b). None were seen on the Colville Delta in 2003, but groups were found on several occasions along the east bank of the main channel of the Colville River (Figure 40). Small groups (1–6 adults) were seen 4 times near the mouth of the Miluveach River between 10 June and 5 July, and a mixed group of 12 adults and 4 calves was in the same area on 23 July. A group of 14 adults and 1 calf was found ~4 km north of the Alpine pipeline HDD crossing on 28 October. Other groups occurred south and east of Nuiqsut (E. Lenart, ADFG, pers. comm.), but were not in areas covered regularly by our aerial surveys in 2003. One group, comprising 9–10 adults, was found ~4 km south of the Alpine pipeline on 24 April and 14 May 2003. In 2002, a large group (maximum 32 adults and 9 calves) of mixed age and sex was seen repeatedly near the mouth of the Kachemach River on the eastern edge of the Colville Delta (Lawhead and Prichard 2003a).

Muskoxen are native to Alaska but were extirpated by the late 1800s (Smith 1989). Muskoxen that inhabit the Colville–Kuparuk region originated from the Arctic National Wildlife Refuge (ANWR) population, which was reestablished through introductions in 1969 and 1970. By the mid-1980s, lone bulls were seen near the Colville River (Reynolds et al. 1986) and a small, mixed-sex group of muskoxen first overwintered in the area southeast of Nuiqsut in 1988–1989 (Golden (1990). A few muskoxen (mostly lone bulls) were seen on the Colville River Delta during summer 1992–1993 and 1995–1998 (Johnson et al. 1999a), and a group of 10–11 adults (mostly bulls) was found on the northeastern delta in summer 2001 (Lawhead and Prichard 2002).

NPRA Study Area

No muskoxen were seen in the NPRA study area in 2003 or 2002 (Burgess et al. 2003b). In 2001, one small group of muskoxen was seen in the NPRA study area (Burgess et al. 2002). That group, comprising 5 or 6 adults at various times, was seen on 5 occasions during 9–27 June, with successive locations proceeding eastward through the southern portion of the study area.

Muskox numbers in northeastern NPRA are not well-documented, but appear to be lower than in the area east of the Colville River. Historical records (e.g., Bee and Hall 1956) indicate a high level of use of the NPRA study area by muskoxen before extirpation. Suitable habitat exists in northeastern NPRA and it is expected that the population in the area will continue to increase (BLM 1998, Danks 2000). Riparian shrub habitats and moist sedge–shrub meadows are the most important summer habitats for muskoxen in the region of the Colville Delta and NPRA study area.

MOOSE

On the Colville Delta in 2003, a single cow moose was seen southwest of the Alpine pipeline HDD crossing on 10 July (Figure 40). No moose have been observed in the NPRA study area during bird and mammal surveys in 2001–2003.

Previous studies indicate that the Colville River Delta is an area of very low population density (Coady 1979). One to 4 moose were reported on the delta annually by USFWS biologists during summer bird studies in the early 1980s (Simpson et al. 1982, Renken et al. 1983, Rothe et al. 1983). No moose were seen during the aerial or ground surveys of the delta conducted in

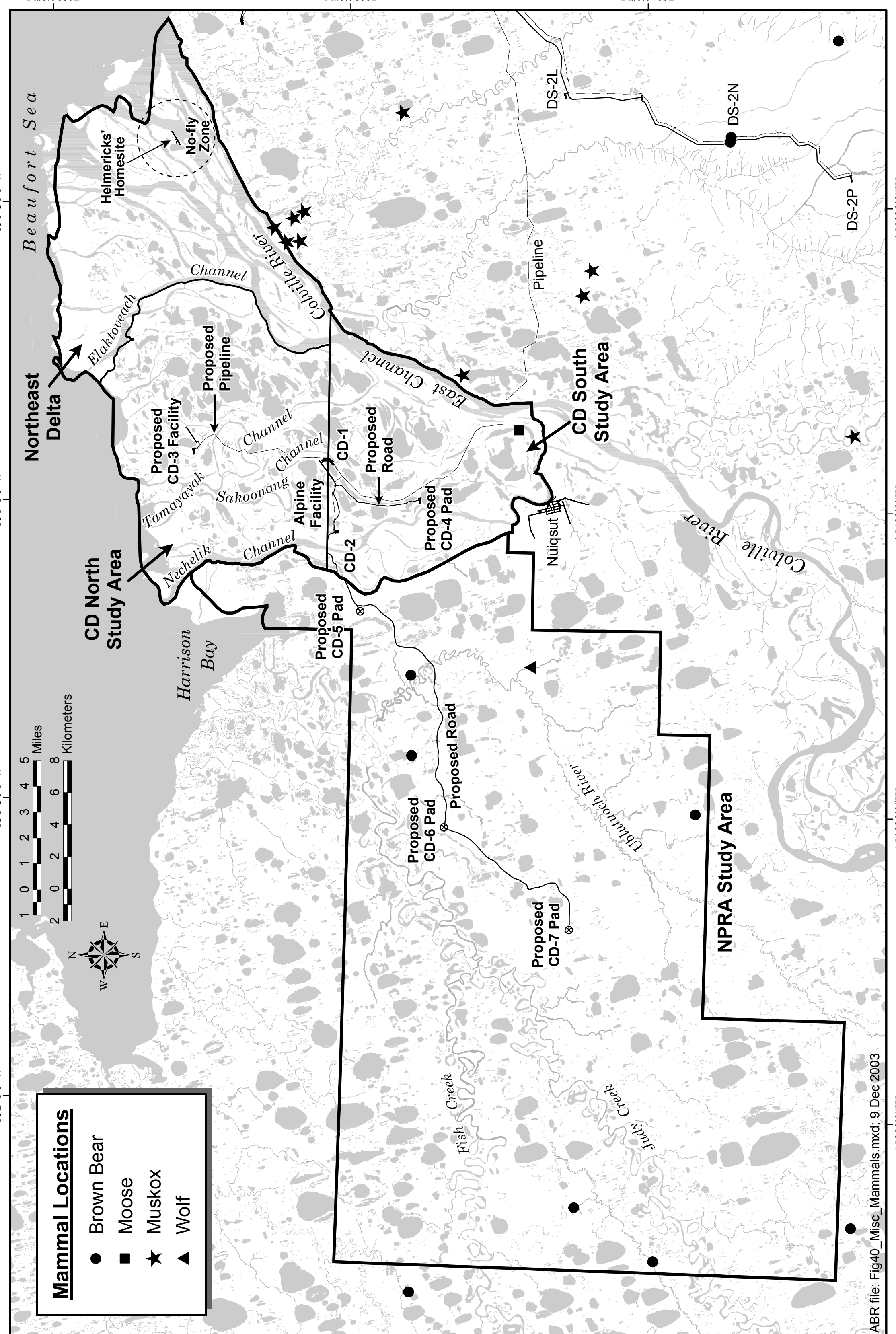

Figure 40. Incidental sightings of other large mammals during aerial surveys for caribou in the Colville Delta and NPRA survey areas, Alaska, April–October 2003.

1992–1993 and 1995–1996, although ground crews saw 2 sets of tracks one year (Johnson et al. 1997). In late July 1997, 2 moose were seen just east of the delta near the East Channel and Pikonik Mound (Johnson et al. 1998). On 10–11 June and 11 July 1998, a female moose was seen near the Alpine oilfield in the area between Nanuk Lake and the Sakoonang Channel (Johnson et al. 1999a).

GRIZZLY BEAR

No grizzly bear sightings were recorded during our surveys of the Colville Delta in 2003. Grizzly bears were seen 5 times in various parts of the NPRA study area and twice just outside the area (Figure 40) between late May and the end of July 2003; 4 of those sightings were of females with cubs. In 2002, a sow with 2 cubs of the year was seen on 24 August and a single adult was seen on 26 August, all in the northwestern corner of the NPRA study area (Burgess et al. 2003b). Grizzly bears were seen 7 times in 2001 and 2 times in 2002 during NPRA surveys (Burgess et al. 2003). We also found no new dens during aerial surveys for caribou and fox dens in 2003, in contrast to 2001 and 2002, when we found 3 each year (Burgess et al. 2002, 2003b), usually in well-drained landforms suitable for fox denning.

Despite the lack of sightings during our surveys in 2003, ADFG located 9 radio-marked males and 6 radio-marked females, including several with dependent offspring, on the Colville Delta and northeastern NPRA in 2003 (R. Shideler, ADFG, pers. comm.). These bears were marked in 2002 and 2003 as part of the ADFG grizzly bear study supported by CPAI. All of these bears were observed feeding on natural foods on the Colville Delta, but one marked adult male also obtained garbage from the drill-rig camp at the CD-2 pad in August 2003. That male was radio-collared in the western Prudhoe Bay field in 1991 as a 2-year-old and occasionally spent time in the Kuparuk field between 1993 and 2000, but was not known to have obtained garbage since 1999.

ADFG marked numerous bears with standard VHF radio-collars in the existing Prudhoe Bay and Kuparuk oilfields in the 1990s (Shideler and Hechtel 2000), and some of those bears included the Colville Delta and northeastern NPRA in their annual home ranges. In 2002 and 2003, ADFG extended the study area west to mark bears in northeastern NPRA and these bears have begun to provide data on habitat use and den locations (R. Shideler, pers. comm.). ADFG deployed collars on 4 females and 2 males in NPRA in summer 2003, after having marked 5 females and 2 males in summer 2002. Marked bears were relocated on 18 fixed-wing and 11 helicopter flights in 2003, culminating in a final flight in December to locate winter dens (R. Shideler, pers. comm.). Several bears previously radio-collared by ADFG in the oilfield region to the east have denned near the Colville River or on the Colville Delta in past years, but none of those bears have denned in the NPRA study area. No bears marked by ADFG have denned in the Colville Delta since 1998.

GRAY WOLF

In the NPRA study area, a single wolf was spotted during a goose brood-rearing survey on 31 July 2003 on a branch of the Ublutuoch River ~10 km west of Nuiqsut (Figure 40). In winter 2002–2003, at least 1 and possibly 2 wolf packs were seen several times northwest of our study area in northeastern NPRA (M. Ahmakak, KSOP, pers. comm.).

Wolves probably have never been abundant on the outer coastal plain, and the North Slope population has remained low since federal predator control in the 1950s and early 1960s (R. Stephenson, ADFG, pers. comm.). In the 1990s, however, increases in take by Nuiqsut residents and in reports of wolves in northern Alaska indicated the population was increasing (G. Carroll, ADFG, pers. comm.). Since winter 1993–1994, several wolf sightings were reported by workers in the Kuparuk Oilfield (A. Schuyler, CPAI, pers. comm.; ABR, Inc., unpublished data). A single wolf was seen pursuing a caribou along the Kachemach River southwest of the Kuparuk oilfield in late July 1997 (Johnson et al. 1998).

WOLVERINE

Wolverines have been observed rarely during caribou and waterfowl surveys in summer and fall on the Kuparuk River (ABR, unpublished data) and on and near the Colville River Delta. None were seen in 2003, but a large wolverine was seen on 25 October 2002 at the southern edge of the NPRA study area on the Ublutuoch River (Burgess et al. 2003b), and an adult was seen south of the

Ublutuoch River in the southwestern portion of the study area on 29 September 2001 during a caribou survey (Burgess et al. 2002). A single adult wolverine was seen crossing a large frozen lake in the extreme northwestern corner of the NPRA study area during an aerial survey for eiders on 13 June 1999 (ABR, Inc., unpublished data). Single adult wolverines were seen along the Tamayayak Channel of the Colville River Delta on 27 June 1993 (Smith et al. 1994) and near the mouth of the Kachemach River on 11 June 1998 (Johnson et al. 1999a). Two wolverine sightings were reported in the vicinity of our NPRA study area in 1977–1978 (BLM 1998).

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Appendix A. Common and scientific names of birds and mammals observed on the Colville River Delta, 1992–2003 and in the NPRA study area, 1999–2003, Alaska.

COMMON NAME	SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME
BIRDS			
Greater White-fronted Goose	*Anser albifrons*	Upland Sandpiper	*Bartramia longicauda*
Snow Goose	*Chen caerulescens*	Whimbrel	*Numenius phaeopus*
Canada Goose	*Branta canadensis*	Bar-tailed Godwit	*Limosa lapponica*
Brant	*Branta bernicla*	Ruddy Turnstone	*Arenaria interpres*
Tundra Swan	*Cygnus columbianus*	Semipalmated Sandpiper	*Calidris pusilla*
American Wigeon[a]	*Anas americana*	Western Sandpiper[a]	*Calidris mauri*
Mallard[a]	*Anas platyrhynchos*	Least Sandpiper[a]	*Calidris minutilla*
Northern Shoveler	*Anas clypeata*	White-rumped Sandpiper[a]	*Calidris fuscicollis*
Northern Pintail	*Anas acuta*	Baird's Sandpiper	*Calidris bairdii*
Green-winged Teal	*Anas crecca*	Pectoral Sandpiper	*Calidris melanotos*
Greater Scaup	*Aythya marila*	Dunlin	*Calidris alpina*
Lesser Scaup[a]	*Aythya affinis*	Stilt Sandpiper	*Calidris himantopus*
Steller's Eider	*Polysticta stelleri*	Buff-breasted Sandpiper	*Tryngites subruficollis*
Spectacled Eider	*Somateria fischeri*	Ruff[a]	*Philomachus pugnax*
King Eider	*Somateria spectabilis*	Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Eider	*Somateria mollissima*	Wilson’s Snipe	*Gallinago delicata*
Surf Scoter	*Melanitta perspicillata*	Red-necked Phalarope	*Phalaropus lobatus*
White-winged Scoter	*Melanitta fusca*	Red Phalarope	*Phalaropus fulicarius*
Black Scoter[a]	*Melanitta nigra*	Pomarine Jaeger	*Stercorarius pomarinus*
Long-tailed Duck	*Clangula hyemalis*	Parasitic Jaeger	*Stercorarius parasiticus*
Red-breasted Merganser	*Mergus serrator*	Long-tailed Jaeger	*Stercorarius longicaudus*
Willow Ptarmigan	*Lagopus lagopus*	Ring-billed Gull[a]	*Larus delawarensis*
Rock Ptarmigan	*Lagopus mutus*	Glaucous Gull	*Larus hyperboreus*
Red-throated Loon	*Gavia stellata*	Sabine's Gull	*Xema sabini*
Pacific Loon	*Gavia pacifica*	Arctic Tern	*Sterna paradisaea*
Yellow-billed Loon	*Gavia adamsii*	Snowy Owl	*Bubo scandiaca*
Red-necked Grebe	*Podiceps grisegena*	Short-eared Owl	*Asio flammeus*
Bald Eagle	*Haliaeetus leucocephalus*	Common Raven	*Corvus corax*
Northern Harrier	*Circus cyaneus*	Horned Lark[a]	*Eremophila alpestris*
Rough-legged Hawk	*Buteo lagopus*	Violet-green Swallow[a]	*Tachycineta bicolor*
Golden Eagle	*Aquila chrysaetos*	American Robin[a]	*Turdus migratorius*
Merlin	*Falco columbarius*	Bluethroat[a]	*Luscinia svecica*
Gyrfalcon	*Falco rusticolus*	Yellow Wagtail	*Motacilla flava*
Peregrine Falcon	*Falco peregrinus*	Wilson's Warbler	*Wilsonia pusilla*
Sandhill Crane	*Grus canadensis*	American Tree Sparrow	*Spizella arborea*
Black-bellied Plover	*Pluvialis squatarola*	Savannah Sparrow	*Passerculus sandwichensis*
American Golden-Plover	*Pluvialis dominica*	Lapland Longspur	*Calcarius lapponicus*
Semipalmated Plover[a]	*Charadrius semipalmatus*	Snow Bunting[a]	*Plectrophenax nivalis*
Lesser Yellowlegs[a]	*Tringa flavipes*	Common Redpoll	*Carduelis flammea*
MAMMALS			
Snowshoe Hare	*Lepus americanus*	Polar Bear[a]	*Ursus maritimus*
Arctic Ground Squirrel	*Spermophilus parryii*	Ermine	*Mustela erminea*
Brown Lemming[a]	*Lemmus trimucronatus*	Wolverine	*Gulo gulo*
Collared Lemming	*Dicrostonyx groenlandicus*	Spotted Seal[a]	*Phoca largha*
Gray Wolf	*Canis lupus*	Moose[a]	*Alces alces*
Arctic Fox	*Alopex lagopus*	Caribou	*Rangifer tarandus*
Red Fox	*Vulpes vulpes*	Muskox	*Ovibos moschatus*
Grizzly Bear	*Ursus arctos*		

[a] Indicates species not observed during NPRA investigations.

Appendix B. Classification and descriptions of wildlife habitat types found on the Colville River Delta and in the NPRA study area, Alaska, 2003.

Habitat Class	Description
Open Nearshore Water (Estuarine Subtidal)	Shallow estuaries, lagoons, and embayments along the coast of the Beaufort Sea. Winds, tides, river discharge, and icing create dynamic changes in physical and chemical characteristics. Tidal range normally is small (< 0.2 m), but storm surges produced by winds may raise sea level as much as 2–3 m. Bottom sediments are mostly unconsolidated mud. Winter freezing generally begins in late September and is completed by late November. An important habitat for some species of waterfowl for molting during spring and fall staging.
Brackish Water (Tidal Ponds)	Coastal ponds and lakes that are flooded periodically with saltwater during storm surges. Salinity levels often are increased by subsequent evaporation of impounded saline water. Sediments may contain peat, reflecting a freshwater/terrestrial origin, but this peat is mixed with deposited silt and clay.
Tapped Lake with Low-water Connection	Waterbodies that have been partially drained by erosion of banks by adjacent river channels and are connected to rivers by distinct, permanently flooded channels. The water typically is brackish and the lakes are subject to flooding every year. Because water levels have dropped, the lakes generally have broad flat shorelines with silty clay sediments. Salt-marsh vegetation is common along the shorelines. Deeper lakes in this habitat do not freeze to the bottom during winter. Sediments are fine-grained silt and clay with some sand. These lakes form important over-wintering habitat for fish.
Tapped Lake with High-water Connection	Similar to Tapped Lake with Low-water Connection except that the connecting channels are dry during low water and the lakes are connected only during flooding events. Water tends to be fresh. Small deltaic fans are common near the connecting channel due to deposition during seasonal flooding. These lakes form important fish habitat.
Salt Marsh	On the Beaufort Sea coast, arctic Salt Marshes generally occur in small, widely dispersed patches, most frequently on fairly stable mudflats associated with river deltas. The surface is flooded irregularly by brackish or marine water during high tides, storm surges, and river flooding events. Salt Marshes typically include a complex assemblage of small brackish ponds, Halophytic Sedge Wet Meadow, Halophytic Willow Dwarf Shrub Tundra, and small barren patches. Dominant plant species usually include *Carex subspathacea, C. ursina, Puccinellia phryganodes, Dupontia fisheri, P. andersonii, Salix ovalifolia, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea*. Salt Marsh is important habitat for brood-rearing and molting waterfowl.
Tidal Flat	Areas of nearly flat, barren mud or sand that are periodically inundated by tidal waters. Tidal Flats occur on the seaward margins of deltaic estuaries, leeward portions of bays and inlets, and at mouths of rivers. Tidal Flats frequently are associated with lagoons and estuaries and may vary widely in actual salinity levels. Tidal Flats are considered separately from other barren habitats because of their importance to estuarine and marine invertebrates and shorebirds.

Appendix B. (Continued).

Habitat Class	Description
Salt-killed Tundra	Coastal areas where saltwater intrusions from storm surges have killed much of the original terrestrial vegetation and are being colonized by salt-tolerant plants. Colonizing plants include *Puccinellia andersonii, Dupontia fisheri, Braya purpurascens, B. pilosa, Cochlearia officinalis, Stellaria humifusa, Cerastium beeringianum,* and *Salix ovalifolia*. This habitat typically occurs either on low-lying areas that originally supported Patterned Wet Meadows and Basin Wetland Complexes or, less commonly, along drier coastal bluffs that originally supported Moist Sedge–Shrub Meadow and Upland Shrub. Salt-killed Tundra differs from Salt Marshes in having abundant litter from dead tundra vegetation, a surface horizon of organic soil, and salt-tolerant colonizers.
Deep Open Water without Islands	Deep (≥1.5 m) waterbodies range in size from small ponds in ice-wedge polygons to large open lakes. Most have resulted from thawing of ice-rich sediments, although some are associated with old river channels. They do not freeze to the bottom during winter and usually are not connected to rivers. Sediments are fine-grained silt in centers with sandy margins. Deep Open Waters without Islands are differentiated from those with islands because of the lack of nest sites for waterbirds that prefer islands.
Deep Open Water with Islands or Polygonized Margins	Similar to above except that they have islands or complex shorelines formed by thermal erosion of low-center polygons. The complex shorelines and islands are important features of nesting habitat for many species of waterbirds.
Shallow Open Water without Islands	Ponds and small lakes <1.5 m deep with emergent vegetation covering <5% of the waterbody's surface. Due to the shallow depth, water freezes to the bottom during winter and thaws by early to mid-June. Maximal summer temperatures are higher than those in deep water. Sediments are loamy to sandy.
Shallow Open Water with Islands or Polygonized Margins	Shallow lakes and ponds with islands or complex low-center polygon shorelines, otherwise similar to Shallow Open Water without Islands. Distinguished from Shallow Open Water without Islands because shoreline complexity appears to be an important feature of nesting habitat for many species of waterbirds.
River or Stream	All permanently flooded channels large enough to be mapped as separate units. Rivers generally experience peak flooding during spring breakup and lowest water levels during mid-summer. The distributaries of Fish Creek are slightly saline, whereas other streams are non-saline.
Aquatic Sedge Marsh	Permanently flooded waterbodies dominated by *Carex aquatilis*. Typically, emergent sedges occur in water ≤0.5 m deep. Water and bottom sediments of this shallow habitat freeze completely during winter, but the ice melts in early June. The sediments generally consist of a peat layer (0.2–0.5 m deep) overlying loam or sand.
Aquatic Sedge with Deep Polygons	A habitat associated with inactive and abandoned floodplains and deltas in which thermokarst of ice-rich soil has produced deep (>0.5 m), permanently flooded polygon centers. Emergent vegetation, mostly *Carex aquatilis,* usually is found around the margins of the polygon centers. Occasionally, centers will have the emergent grass *Arctophila fulva*. Polygon rims are moderately well drained and dominated by sedges and dwarf shrubs, including *Carex aquatilis, Eriophorum angustifolium, C. bigelowii, Dryas integrifolia, Salix reticulata,* and *S. ovalifolia*.

Appendix B. (Continued).

Habitat Class	Description
Aquatic Grass Marsh	Ponds and lake margins with the emergent grass *Arctophila fulva*. Due to shallow water depths (<1 m), the water freezes to the bottom in the winter, and thaws by early June. *Arctophila fulva* stem densities and annual productivity can vary widely among sites. Sediments generally lack peat. This type usually occurs as an early successional stage in recently drained lake basins and is more productive than Aquatic Sedge Marsh. This habitat tends to have abundant invertebrates and is important to many waterbirds.
Young Basin Wetland Complex (Ice-poor)	Complex habitat found in recently drained lake basins and characterized by a mosaic of open water, Aquatic Sedge and Grass Marshes, Nonpatterned Wet Meadows, and Moist Sedge–Shrub Meadows in patches too small (<0.5 ha) to map individually. During spring breakup, basins may be entirely inundated, though water levels recede by early summer. Basins often have distinct banks marking the location of old shorelines, but these boundaries may be indistinct due to the coalescence of thaw basins and the presence of several thaw lake stages. Soils generally are loamy to sandy, moderately to richly organic, and ice-poor. Because there is little segregated ground ice the surface form is nonpatterned ground or disjunct polygons and the margins of waterbodies are indistinct and often interconnected. Ecological communities within young basins appear to be much more productive than are those in older basins: this was the primary rationale for differentiating these two types.
Old Basin Wetland Complex (Ice-rich)	Similar to above but characterized by well-developed low- and high-centered polygons resulting from ice-wedge development and aggradation of segregated ice. Complexes in basin margins generally include Aquatic Sedge Marsh, Patterned Wet Meadow, Moist Sedge–Shrub Meadows, and small ponds (<0.25 ha). The waterbodies in old basins tend to have smoother, more rectangular shorelines and are not as interconnected as those in more recently drained basins. The vegetation types in basin centers generally include Moist Sedge–Shrub Meadow and Moist Tussock Tundra on high-centered polygons, and Patterned Wet Meadows. Aquatic Grass Marsh generally is absent. Soils have a moderately thick (0.2–0.5 m) organic layer overlying loam or sand.
Riverine Complex	Permanently flooded streams and floodplains characterized by a complex mosaic of water, Barrens, Riverine Dwarf Shrub, Riverine Low and Tall Shrub, Aquatic Sedge and Grass Marsh, Nonpatterned and Patterned Wet Meadow, and Moist Sedge–Shrub Meadow in patches too small (<0.5 ha) to map individually. Surface form varies from nonpatterned point bars and meadows to mixed high- and low-centered polygons and small stabilized dunes. Small ponds tend to have smooth, rectangular shorelines resulting from the coalescing of low centered polygons. During spring flooding these areas may be entirely inundated, following breakup water levels gradually recede.
Dune complex	Complex formed from the action of irregular flooding on inactive sand dunes, most commonly on river point bars. A series of narrow swale and ridge features develop in parallel with river flow that are too small to map separately. Swales are moist or saturated while ridges are moist to dry. Habitat classes in swales typically are Riverine Low Shrub, Nonpatterned Wet Meadow, or Fresh Sedge Marsh, while ridges commonly are Upland Dwarf Shrub or Upland Low Shrub.

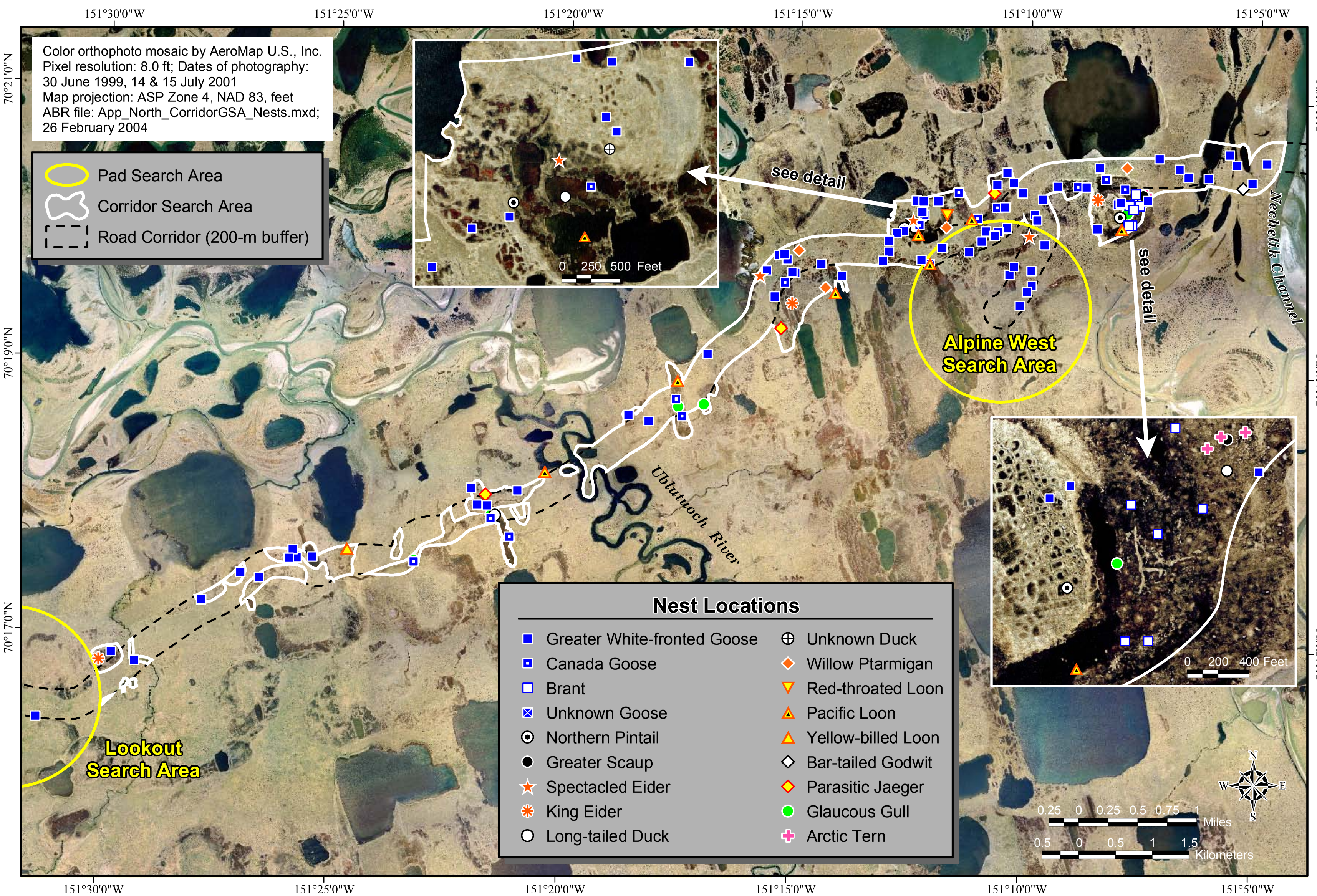
Habitat Class	Description
Nonpatterned Wet Meadow	Sedge-dominated meadows that occur within recently drained lake basins, as narrow margins of receding waterbodies, or along edges of small stream channels in areas that have not yet undergone extensive ice-wedge polygonization. Disjunct polygon rims and strang cover <5% of the ground surface. The surface generally is flooded during early summer (depth <0.3 m) and drains later, but water remains close to the surface throughout the growing season. The uninterrupted movement of water (and dissolved nutrients) in nonpatterned ground results in more robust growth of sedges than occurs in polygonized habitats. Usually dominated by *Carex aquatilis* and *Eriophorum angustifolium*, although other sedges may be present. Near the coast, the grass *Dupontia fisheri* may be present. Low and dwarf willows (*Salix lanata richardsonii, S. reticulata, S. planifolia pulchra*) occasionally are present. Soils generally have a moderately thick (10–30 cm) organic horizon overlying loam or sand.
Patterned Wet Meadow	Lowland areas with low-centered polygons or strang within drained lake basins, level floodplains, and flats and water tracks on terraces. Polygon centers are flooded in spring and water remains close to the surface throughout the growing season. Polygon rims or strang interrupt surface and groundwater flow, so only interconnected polygon troughs receive downslope flow and dissolved nutrients; in contrast, the input of water to polygon centers is limited to precipitation. As a result, vegetation growth typically is more robust in polygon troughs than in centers. Vegetation is dominated by sedges, usually *Carex aquatilis* and *Eriophorum angustifolium*, although other sedges may be present including *C. rotundata, C. saxatilis, C. membranacea, C. chordorrhiza,* and *E. russeolum*. On polygon rims, willows (e.g., *Salix lanata richardsonii, S. reticulata, S. planifolia pulchra*) and the dwarf shrubs *Dryas integrifolia* and *Cassiope tetragona* may be abundant along with other species typical of moist tundra.
Moist Sedge–Shrub Meadow	High-centered, low-relief polygons and mixed high- and low-centered polygons on gentle slopes of lowland, riverine, drained basin, and solifluction deposits. Soils are saturated at intermediate depths (>0.15 m) but generally are free of surface water during summer. Vegetation is dominated by *Dryas integrifolia*, and *Carex bigelowii*. Other common species include *C. aquatilis*, *Eriophorum angustifolium*, *Salix reticulata, S. lanata richardsonii,* and the moss *Tomentypnum nitens*. The active layer is relatively shallow and the organic horizon is moderate (0.1–0.2 m).
Moist Tussock Tundra	Gentle slopes and ridges of coastal deposits and terraces, pingos, and the uplifted centers of older drained lake basins. Vegetation is dominated by tussock-forming plants, most commonly *Eriophorum vaginatum*. High-centered polygons of low or high relief are associated with this habitat. Soils are loamy to sandy, somewhat well-drained, acidic to circumneutral, with moderately thick (0.1–0.3 m) organic horizons and shallow (<0.4 m) active layer depths. On acidic sites, associated species include *Ledum decumbens, Betula nana, Salix planifolia pulchra, Cassiope tetragona* and *Vaccinium vitis-idaea*. On circumneutral sites common species include *Dryas integrifolia, S. reticulata, Carex bigelowii,* and lichens. Mosses are common at most sites.

Appendix B. (Continued).

Habitat Class	Description
Riverine or Upland Shrub	Both open and closed stands of low (≤1.5 m high) and tall (>1.5 m high) willows along riverbanks and *Dryas* tundra on upland ridges and stabilized sand dunes. Tall willows occur mainly along larger streams and rivers, where the vegetation is dominated by *Salix alaxensis*. Low willow stands are widespread and typically have a canopy of *S. lanata* and *S. glauca*. Understory plants include the shrubs *Arctostaphylos rubra, S. reticulata,* and *D. integrifolia,* and the forbs *Astragalus* spp., *Lupinus arcticus*, and *Equisetum* spp. *Dryas* tundra is dominated by *D. integrifolia* but may include abundant dwarf willows such as *S. phlebophylla*. Common forbs include *Silene acaulis, Pedicularis lanata,* and *Astragalus umbellatus,* and *C. bigelowii* frequently is present. In Riverine Shrub, an organic horizon generally is absent or buried due to frequent sediment deposition. In Upland Shrub, soils generally have a thin (<5 cm) organic horizon.
Riverine Low and Tall Shrub	Both open and closed stands of low (≤1.5 m) and tall (>1.5 m) willows along riverbanks. Tall willows occur mainly on active riverine deposits along larger streams and rivers, where the vegetation is dominated by open (<75% cover) stands of *Salix alaxensis* with a sparse understory including *Equisetum arvense, Gentiana propinqua, Chrysanthemum bipinnatum, Festuca rubra,* and *Aster sibiricus*. Soils are well-drained riverine sands with a poorly developed organic horizon. Low willow stands, which can occur on active and inactive deposits, typically have an open to closed canopy of *S. lanata richardsonii* occasionally mixed with *S. planifolia pulchra*. Understory plants include *Equisetum arvense, Astragalus alpinus, Drepanocladus sp. Arctagrostis latifolia, Petasites frigidus,* and *Tomentypnum nitens*. Soils are interbedded layers of riverine sands, silts, and organics.
Upland Low and Tall Shrub	Open to closed stands of low (≤1.5 m) and tall (>1.5 m) willow often found on banks, dunes, and high-centered polygons. Upland Tall Shrub can be found on active sand dunes and is defined by the presence of *Salix alaxensis*. Low Shrub stands are found on short, steep banks of basins and on inactive sand dunes. Sites are dominated by *Salix glauca*, with *Dryas integrifolia, Salix lanata richardsonii, Arctostaphylos rubra*, and mosses in the understory. Included in this class are sites dominated by low shrub birch, *Betula nana*.
Upland and Riverine Dwarf Shrub	Dwarf scrub tundra on upland ridges, stabilized sand dunes and river terraces dominated by *Dryas integrifolia* or *Cassiope tetragona*. Upland *Dryas* sites typically are dry and sandy with deep thaw depths (>1.0 m), common associated species include *Salix glauca, S. reticulata, Arctostaphylos alpina, Arctagrostis latifolia, Thamnolia vermicularis,* and *Cetraria cuculata*. Riverine *Dryas* sites occur on well-drained, sandy river terraces, co-dominant species often include *Equisetum variegatum* and *Salix reticulata,* with *S. lanata richardsonii, Arctostaphylos rubra*, *Oxytropis deflexa, Tomentypnum nitens,* and *Thamnolia vermicularis* as associated species. *Cassiope tetragona* is found on slightly moister sites such as banks of thaw basins, riverbanks, and banks of older, well-stabilized dunes. On intermediate soils *Dryas integrifolia* may be co-dominant. Species found in association with *Cassiope* include *S. phlebophylla, Salix reticulata*, *Vaccinium vitis-idaea*, *Carex bigelowii*, *Hierochloe alpina,* and *Arctagrostis latifolia*. Cryptogams present include crustose lichens, *Hylocomium splendens, Dicranum* sp., *Tomentypnum nitens*, and *Rhytidium rugosum*. All sites have a wide variety of forbs.

Appendix B. (Continued).

Habitat Class	Description
Barrens (Riverine, Eolian, or Lacustrine)	Includes barren and partially vegetated (<30% plant cover) areas related to riverine, eolian, or thaw basin processes. Riverine Barrens on river flats and bars are underlain by moist sands and are flooded seasonally. Early colonizers are *Deschampsia caespitosa, Poa hartzii, Festuca rubra, Salix alaxensis*, and *Equisetum arvense.* Eolian Barrens are active sand dunes that are too unstable to support more than a few pioneering plants (<5% cover). Typical species include *Salix alaxensis, Festuca rubra,* and *Chrysanthemum bipinnatum*. Lacustrine Barrens occur within recently drained lakes and ponds. These areas may be flooded seasonally or can be well drained. Typical colonizers are forbs, graminoids, and mosses including *Carex aquatilis, Dupontia fisheri, Scorpidium scorpioides*, and *Calliergon* sp. on wet sites and *Poa* spp., *Festuca rubra, Deschampsia caespitosa, Stellaria humifusa, Senecio congestus,* and *Salix ovalifolia* on drier sites. Barrens may receive intense use seasonally by caribou as mosquito-relief habitat.
Artificial (Water, Fill, Peat Road)	A variety of small disturbed areas, including impoundments, gravel fill, and a sewage lagoon at Nuiqsut. Gravel fill is present at Nuiqsut, the Alpine facilities, and at the Helmericks' residence near the mouth of the Colville River.

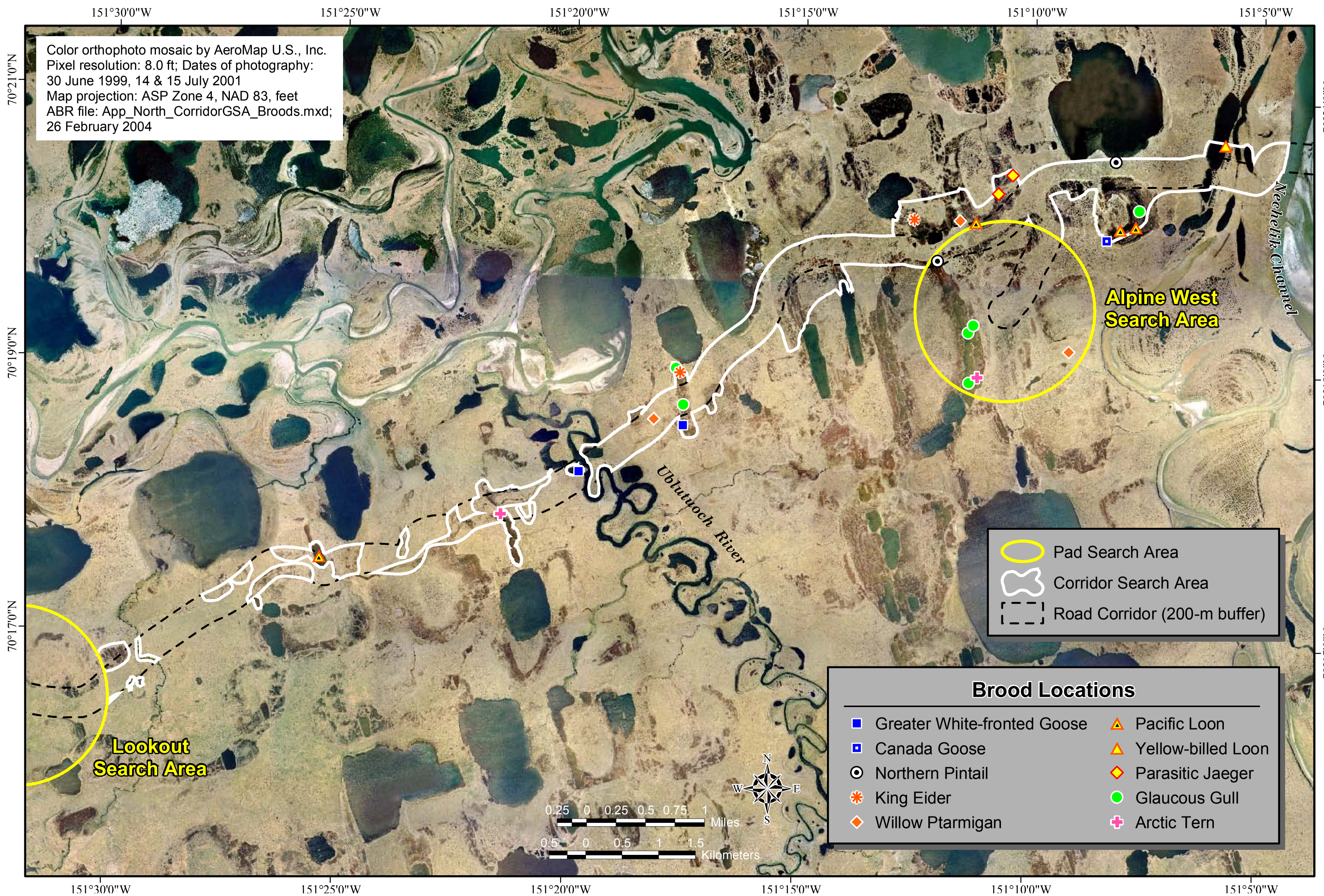


Appendix C1. Nest locations in the northern road corridor, NPRA study area, Alaska, 2003.

Appendix C2. Number and density of nests in the northern road corridor, NPRA study area, Alaska, 2003.

	Nechelik Channel to Lookout				Northern Corridor[a]					
	200-m Buffer		Extended Buffer		200-m Buffer		Extended Buffer		Total	
Species	No. of nests	Density (nests/km²)	No. of nests	Density (nests/km²)	No. of nests	Density (nests/km²)	No. of nests	Density (nests/km²)	No. of nests	Density (nests/km²)
Greater White-fronted Goose	55	7.8	19	8.3	57	6.7	21	5.8	78	6.4
Canada Goose	7	1.0	6[b]	2.6	7	0.8	10[a]	2.8	17	1.4
Brant	0	0	6	2.6	0	0	6	1.7	6	0.5
Unknown goose	1	0.1	0	0	1	0.1	0	0	1	0.1
Northern Pintail	0	0	2	0.9	0	0	2	0.5	2	0.2
Green-winged Teal	0	0	0	0	1	0.1	0	0	1	0.1
Greater Scaup	0	0	1	0.4	0	0	1	0.3	1	0.1
Spectacled Eider	2	0.3	1	0.4	2	0.2	1	0.3	3	0.2
King Eider	0	0	3	1.3	1	0.1	6[c]	1.7	7	0.6
Long-tailed Duck	1	0.1	2	0.9	1	0.1	4	1.1	5	0.4
Red-breasted Merganser	0	0	0	0	0	0	1	0.3	1	0.1
Unknown duck	0	0	1	0.4	0	0	2	0.5	2	0.2
Willow Ptarmigan	3	0.4	1	0.4	4	0.5	1	0.3	5	0.4
Red-throated Loon	0	0	1	0.4	0	0	1	0.3	1	0.1
Pacific Loon	1	0.1	6	2.6	2	0.2	7[d]	1.9[d]	9[d]	0.7[d]
Yellow-billed Loon	1	0.1	0	0	1	0.1	0	0	1	0.1
Bar-tailed Godwit	1	0.1	0	0	2	0.2	1	0.3	3	0.2
Parasitic Jaeger	1	0.1	2	0.9	1	0.1	2	0.5	3	0.2
Glaucous Gull	3	0.4	2	0.9	4	0.5	9	2.5	13	1.1
Sabine's Gull	0	0	0	0	0	0	2	0.5	2	0.2
Arctic Tern	1	0.1	3	1.3	2	0.2	7	1.9	9	0.7
Area Searched (km²)	7.08		2.32		8.57		3.62		12.18	
Waterbird[e] Nest Density	10.5		23.7		9.6		23.0[d]		13.5[d]	
Total Nest Density	10.9		24.1		10.0		23.3[d]		14.0[d]	
Total Number of Nests	77		56		86		84[d]		170[d]	
Number of Species	11		14		13		17		19	

[a] Northern road corridor alternative includes 2 sections: Nechelik to Lookout (see Appendix C1) and Lookout to Spark (see Figure 5); the Lookout to Spark section is identical in the northern road corridor and the proposed road corridor
[b] Includes 1 nest identified to species by feather and down sample
[c] Includes 2 nests identified to species by feather and down samples
[d] Includes 1 case of renesting, in which a loon pair used 2 adjacent nest sites in one season
[e] Waterbirds include: loons, grebes, swans, ducks, cranes, jaegers, gulls, terns, and larger shorebirds



Appendix C3. Brood locations in the northern road corridor, NPRA study area, Alaska, 2003.

Appendix C4. Number of brood-rearing adults and young in the northern road corridor, NPRA study area, Alaska, 2003.

	Nechelik Channel to Lookout Subtotal						Northern Corridor[a]					
	200-m Buffer			Extended Buffer			200-m Buffer			Extended Buffer		
Species	Adults	Young	Groups	Adults	Young	Groups	Adults	Young	Groups	Adults	Young	Groups
Greater White-fronted Goose	6	1	1	2	2	1	8	6	2	6	9	3
Canada Goose	0	0	0	1	1[b]	1	0	0	0	1	1[b]	1
Brant	0	0	0	0	0	0	0	0	0	4	8	2
Northern Pintail	2	8	2	0	0	0	2	8	2	0	0	0
Spectacled Eider	0	0	0	0	0	0	0	0	0	1	3	1
King Eider	0	0	0	2	6	2	0	0	0	2	6	2
Long-tailed Duck	0	0	0	0	0	0	0	0	0	1	4	1
Willow Ptarmigan	2	1	1	1	4	1	2	1	1	1	4	1
Pacific Loon	4	2	2	4	4	2	4	2	2	7	7	4
Yellow-billed Loon	0	0	0	2	1	1	0	0	0	2	1	1
Parasitic Jaeger	0	0	0	3	2	2	2	2	1	3	2	2
Glaucous Gull	2	2	1	2	3	2	2	2	1	4	4	3
Arctic Tern	2	1	1	0	0	0	8[c]	2	2	1	1	1
Total	18	15	8	17	23	12	28	24	11	33	49	22

[a] Northern road corridor alternative includes 2 sections: Nechelik to Lookout (see Appendix C1) and Lookout to Spark (see Figure 5); the Lookout to Spark section is identical in the northern road corridor and the proposed road corridor
[b] Minimum count of young
[c] Includes adults other than the parents in the vicinity of the young

Appendix C5. Habitat availability in the northern road corridor, NPRA study area, Alaska, 2003.

Habitat	Entire Corridor		200-m Buffer		Extended Buffer	
	Area (km^2)	Availability (%)	Area (km^2)	Availability (%)	Area (km^2)	Availability (%)
Deep Open Water without Islands	0.12	0.9	0.09	1.1	0.54	15.0
Deep Open Water with Islands or Polygonized Margins	0.09	0.7	0.09	1.1	0.12	3.4
Shallow Open Water without Islands	0.05	0.3	0.05	0.5	0.06	1.8
Shallow Open Water with Islands or Polygonized Margins	0.21	1.5	0.21	2.5	0.48	13.2
River or Stream	0.14	1.0	0.00	0.0	<0.01	<0.1
Aquatic Sedge Marsh	0.12	0.8	0.11	1.4	0.04	1.2
Aquatic Grass Marsh	0.04	0.3	0.04	0.4	–	–
Young Basin Wetland Complex	0.34	2.4	0.34	4.1	0.27	7.5
Old Basin Wetland Complex	1.44	10.3	1.41	16.6	0.97	26.7
Riverine Complex	0.04	0.3	0.03	0.4	0.02	0.5
Nonpatterned Wet Meadow	0.72	5.2	0.54	6.5	0.13	3.5
Patterned Wet Meadow	1.20	8.6	0.97	11.7	0.37	10.4
Moist Sedge–Shrub Meadow	2.88	20.7	1.41	17.1	0.48	13.3
Moist Tussock Tundra	6.31	45.2	2.97	35.8	0.11	3.1
Riverine Low and Tall Shrub	0.06	0.5	0.05	0.6	0.01	0.4
Riverine or Upland Shrub	0.14	1.0	<0.01	<0.1	0	0
Upland Low and Tall Shrub	<0.01	<0.1	0	0	0	0
Barrens	0.07	0.5	0	0	0	0
Subtotal	13.96	100	8.32	100	3.62	100
Unknown (Unmapped areas)	0.25	1.8	0.25	2.9	0	0
Total	14.21	100	8.57	100	3.62	100

Appendix D1. Number and density of nests on clusters of breeding-bird plots, NPRA study area, Alaska, 2003.

Species	Plots 1–4	Plots 25–28	Plots 33–36	Plots 45–48	Plots 53–56	Plots 101–104	Total Nests	Density (nests/km²)
Greater White-fronted Goose	0	1	1	0	0	2	4	1.7
Northern Pintail	0	2	0	0	0	1	3	1.3
King Eider	0	0	0	1	1	0	2	0.8
Long-tailed Duck	1	0	0	0	1	0	2	0.8
Willow Ptarmigan	0	0	1	0	0	1	2	0.8
Black-bellied Plover	0	0	0	2	1	0	3	1.3
American Golden Plover	1	1	0	0	1	0	3	1.3
Bar-tailed Godwit	0	0	0	1	0	0	1	0.4
Semipalmated Sandpiper	2	8	4	9	3	2	28	11.7
Pectoral Sandpiper	5	2	4	1	10	4	26	10.8
Dunlin	0	0	0	1	1	1	3	1.3
Stilt Sandpiper	0	0	0	1	3	0	4	1.7
Long-billed Dowitcher	3	0	0	0	3	2	8	3.3
Red-necked Phalarope	2	0	4	0	1	0	7	2.9
Red Phalarope	0	0	2	0	8	0	10	4.2
Arctic Tern	0	1	0	0	0	0	1	0.4
Yellow Wagtail	0	1	0	0	0	0	1	0.4
Savannah Sparrow	0	4	3	0	0	1	8	3.3
Lapland Longspur	14	16	13	5	10	19	77	32.1
Common Redpoll	1	2	0	0	3	0	6	2.5
Total Nests	29	38	32	21	46	33	199	
Density (nests/km²)	72.5	95.0	80.0	52.5	115.0	82.5		82.9
Number of Species	8	10	8	8	13	9	20	

Appendix D2. Nest evidence at successful and failed shorebird nests in the NPRA study area, Alaska, 2003.

Fate/Species	*n*	Eggshell Fragments[a](%)[b]		Eggshell Parts (%)[b]		
		Present	Absent	None Found	Piece[a]	Top or Bottom
SUCCESSFUL NESTS						
Semipalmated Sandpiper	11	100	0	73	27	0
Pectoral Sandpiper	4	100	0	50	25	25
Stilt Sandpiper	2	100	0	50	50	50
Long-billed Dowitcher	4	100	0	0	100	50
Red-necked Phalarope	2	100	0	0	50	100
Red Phalarope	2	100	0	0	0	100
Total	25	100	0	44	40	32
FAILED NESTS						
Black-bellied Plover	7	43	57	71	29	0
American Golden-Plover	2	0	100	100	0	0
Bar-tailed Godwit	1	0	100	0	100	0
Semipalmated Sandpiper	7	0	100	100	0	0
Pectoral Sandpiper	10	0	100	80	20	0
Dunlin	1	100	0	0	100	0
Stilt Sandpiper	2	0	100	100	0	0
Long-billed Dowitcher	1	0	100	100	0	0
Red-necked Phalarope	2	0	100	100	0	0
Red Phalarope	2	0	100	100	0	0
Total	35	11	89	83	17	0

[a] Eggshell fragments are ≤5 mm; eggshell pieces are >5 mm
[b] Values represent percent of total nests for each type of evidence and nest fate

Appendix D3. Mean number of predators (number/h) on clusters of breeding-bird plots, NPRA study area, Alaska, 2003.

SURVEY METHOD Visit Type (sample size) Predator	Plots 1–4	Plots 25–28	Plots 33–36	Plots 45–48	Plots 53–56	Plots 101–104	Total Count	Overall Mean (no./h)
TIMED COUNT								
Plot Marking (no. 10-min counts)	(12)	(12)	(12)	(12)	(12)	(12)	(72)	
Pomarine/Parasitic/Long-tailed Jaeger	2.0	1.5	3.0	2.5	1.0	1.5	23	1.92
Glaucous Gull	0	1.5	0	3.5	2.5	1.5	18	1.50
Common Raven	0.5	0	0	0	0	0	1	0.08
Arctic Ground Squirrel	0	0	0	0.5	0	0	1	0.08
Caribou	0	0	0	0	0	1.5	3	0.25
Nest Searching (no. 10-min counts)	(4)	(4)	(4)	(4)	(4)	(4)	(24)	
Parasitic/Long-tailed Jaeger	1.5	12.0	4.5	4.5	0	7.5	20	5.00
Glaucous Gull	0	1.5	1.5	0	4.5	0	5	1.25
Common Raven	0	0	0	0	0	1.5	1	0.25
Nest Monitoring (no. 10-min counts)	(8)	(8)	(8)	(8)	(8)	(8)	(48)	
Parasitic/Long-tailed Jaeger	2.3	2.3	0.8	1.5	3.0	4.5	19	2.38
Glaucous Gull	0.8	0.8	0	3.8	1.5	0	9	1.13
Common Raven	0	0	0	0	0	0.8	1	0.13
Gyrfalcon	0	0	0.8	0	0	0	1	0.13
Total Predator Count	10	19	12	23	16	22	102	
Total Predator Mean (no./h)	2.5	4.8	3.0	5.8	4.0	5.5		4.30
INCIDENTAL COUNT								
Plot Marking (h)	(7.0)	(5.4)	(6.3)	(5.1)	(4.5)	(7.0)	(35.1)	
Pomarine/Parasitic/Long-tailed Jaeger	0.9	1.1	1.9	1.6	0.7	0.7	40	1.14
Glaucous Gull	0.3	1.3	0	1.6	1.1	0.9	28	0.80
Common Raven	0.1	0	0	0	0	0	1	0.03
Arctic Ground Squirrel	0	0	0	0.4	0	0	2	0.06
Red Fox	0	0.2	0	0	0	0	1	0.03
Caribou	0	0	0	0	0	0.4	3	0.09
Nest Searching (h)	(70.2)	(65.6)	(72.8)	(67.1)	(81.1)	(65.5)	(422.2)	
Pomarine/Parasitic/Long-tailed Jaeger	0.5	1.1	0.6	0.9	0.4	0.8	293	0.69
Glaucous Gull	0.3	0.3	0.2	0.3	0.4	0.2	117	0.28
Common Raven	0.1	<0.1	0	0.1	<0.1	<0.1	18	0.04
Peregrine Falcon/Northern Harrier	<0.1	0	0	<0.1	<0.1	0	4	0.01
Arctic Ground Squirrel	0	<0.1	0	0.1	0	0	9	0.02
Arctic and Red Fox	0	<0.1	<0.1	0.1	0	<0.1	12	0.03
Caribou	0.1	0.1	0.1	0.2	0	0	29	0.07
Nest Monitoring (h)	(13.6)	(15.5)	(16.2)	(15.3)	(21.1)	(13.6)	(95.3)	
Parasitic/Long-tailed Jaeger	0.7	0.6	0.6	1.0	0.3	1.1	66	0.69
Glaucous Gull	0.1	0.2	0.1	0.7	0.1	0.1	22	0.23
Common Raven	0	0	0	0	0	0.1	2	0.02
Gyrfalcon	0	0	0.1	0	0	0	1	0.01
Arctic Fox	0	0	0.1	0	0	0	2	0.02
Total Predator Count	88	126	94	153	84	105	650	
Total Predator Mean (no./h)	0.97	1.46	0.99	1.75	0.79	1.22		1.18

Appendix D4. Number of predators[a] on 24 breeding-bird plots, NPRA study area, Alaska, 2003.

	Plot Marking[b]					Nest Searching[b]			Nest Monitoring[b]				Total Count[b]					
Plot	Jaeger	Gull	Raven	Squirrel	Caribou	Jaeger	Gull	Raven	Jaeger	Gull	Raven	Gyrfalcon	Jaeger	Gull	Raven	Gyrfalcon	Squirrel	Caribou
1	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
2	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0
3	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
4	1	0	0	0	0	0	0	0	3	0	0	0	4	0	0	0	0	0
25	3	1	0	0	0	3	0	0	0	0	0	0	6	1	0	0	0	0
26	0	0	0	0	0	2	0	0	0	1	0	0	2	1	0	0	0	0
27	0	1	0	0	0	2	0	0	3	0	0	0	5	1	0	0	0	0
28	0	1	0	0	0	1	1	0	0	0	0	0	1	2	0	0	0	0
33	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	4	0	0	0	0	1	1	0	0	0	0	0	5	1	0	0	0	0
36	2	0	0	0	0	0	0	0	1	0	0	1	3	0	0	1	0	0
45	0	3	0	0	0	1	0	0	0	4	0	0	1	7	0	0	0	0
46	3	2	0	1	0	1	0	0	0	0	0	0	4	2	0	0	1	0
47	2	1	0	0	0	1	0	0	0	0	0	0	3	1	0	0	0	0
48	0	1	0	0	0	0	0	0	2	1	0	0	2	2	0	0	0	0
53	0	0	0	0	0	0	0	0	2	1	0	0	2	1	0	0	0	0
54	1	1	0	0	0	0	1	0	2	1	0	0	3	3	0	0	0	0
55	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
56	1	3	0	0	0	0	2	0	0	0	0	0	1	5	0	0	0	0
101	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
102	0	0	0	0	3	1	0	1	1	0	1	0	2	0	2	0	0	3
103	1	2	0	0	0	1	0	0	2	0	0	0	4	2	0	0	0	0
104	2	0	0	0	0	3	0	0	3	0	0	0	8	0	0	0	0	0
Total	23	18	1	1	3	20	5	1	19	9	1	1	62	32	3	1	1	3
Mean	0.32	0.25	0.01	0.01	0.04	0.83	0.21	0.04	0.40	0.19	0.02	0.02	0.43	0.22	0.02	0.01	0.01	0.02
SE	0.15	0.11	0.02	0.02	0.07	0.20	0.10	0.04	0.16	0.13	0.03	0.03	0.17	0.14	0.04	0.02	0.02	0.05
n[c]	72	72	72	72	72	24	24	24	48	48	48	48	144	144	144	144	144	144

[a] Includes Long-tailed, Parasitic, and Pomarine Jaeger; Glaucous Gull; Common Raven; Gyrfalcon; Arctic Ground Squirrel; and Caribou
[b] Plot marking includes three 10-min counts, nest searching includes one 10-min count, and nest monitoring includes two 10-min counts
[c] n = number of counts (10-min per count)

Appendix E1. Habitat selection by pre-nesting Spectacled Eider and King Eider groups on the Colville River Delta, Alaska, 1993–2003.

SPECIES Habitat	No. Adults	No. Groups	Use (%)	Availability (%)	Monte Carlo Results[a]
SPECTACLED EIDERS					
Open Nearshore Water	0	0	0	1.6	ns
Brackish Water	53	23	12.6	1.3	prefer
Tapped Lake with Low-water Connection	29	12	6.6	4.5	ns
Tapped Lake with High-water Connection	10	6	3.3	3.7	ns
Salt Marsh	29	14	7.7	3.3	prefer
Tidal Flat	0	0	0	7.1	avoid
Salt-killed Tundra	33	18	9.9	5.1	prefer
Deep Open Water without Islands	10	7	3.8	4.0	ns
Deep Open Water with Islands or Polygonized Margins	18	10	5.5	1.6	prefer
Shallow Open Water without Islands	4	2	1.1	0.4	ns
Shallow Open Water with Islands or Polygonized Margins	3	2	1.1	0.1	prefer
River or Stream	16	8	4.4	14.2	avoid
Aquatic Sedge Marsh	0	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	73	40	22.0	2.7	prefer
Aquatic Grass Marsh	2	2	1.1	0.2	ns
Young Basin Wetland Complex	0	0	0	<0.1	ns
Old Basin Wetland Complex	0	0	0	<0.1	ns
Nonpatterned Wet Meadow	41	20	11.0	8.1	ns
Patterned Wet Meadow	36	16	8.8	19.3	avoid
Moist Sedge–Shrub Meadow	0	0	0	2.3	avoid
Moist Tussock Tundra	0	0	0	0.6	ns
Riverine or Upland Shrub	0	0	0	4.8	avoid
Barrens	4	2	1.1	15.0	avoid
Artificial	0	0	0	<0.1	ns
Total	361	182	100	100	
KING EIDERS					
Open Nearshore Water	11	3	2.7	1.6	ns
Brackish Water	10	6	5.4	1.3	prefer
Tapped Lake with Low-water Connection	19	9	8.1	4.5	ns
Tapped Lake with High-water Connection	8	3	2.7	3.7	ns
Salt Marsh	8	3	2.7	3.3	ns
Tidal Flat	4	2	1.8	7.1	avoid
Salt-killed Tundra	20	10	9.0	5.1	ns
Deep Open Water without Islands	4	1	0.9	4.0	avoid
Deep Open Water with Islands or Polygonized Margins	5	2	1.8	1.6	ns
Shallow Open Water without Islands	0	0	0	0.4	ns
Shallow Open Water with Islands or Polygonized Margins	0	0	0	0.1	ns
River or Stream	163	51	45.9	14.2	prefer
Aquatic Sedge Marsh	0	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	8	5	4.5	2.7	ns
Aquatic Grass Marsh	0	0	0	0.2	ns
Young Basin Wetland Complex	0	0	0	<0.1	ns
Old Basin Wetland Complex	0	0	0	<0.1	ns
Nonpatterned Wet Meadow	2	2	1.8	8.1	avoid
Patterned Wet Meadow	14	9	8.1	19.3	avoid
Moist Sedge–Shrub Meadow	0	0	0	2.3	ns
Moist Tussock Tundra	0	0	0	0.6	ns
Riverine or Upland Shrub	2	1	0.9	4.8	avoid
Barrens	11	4	3.6	15.0	avoid
Artificial	0	0	0	<0.1	ns
Total	289	111	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability. % use = (groups / total groups) × 100

Appendix E2. Habitat selection by nesting Spectacled Eiders in the CD North search area, Colville River Delta, Alaska, 2000–2003.

Habitat	No. of Nests[a]	Use (%)	Availability (%)	Monte Carlo Results[b]
Brackish Water	1	2.5	3.5	ns
Tapped Lake with Low-water Connection	0	0	1.3	ns
Tapped Lake with High-water Connection	0	0	3.9	ns
Salt Marsh	0	0	4.6	ns
Tidal Flat	0	0	<0.1	ns
Salt-killed Tundra	11	27.5	15.0	ns
Deep Open Water without Islands	0	0	3.5	ns
Deep Open Water with Islands or Polygonized Margins	3	7.5	9.9	ns
Shallow Open Water without Islands	0	0	0.2	ns
Shallow Open Water with Islands or Polygonized Margins	0	0	0.8	ns
River or Stream	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	9	22.5	12.4	ns
Aquatic Grass Marsh	0	0	0.2	ns
Nonpatterned Wet Meadow	4	10.0	13.7	ns
Patterned Wet Meadow	12	30.0	23.5	ns
Moist Sedge–Shrub Meadow	0	0	2.6	ns
Riverine or Upland Shrub	0	0	1.1	ns
Barrens	0	0	3.7	ns
Total	40	100	100	

[a] Nests and habitat availability pooled among years. Annual search areas varied from 12.2 to 18.9 km²

[b] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix E3. Habitat selection by pre-nesting Spectacled Eiders and King Eiders in the NPRA study area, Alaska, 2001–2003.

SPECIES Habitat	No. of Adults	No. of Groups	Use (%)	Availability (%)	Monte Carlo Results[a]
SPECTACLED EIDER					
Open Nearshore Water	0	0	0	0.1	ns
Brackish Water	0	0	0	0.3	ns
Tapped Lake with Low-water Connection	0	0	0	0.3	ns
Tapped Lake with High-water Connection	0	0	0	<0.1	ns
Salt Marsh	4	2	12.5	0.6	prefer
Tidal Flat	0	0	0	0.3	ns
Salt-killed Tundra	0	0	0	<0.1	ns
Deep Open Water without Islands	0	0	0	6.9	ns
Deep Open Water with Islands or Polygonized Margins	4	2	12.5	5.3	ns
Shallow Open Water without Islands	1	1	6.3	1.0	ns
Shallow Open Water with Islands or Polygonized Margins	6	2	12.5	1.7	prefer
River or Stream	0	0	0	0.8	ns
Aquatic Sedge Marsh	0	0	0	1.8	ns
Aquatic Sedge with Deep Polygons	0	0	0	<0.1	ns
Aquatic Grass Marsh	0	0	0	0.3	ns
Young Basin Wetland Complex	0	0	0	0.3	ns
Old Basin Wetland Complex	10	5	31.3	9.0	prefer
Riverine Complex	0	0	0	0.4	ns
Dune Complex	0	0	0	1.1	ns
Nonpatterned Wet Meadow	0	0	0	3.3	ns
Patterned Wet Meadow	1	1	6.3	11.4	ns
Moist Sedge–Shrub Meadow	4	2	12.5	23.7	ns
Moist Tussock Tundra	0	0	0	27.7	avoid
Riverine Low and Tall Shrub	0	0	0	1.1	ns
Upland and Riverine Dwarf Shrub	0	0	0	1.2	ns
Upland Low and Tall Shrub	1	1	6.3	0.4	ns
Barrens	0	0	0	1.0	ns
Total	31	16	100	100	
KING EIDER					
Open Nearshore Water	0	0	0	0.1	ns
Brackish Water	5	3	3.0	0.3	prefer
Tapped Lake with Low-water Connection	8	1	1.0	0.3	ns
Tapped Lake with High-water Connection	0	0	0	<0.1	ns
Salt Marsh	2	1	1.0	0.6	ns
Tidal Flat	0	0	0	0.3	ns
Salt-killed Tundra	0	0	0	<0.1	ns
Deep Open Water without Islands	54	17	17.0	6.9	prefer
Deep Open Water with Islands or Polygonized Margins	41	13	13.0	5.3	prefer
Shallow Open Water without Islands	15	9	9.0	1.0	prefer
Shallow Open Water with Islands or Polygonized Margins	43	17	17.0	1.7	prefer
River or Stream	2	1	1.0	0.8	ns
Aquatic Sedge Marsh	5	3	3.0	1.8	ns
Aquatic Sedge w/Deep Polygons	0	0	0	<0.1	ns
Aquatic Grass Marsh	2	1	1.0	0.3	ns
Young Basin Wetland Complex	0	0	0	0.3	ns
Old Basin Wetland Complex	38	14	14.0	9.0	ns
Riverine Complex	0	0	0	0.4	ns
Dune Complex	0	0	0	1.1	ns
Nonpatterned Wet Meadow	4	4	4.0	3.3	ns
Patterned Wet Meadow	9	5	5.0	11.4	avoid
Moist Sedge–Shrub Meadow	20	6	6.0	23.7	avoid
Moist Tussock Tundra	6	3	3.0	27.7	avoid
Riverine Low and Tall Shrub	1	1	1.0	1.1	ns
Upland and Riverine Dwarf Shrub	2	1	1.0	1.2	ns
Upland Low and Tall Shrub	0	0	0	0.4	ns
Barrens	0	0	0	1.0	ns
Total	257	100	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability. % use = (groups / total groups) × 100

Appendix F. Habitat selection by nesting Long-tailed Ducks in the CD North search area, Alaska, 2000–2003.

Habitat	No. of Nests	Use (%)	Availability (%)	Monte Carlo Results[a]
Brackish Water	0	0	3.5	ns
Tapped Lake with Low-water Connection	0	0	1.3	ns
Tapped Lake with High-water Connection	1	1.1	3.9	ns
Salt Marsh	2	2.3	4.6	ns
Tidal Flat	0	0	<0.1	ns
Salt-killed Tundra	3	3.4	15.0	avoid
Deep Open Water without Islands	8	9.1	3.5	prefer
Deep Open Water with Islands or Polygonized Margins	19	21.6	9.9	prefer
Shallow Open Water without Islands	0	0	0.2	ns
Shallow Open Water with Islands or Polygonized Margins	5	5.7	0.8	prefer
River or Stream	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	20	22.7	12.4	prefer
Aquatic Grass Marsh	0	0	0.2	ns
Nonpatterned Wet Meadow	8	9.1	13.7	ns
Patterned Wet Meadow	18	20.5	23.5	ns
Moist Sedge–Shrub Meadow	3	3.4	2.6	ns
Riverine or Upland Shrub	1	1.1	1.1	ns
Barrens	0	0	3.7	ns
Total	88	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability. % use = (groups / total groups) × 100

Appendix G1. Habitat selection by nesting (1993–2003) and brood-rearing (1995–2003) Yellow-billed Loons on the Colville River Delta, Alaska.

SEASON Habitat	No. of Nests or Broods	Use (%)	Availability (%)	Monte Carlo Results[a]
NESTING				
Open Nearshore Water	0	0	2.0	ns
Brackish Water	0	0	1.1	ns
Tapped Lake with Low-water Connection	0	0	5.4	avoid
Tapped Lake with High-water Connection	12	8.2	5.4	ns
Salt Marsh	0	0	2.6	ns
Tidal Flat	0	0	3.4	avoid
Salt-killed Tundra	0	0	4.2	avoid
Deep Open Water without Islands	13	8.8	5.5	ns
Deep Open Water with Islands or Polygonized Margins	37	25.2	1.8	prefer
Shallow Open Water without Islands	1	0.7	0.4	ns
Shallow Open Water with Islands or Polygonized Margins	0	0	0.1	ns
River or Stream	0	0	8.8	avoid
Aquatic Sedge Marsh	2	1.4	<0.1	prefer
Aquatic Sedge with Deep Polygons	6	4.1	2.8	ns
Aquatic Grass Marsh	1	0.7	0.3	ns
Young Basin Wetland Complex	0	0	<0.1	ns
Old Basin Wetland Complex	0	0	<0.1	ns
Nonpatterned Wet Meadow	19	12.9	8.8	ns
Patterned Wet Meadow	56	38.1	24.6	prefer
Moist Sedge–Shrub Meadow	0	0	3.2	avoid
Moist Tussock Tundra	0	0	0.9	ns
Riverine or Upland Shrub	0	0	6.5	avoid
Barrens	0	0	12.2	avoid
Artificial	0	0	0.1	ns
Total	147	100	100	
BROOD-REARING				
Open Nearshore Water	0	0	2.0	ns
Brackish Water	0	0	1.1	ns
Tapped Lake with Low-water Connection	0	0	5.4	ns
Tapped Lake with High-water Connection	12	20.0	5.4	prefer
Salt Marsh	0	0	2.6	ns
Tidal Flat	0	0	3.4	ns
Salt-killed Tundra	0	0	4.2	ns
Deep Open Water without Islands	36	60.0	5.5	prefer
Deep Open Water with Islands or Polygonized Margins	12	20.0	1.8	prefer
Shallow Open Water without Islands	0	0	0.4	ns
Shallow Open Water with Islands or Polygonized Margins	0	0	0.1	ns
River or Stream	0	0	8.8	avoid
Aquatic Sedge Marsh	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	0	0	2.8	ns
Aquatic Grass Marsh	0	0	0.3	ns
Young Basin Wetland Complex	0	0	<0.1	ns
Old Basin Wetland Complex	0	0	<0.1	ns
Nonpatterned Wet Meadow	0	0	8.8	avoid
Patterned Wet Meadow	0	0	24.6	avoid
Moist Sedge–Shrub Meadow	0	0	3.2	ns
Moist Tussock Tundra	0	0	0.9	ns
Riverine or Upland Shrub	0	0	6.5	ns
Barrens	0	0	12.2	avoid
Artificial	0	0	0.1	ns
Total	60	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix G2. Habitat selection by nesting Yellow-billed Loons in the NPRA study area, Alaska, 2001–2003.

Habitat	No. of Nests	Use (%)	Availability (%)	Monte Carlo Results[a]
Open Nearshore Water	0	0	0.3	ns
Brackish Water	0	0	0.1	ns
Tapped Lake with Low-water Connection	0	0	0.3	ns
Tapped Lake with High-water Connection	0	0	<0.1	ns
Salt Marsh	0	0	0.4	ns
Tidal Flat	0	0	0.8	ns
Salt-killed Tundra	0	0	<0.1	ns
Deep Open Water without Islands	6	9.5	7.0	ns
Deep Open Water with Islands or Polygonized Margins	31	49.2	5.2	prefer
Shallow Open Water without Islands	0	0	1.0	ns
Shallow Open Water with Islands or Polygonized Margins	1	1.6	1.6	ns
River or Stream	0	0	0.9	ns
Aquatic Sedge Marsh	7	11.1	1.7	prefer
Aquatic Sedge with Deep Polygons	0	0	<0.1	ns
Aquatic Grass Marsh	2	3.2	0.3	prefer
Young Basin Wetland Complex	0	0	0.4	ns
Old Basin Wetland Complex	0	0	8.8	avoid
Riverine Complex	0	0	0.4	ns
Dune Complex	0	0	1.1	ns
Nonpatterned Wet Meadow	5	7.9	3.1	ns
Patterned Wet Meadow	6	9.5	11.3	ns
Moist Sedge–Shrub Meadow	5	7.9	23.7	avoid
Moist Tussock Tundra	0	0	27.8	avoid
Riverine Low and Tall Shrub	0	0	1.1	ns
Upland and Riverine Dwarf Shrub	0	0	1.3	ns
Upland Low and Tall Shrub	0	0	0.4	ns
Barrens	0	0	1.0	ns
Total	63	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix G3. Habitat selection by brood-rearing Yellow-billed Loons in the NPRA study area, Alaska, 2001–2003.

Habitat	No. of Broods	Use (%)	Availability (%)	Monte Carlo Results[a]
Open Nearshore Water	0	0	0.3	ns
Brackish Water	0	0	0.1	ns
Tapped Lake with Low-water Connection	0	0	0.3	ns
Tapped Lake with High-water Connection	0	0	<0.1	ns
Salt Marsh	0	0	0.4	ns
Tidal Flat	0	0	0.8	ns
Salt-killed Tundra	0	0	<0.1	ns
Deep Open Water without Islands	8	30.8	7.0	prefer
Deep Open Water with Islands or Polygonized Margins	18	69.2	5.2	prefer
Shallow Open Water without Islands	0	0	1.0	ns
Shallow Open Water with Islands or Polygonized Margins	0	0	1.6	ns
River or Stream	0	0	0.9	ns
Aquatic Sedge Marsh	0	0	1.7	ns
Aquatic Sedge with Deep Polygons	0	0	<0.1	ns
Aquatic Grass Marsh	0	0	0.3	ns
Young Basin Wetland Complex	0	0	0.4	ns
Old Basin Wetland Complex	0	0	8.8	ns
Riverine Complex	0	0	0.4	ns
Dune Complex	0	0	1.1	ns
Nonpatterned Wet Meadow	0	0	3.1	ns
Patterned Wet Meadow	0	0	11.3	ns
Moist Sedge–Shrub Meadow	0	0	23.7	avoid
Moist Tussock Tundra	0	0	27.8	avoid
Riverine Low and Tall Shrub	0	0	1.1	ns
Upland and Riverine Dwarf Shrub	0	0	1.3	ns
Upland Low and Tall Shrub	0	0	0.4	ns
Barrens	0	0	1.0	ns
Total	26	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix G4. Habitat selection by nesting Pacific Loons in the CD North search area, Colville River Delta, Alaska, 2001–2003.

Habitat	No. of Nests	Use (%)	Availability (%)	Monte Carlo Results[a]
Brackish Water	9	16.4	3.5	prefer
Tapped Lake with Low-water Connection	0	0	1.3	ns
Tapped Lake with High-water Connection	12	21.8	3.9	prefer
Salt Marsh	0	0	4.6	ns
Tidal Flat	0	0	<0.1	ns
Salt-killed Tundra	2	3.6	15.0	avoid
Deep Open Water without Islands	4	7.3	3.5	ns
Deep Open Water with Islands or Polygonized Margins	14	25.5	9.9	prefer
Shallow Open Water without Islands	0	0	0.2	ns
Shallow Open Water with Islands or Polygonized Margins	4	7.3	0.8	prefer
River or Stream	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	2	3.6	12.4	avoid
Aquatic Grass Marsh	1	1.8	0.2	ns
Nonpatterned Wet Meadow	1	1.8	13.7	avoid
Patterned Wet Meadow	5	9.1	23.5	avoid
Moist Sedge–Shrub Meadow	1	1.8	2.6	ns
Riverine or Upland Shrub	0	0	1.1	ns
Barrens	0	0	3.7	ns
Total	55	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix H1. Habitat selection by nesting and brood-rearing Tundra Swans on the Colville River Delta, Alaska, 1992–2003.

SEASON Habitat	No. of Nests or Broods	Use (%)	Availability (%)	Monte Carlo Results[a]
NESTING				
Open Nearshore Water	0	0	1.8	avoid
Brackish Water	3	0.9	1.2	ns
Tapped Lake with Low-water Connection	2	0.6	3.9	avoid
Tapped Lake with High-water Connection	5	1.5	3.7	avoid
Salt Marsh	23	6.8	3.0	prefer
Tidal Flat	5	1.5	10.1	avoid
Salt-killed Tundra	43	12.8	4.7	prefer
Deep Open Water without Islands	9	2.7	3.8	ns
Deep Open Water with Islands or Polygonized Margins	13	3.9	1.4	prefer
Shallow Open Water without Islands	1	0.3	0.4	ns
Shallow Open Water with Islands or Polygonized Margins	1	0.3	0.1	ns
River or Stream	1	0.3	14.9	avoid
Aquatic Sedge Marsh	1	0.3	<0.1	ns
Aquatic Sedge with Deep Polygons	27	8.0	2.4	prefer
Aquatic Grass Marsh	3	0.9	0.3	ns
Young Basin Wetland Complex	0	0	0	ns
Old Basin Wetland Complex	0	0	<0.1	ns
Nonpatterned Wet Meadow	35	10.4	7.5	ns
Patterned Wet Meadow	129	38.3	18.6	prefer
Moist Sedge–Shrub Meadow	20	5.9	2.2	prefer
Moist Tussock Tundra	3	0.9	0.6	ns
Riverine or Upland Shrub	6	1.8	5.0	avoid
Barrens	7	2.1	14.3	avoid
Artificial	0	0	0.1	ns
Total	337	100	100	
BROOD-REARING				
Open Nearshore Water	0	0	1.8	avoid
Brackish Water	13	5.2	1.2	prefer
Tapped Lake with Low-water Connection	34	15.6	3.9	prefer
Tapped Lake with High-water Connection	17	7.8	3.7	prefer
Salt Marsh	17	8.9	3.0	prefer
Tidal Flat	3	1.0	10.1	avoid
Salt-killed Tundra	17	6.3	4.7	ns
Deep Open Water without Islands	20	9.9	3.8	prefer
Deep Open Water with Islands or Polygonized Margins	9	4.7	1.4	prefer
Shallow Open Water without Islands	2	0.5	0.4	ns
Shallow Open Water with Islands or Polygonized Margins	1	0.5	0.1	ns
River or Stream	9	4.2	14.9	avoid
Aquatic Sedge Marsh	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	6	3.1	2.4	ns
Aquatic Grass Marsh	3	1.6	0.3	prefer
Young Basin Wetland Complex	0	0	0	ns
Old Basin Wetland Complex	0	0	<0.1	ns
Nonpatterned Wet Meadow	12	5.2	7.5	ns
Patterned Wet Meadow	33	16.1	18.6	ns
Moist Sedge–Shrub Meadow	3	1.6	2.2	ns
Moist Tussock Tundra	1	0	0.6	ns
Riverine or Upland Shrub	4	1.6	5.0	avoid
Barrens	15	6.3	14.3	avoid
Artificial	0	0	0.1	ns
Total	219	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix H2. Habitat selection by nesting Tundra Swans in the NPRA study area, Alaska, 2001–2003.

Habitat	No. of Nests	Use (%)	Availability (%)	Monte Carlo Results[a]
Open Nearshore Water	0	0	0.1	ns
Brackish Water	0	0	0.2	ns
Tapped Lake with Low-water Connection	0	0	0.2	ns
Tapped Lake with High-water Connection	0	0	<0.1	ns
Salt Marsh	1	1.3	0.5	ns
Tidal Flat	0	0	0.5	ns
Salt-killed Tundra	0	0	<0.1	ns
Deep Open Water without Islands	1	1.3	7.3	avoid
Deep Open Water with Islands or Polygonized Margins	8	10.4	5.3	ns
Shallow Open Water without islands	0	0	1.0	ns
Shallow Open Water with Islands or Polygonized Margins	5	6.5	1.7	prefer
River or Stream	0	0	0.9	ns
Aquatic Sedge Marsh	2	2.6	1.7	ns
Aquatic Sedge with Deep Polygons	0	0	<0.1	ns
Aquatic Grass Marsh	3	3.9	0.3	prefer
Young Basin Wetland Complex	2	2.6	0.4	ns
Old Basin Wetland Complex	11	14.3	8.9	ns
Riverine Complex	0	0	0.4	ns
Dune Complex	1	1.3	1.1	ns
Nonpatterned Wet Meadow	2	2.6	3.1	ns
Patterned Wet Meadow	7	9.1	11.5	ns
Moist Sedge–Shrub Meadow	13	16.9	23.5	ns
Moist Tussock Tundra	21	27.3	27.7	ns
Riverine Low and Tall Shrub	0	0	1.1	ns
Upland and Riverine Dwarf Shrub	0	0	1.3	ns
Upland Low and Tall Shrub	0	0	0.4	ns
Barrens	0	0	1.0	ns
Total	77	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix H3. Habitat selection by brood-rearing Tundra Swans in the NPRA study area, Alaska, 2001–2003.

Habitat	No. of Broods	Use (%)	Availability (%)	Monte Carlo Results[a]
Open Nearshore Water	0	0	0.1	ns
Brackish Water	0	0	0.2	ns
Tapped Lake with Low-water Connection	3	6.5	0.2	prefer
Tapped Lake with High-water Connection	0	0	<0.1	ns
Salt Marsh	0	0	0.5	ns
Tidal Flat	0	0	0.5	ns
Salt-killed Tundra	0	0	<0.1	ns
Deep Open Water without islands	16	34.9	7.3	prefer
Deep Open Water with Islands or Polygonized Margins	12	26.1	5.3	prefer
Shallow Open Water without islands	1	2.2	1.0	ns
Shallow Open Water with Islands or Polygonized Margins	2	4.3	1.7	ns
River or Stream	0	0	0.9	ns
Aquatic Sedge Marsh	0	0	1.7	ns
Aquatic Sedge with Deep Polygons	0	0	<0.1	ns
Aquatic Grass Marsh	1	2.2	0.3	ns
Young Basin Wetland Complex	0	0	0.4	ns
Old Basin Wetland Complex	1	2.2	8.9	avoid
Riverine Complex	1	2.2	0.4	ns
Dune Complex	0	0	1.1	ns
Nonpatterned Wet Meadow	4	8.7	3.1	ns
Patterned Wet Meadow	1	2.2	11.5	avoid
Moist Sedge–Shrub Meadow	2	4.3	23.5	avoid
Moist Tussock Tundra	1	2.2	27.7	avoid
Riverine Low and Tall Shrub	0	0	1.1	ns
Upland and Riverine Dwarf Shrub	0	0	1.3	ns
Upland Low and Tall Shrub	0	0	0.4	ns
Barrens	1	2.2	1.0	ns
Total	46	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix I1. Habitat selection by nesting Greater White-fronted Geese in the CD North search area, Colville River Delta, Alaska, 2000–2003.

Habitat	No. of Nests	Use (%)	Availability (%)	Monte Carlo Results[a]
Brackish Water	1	0.1	3.5	avoid
Tapped Lake with Low-water Connection	0	0	1.3	avoid
Tapped Lake with High-water Connection	2	0.3	3.9	avoid
Salt Marsh	17	2.2	4.6	avoid
Tidal Flat	0	0	<0.1	ns
Salt-killed Tundra	85	11.0	15.0	avoid
Deep Open Water without Islands	8	1.0	3.5	avoid
Deep Open Water with Islands or Polygonized Margins	9	1.2	9.9	avoid
Shallow Open Water without Islands	0	0	0.2	ns
Shallow Open Water with Islands or Polygonized Margins	11	1.4	0.8	ns
River or Stream	0	0	<0.1	ns
Aquatic Sedge with Deep Polygons	224	28.9	12.4	prefer
Aquatic Grass Marsh	0	0	0.2	ns
Nonpatterned Wet Meadow	99	12.8	13.7	ns
Patterned Wet Meadow	304	39.3	23.5	prefer
Moist Sedge–Shrub Meadow	10	1.3	2.6	avoid
Riverine or Upland Shrub	2	0.3	1.1	avoid
Barrens	2	0.3	3.7	avoid
Total	774	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix I2. Habitat selection by nesting Greater White-fronted Geese in the NPRA search area, Alaska, 2003.

Habitat	No. of Nests	Use (%)	Availability (%)	Monte Carlo Results[a]
Deep Open Water without Islands	0	0	3.5	avoid
Deep Open Water with Islands or Polygonized Margins	0	0	3.4	avoid
Shallow Open Water without Islands	1	0.5	0.9	ns
Shallow Open Water with Islands or Polygonized Margins	1	0.5	4.9	avoid
River or Stream	0	0	<0.1	ns
Aquatic Sedge Marsh	1	0.5	4.0	avoid
Aquatic Grass Marsh	0	0.0	0.2	ns
Young Basin Wetland Complex	7	3.8	5.0	ns
Old Basin Wetland Complex	47	25.8	14.6	prefer
Riverine Complex	4	2.2	0.8	ns
Nonpatterned Wet Meadow	4	2.2	8.4	avoid
Patterned Wet Meadow	52	28.6	14.0	prefer
Moist Sedge–Shrub Meadow	36	19.8	17.8	ns
Moist Tussock Tundra	29	15.9	22.1	avoid
Riverine Low and Tall Shrub	0	0	0.3	ns
Riverine or Upland Shrub	0	0	<0.1	ns
Upland and Riverine Dwarf Shrub	0	0	0.1	ns
Total	182	100	100	

[a] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability

Appendix J. Habitat selection by arctic and red foxes for denning in the NPRA study area, Alaska, 2001–2003.

Habitat	Area[a] (km²)	No. of Dens	Use (%)	Availability[a] (%)	Monte Carlo Results[b]
Open Nearshore Water	0	–	–	0	–
Brackish Water	0	–	–	0	–
Tapped Lake with Low-water Connection	0	–	–	0	–
Tapped Lake with High-water Connection	0	–	–	0	–
Salt Marsh	3.65	1	2.7	0.7	ns
Tidal Flat	0	–	–	0	–
Salt-killed Tundra	0.14	0	0	<0.1	ns
Deep Open Water without Islands	0	–	–	0	–
Deep Open Water with Islands or Polygonized Margins	0	–	–	0	–
Shallow Open Water without Islands	0	–	–	0	–
Shallow Open Water with Islands or Polygonized Margins	0	–	–	0	–
River or Stream	0	–	–	0	–
Aquatic Sedge Marsh	0	–	–	0	–
Aquatic Sedge with Deep Polygons	0.30	0	0	<0.1	ns
Aquatic Grass Marsh	0	–	–	0	–
Young Basin Wetland Complex	2.52	0	0	0.5	ns
Old Basin Wetland Complex	61.18	2	5.4	11.0	ns
Riverine Complex	2.78	0	0	0.5	ns
Dune Complex	7.59	0	0	1.4	ns
Nonpatterned Wet Meadow	21.47	0	0	3.9	ns
Patterned Wet Meadow	78.86	5	13.5	14.2	ns
Moist Sedge–Shrub Meadow	161.55	12	32.4	29.0	ns
Moist Tussock Tundra	190.61	11	29.7	34.3	ns
Riverine Low and Tall Shrub	7.26	0	0	1.3	ns
Upland and Riverine Dwarf Shrub	8.97	5	13.5	1.6	prefer
Upland Low and Tall Shrub	2.80	1	2.7	0.5	ns
Barrens	6.84	0	0	1.2	ns
Total	556.51	37	100	100	

[a] Aquatic habitats were assigned zero availability for fox denning
[b] Significance calculated from 1,000 simulations at $\alpha = 0.05$; ns = not significant; prefer = use significantly greater than availability; avoid = use significantly less than availability