FINAL REPORT

# WILDLIFE STUDIES IN THE NORTHEAST PLANNING AREA OF THE NATIONAL PETROLEUM RESERVE–ALASKA, 2001


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PREPARED FOR

**PHILLIPS ALASKA, INC.**
ANCHORAGE, ALASKA

PREPARED BY

**ABR, INC.**
FAIRBANKS, ALASKA

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Prepared for


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August 2002


*Printed on recycled paper.*

# EXECUTIVE SUMMARY


Field surveys for selected birds and mammals were conducted in 2001 in the Northeast Planning Area of the National Petroleum Reserve–Alaska (NPRA), within a 615-km² study area located 6–39 km west of Nuiqsut and 6–43 km southwest of the Alpine Project. The surveys were designed to gather preconstruction baseline data on wildlife use of an area of potential future oil and gas development. The 2001 study area encompassed 6 exploration sites that were drilled in 1999–2001 and most of the sites that were proposed to be drilled by PHILLIPS Alaska, Inc. (PAI) in 2002. Similar surveys were conducted for PAI in this region of potential future development in 1999 (Anderson and Johnson 1999) and 2000 (Murphy and Stickney 2000), although study area boundaries differed among years in response to changes in future planned drilling locations and other factors. The wildlife studies in the NPRA were part of an overall baseline program, comprising investigations of fisheries, hydrology, geomorphology, water quality, air quality, archaeology and cultural resources, and oil spill planning.

Wildlife surveys in the NPRA Study Area were designed to provide baseline information on the distribution, abundance, and habitat use of 10 focal species: Spectacled Eider, King Eider, Tundra Swan, Brant, Yellow-billed Loon, Red-throated Loon, Glaucous Gull, caribou, and arctic and red foxes. 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).

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
- 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 – met with BLM Subsistence Advisory Panel concerning NPRA development and summer studies

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 NSB and Nuiqsut residents. On 8 May 2001, PAI held a science fair in Nuiqsut to discuss exploration and development in NPRA, as well as the environmental studies scheduled for 2001. On 9 May 2001, PAI 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. Doreen Nukapigak (KSOP) was a subsistence representative involved in our studies. In addition, PAI published "NPRA Update," a newsletter on NPRA activities, in the "Arctic Sounder" newspaper in December 2001. The newsletter discussed summer field studies, subsistence representatives and ice-road monitors, public meetings, and other information.

## LARGE WATERBIRD GROUND SEARCHES

Ground-based nest searches were conducted in 4 areas of the NPRA Study Area where Spectacled Eiders were seen during pre-nesting

and other aerial surveys in 2001. The total area searched was 6.2 km². Two Spectacled Eider nests and one probable Spectacled Eider nest were found, all in one ground-search area ~9 km north of the Spark 7 exploratory well site. Eight King Eider nests were found in 3 of the 4 ground-search areas. Altogether, nests of 14 species of large waterbirds were found in the ground-search areas. The most abundant nests belonged to Greater White-fronted Geese.

## BREEDING-BIRD PLOTS

A census of breeding birds was conducted on 24 10-ha plots in the NPRA Study Area. Plot locations were selected to represent a variety of avian habitat types. Each plot was visited 4 times between 12 June and 2 July at intervals of approximately one week. Overall, 172 nests of 20 species were found; among plots, nest densities ranged from 30 to 120 nests/km². The Lapland Longspur was the most common nesting bird and the only species that nested on every plot (49 nests total), followed by Semipalmated Sandpiper (28 nests), Pectoral Sandpiper (19 nests), and Long-billed Dowitcher (19 nests). Densities of nests in the NPRA Study Area were lower than on the adjacent Colville River delta.

## EIDER SURVEYS

Aerial surveys for pre-nesting eiders were conducted at 50% coverage of the NPRA Study Area during 11–12 June 2001. Fourteen Spectacled Eiders were seen in the study area. None were found at permitted or proposed exploration sites. The closest eider sighting to these sites was a pair of Spectacled Eiders ~1.5 km southeast of the proposed Mitre 1 exploration site. The density of Spectacled Eiders in the NPRA Study Area (0.04 indicated birds/km²) was about 50% of the density in the Kuparuk Oilfield and 25–33% of the density on the Colville River delta. The density of King Eiders in the NPRA Study Area was about 5 times greater than that of Spectacled Eiders.

## LOON SURVEYS

Aerial surveys for Yellow-billed Loon were conducted in the NPRA Study Area during nesting and brood-rearing on 26–27 June and 24 August 2001, respectively. On the nesting survey, 44 Yellow-billed Loons were seen and 19 nests were found; an additional 3 nests were found during ground surveys. Nests were concentrated in the northcentral part of the study area in lakes adjacent to Fish Creek. On the brood-rearing aerial survey, 47 adult Yellow-billed Loons and 5 broods (with 1 young each) were seen.

Ground surveys for nesting Red-throated Loons were conducted on 16 5.2-km² plots in the NPRA Study Area in 2001. Plot locations were randomly selected pairs of USGS square-mile sections (each plot comprised 2 adjacent sections). Plots were searched for nests during 28 June–3 July and 10–15 July 2001. Plots on which Red-throated Loons (nests or birds) were observed during nesting were surveyed for broods on 21 August. Six Red-throated Loon nests were found on 3 plots; all 6 nests and a single adult were within 2.4 km of Fish or Judy creek. Only one brood with one young was seen during the brood search. During the same search, 6 Yellow-billed Loon nests were found on 4 plots and 31 Pacific Loon nests were found on 15 plots.

## TUNDRA SWAN SURVEYS

Aerial surveys of the NPRA Study Area were conducted at 100% coverage for nesting swans on 19 June and for brood-rearing swans on 20 August 2001. During nesting, 133 adults and 21 nests were counted. During brood-rearing, we saw 140 adults and 16 broods (39 young). Nest density in the NPRA Study Area (0.03 nests/km²) was about the same as in the Kuparuk Oilfield but about half of that on the Colville River delta.

## GOOSE SURVEYS

Brant nesting colonies in the NPRA Study Area were surveyed on a lake-to-lake aerial survey on 18 June 2001. Seven colonies with 20 adults and 3 nests were observed inside the NPRA Study Area and an additional colony with 50 adults and 25 nests was observed < 1 mile north of the study area. Additional aerial surveys for all species of geese were conducted at 50% coverage of the NPRA Study Area during brood-rearing (25 July 2001) and fall staging (20 August 2001). On these 2 surveys, only Greater White-fronted Geese were seen in the study area: 508 geese were counted in

17 groups during brood-rearing and 620 geese were counted in 23 groups during fall staging.

## GULL AND TERN SURVEYS

Nesting gulls and terns were counted during ground surveys and also were recorded during the aerial survey for nesting Yellow-billed Loons. Thirty Glaucous Gull nests were found distributed throughout the NPRA Study Area; 22 nests were found on the aerial survey and 8 other nests were found during ground searches. Based on those counts, nest density for Glaucous Gulls was 0.05 nests/km² for the NPRA Study Area. Two nesting colonies of Sabine's Gulls were seen during aerial surveys, with at least 5 nests at each site. Seven other Sabine's Gull nests were found during ground searches. All 17 Sabine's Gull nests were located on islands in the western part of the study area. During ground searches, we found 27 Arctic Tern nests and 1 brood in the study area.

## CARIBOU SURVEYS

Twelve systematic aerial surveys (400-m and 800-m-wide strip transects spaced at 1.6- and 3.2-km intervals, depending on season, for sampling intensity of ~50%) were conducted in the NPRA Study Area between 20 May and 24 October 2001, covering the period from precalving through calving, the insect harassment season, late summer, and fall, including rut. The density of caribou varied widely among season, ranging from lows in August (0.02–0.30 caribou/km²) to a high in mid-October (1.73 caribou/km²). The estimated number of caribou using the survey area ranged from a low of ~20 animals in early August to highs of ~1,400 in late June, ~1,300 in mid-July, ~1,400 in late September, and ~1,700 in mid-October. The area was little used for calving, based on 2 calving surveys in June (total density 0.26–0.97 caribou/km²) and a sex- and age-composition survey on 15 June (~7 calves:100 cows). The study area is used primarily by caribou of the Teshekpuk Lake Herd, but a large proportion of the Central Arctic Herd moved west across the Colville River and far west into NPRA in late July in an unusual movement of unprecedented magnitude.

## FOX DEN SURVEYS

Aerial survey by helicopter (~15 hr total effort on 1–2 July and 12 July 2001) was the principal method used to locate dens of arctic and red foxes, intensively covering 85% (524 km²) of the study area; more search effort will be expended in future years to complete the survey. Four dens were found by avian nest-search crews. Both active and inactive sites were located, totaling 23 arctic fox dens and 1 red fox den. Sites judged to be active were observed on 12, 14, and 16 July, totaling ~24 observation hr. Five arctic fox dens (22% of the total) were confirmed or suspected to be natal sites in 2001, but the single red fox den was inactive. Nine arctic fox pups were observed at 3 of the natal dens, for a mean litter size of 3 pups, so it is estimated that ~15 arctic fox pups may have been produced at the 5 active dens in the study area in 2001.

## OTHER MAMMALS

A single group of muskoxen numbering 5–6 adults (no calves) was seen 5 times during 9–27 June, as it moved slowly eastward through the southern half of the study area. Grizzly bears were seen 4 times in the study area and 3 times nearby (outside the area); grizzlies were observed more commonly in or near riparian habitats along Fish and Judy creeks. Two of the 7 sightings were of females with cubs. Three winter dens used by grizzly bears in recent years were found in the study area, but no polar bear dens have yet been reported in the study area. A single adult wolverine was seen in the southwestern part of the study area in late September.

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**ACKNOWLEDGMENTS**

The NPRA studies required the combined effort of a large number of people in the field and office. Sally Andersen, Renee Crain, Melissa Cunningham, Cathy Egan, J.J. Frost, Jackie Hrabok, Beth Hahn, Mark Hopey, Mike Knoche, Pat Lovely, Matt Macander, Randy Mullen, Steve Murphy, Julie Neville, Jason Ontjes, Lincoln Parrett, Julie Petersen, Alex Prichard, Bob Ritchie, John Rose, Una Swain, Teresa Troyer, and Rich Young spent many hours on the tundra or in aircraft collecting data. We thank our pilots Sandy Hamilton and Jay Martin, Arctic Alaska Air, for keeping our aerial surveys on track, and our expeditor Doris Armijo for her logistical talents. Will Lentz, Allison Zusi-Cobb, and Tai Graham provided GIS expertise to transform our field data into clear maps depicting a multitude of wildlife observations. Our reviewer, Betty Anderson, provided valuable input for the final report. Finally, the authors would like to acknowledge Caryn Rea for her assistance in designing this study and thank all the other PHILLIPS staff and contractors in the Alpine and Kuparuk oilfields whose support was crucial to the success of theses environmental studies.

## INTRODUCTION

During 2001, ABR, Inc., conducted wildlife surveys for selected birds and mammals in a portion of the Northeast Planning Area of the National Petroleum Reserve–Alaska (NPRA), which was opened for oil and gas leasing in 1999 after completion of an Integrated Activity Plan and EIS (BLM 1998). These surveys were designed to gather baseline data on wildlife use in areas that PHILLIPS Alaska, Inc. (PAI) currently views as potential future oil and gas development sites within the Northeast Planning Area. The 2001 NPRA Study Area encompassed the 6 exploration sites that were drilled in 1999–2001 (Figure 1) and also encompassed most of the sites tentatively proposed for drilling by PAI in 2002. This report summarizes information on wildlife resources in the study area, hereafter referred to as the NPRA Study Area.

As part of long-term monitoring of wildlife species in the Kuparuk Oilfield and surrounding new developments, ARCO Alaska and PAI have studied the distribution, abundance, and productivity of Spectacled Eiders (scientific names are listed in Appendix A), Tundra Swans, other waterbirds, caribou, and arctic foxes over large areas of the central Arctic Coastal Plain since the early 1980s (see Murphy and Anderson 1993, Stickney et al. 1993, Anderson et al. 2001, Johnson et al. 2001, Lawhead and Prichard 2002). As development plans expanded westward, wildlife survey areas also have expanded to evaluate pre-development, construction, and operations impacts of oil development on wildlife populations (Smith et al. 1994; Johnson et al. 1999, 2000a, 2000b, 2001; Burgess et al. 2000). The wildlife studies in the NPRA were part of an overall baseline program, comprising investigations of fisheries, hydrology, geomorphology, water quality, air quality, archaeology and cultural resources, and oil spill planning.

ARCO Alaska, Inc. (ARCO) purchased leases in the NPRA in 1999. In summer 1999, in preparation for exploration activities in the Northeast Planning Area of NPRA during winter 1999–2000, ARCO initiated avian studies to evaluate the distribution and abundance of important breeding species in the vicinity of the lease blocks (Anderson and Johnson 1999). In 1999, aerial surveys for waterfowl were conducted in blocks containing proposed exploration sites, and ground searches for eider nests were conducted where Spectacled Eiders were seen on pre-nesting aerial surveys. Eiders and Tundra Swans were selected as the focal species of these surveys because of their special status (threatened status for Spectacled and Steller's eiders) or their interest to management agencies (Tundra Swans).

Prior to the exploration program in winter 2000–2001, PAI purchased ARCO's Alaska assets in the area and requested that additional sites in NPRA be surveyed during summers 2000 (Murphy and Stickney 2000) and 2001 (Johnson and Stickney 2001). In 2000, aerial surveys for eiders and Tundra Swans again were conducted in blocks that included the proposed exploration sites, but (in accordance with BLM permit guidelines) ground searches for nests were conducted only in the immediate vicinity (~40 acres) of proposed exploration sites. Surveys for eiders and swans were continued in 2001 in a broad area referred to as the NPRA exploration survey area (1,022 $km^2$), which encompassed all additional exploration drill sites (Johnson and Stickney 2001). In 2001, aerial surveys for other waterbird species (see below) and mammals were initiated in the NPRA Study Area (615 $km^2$, the study area for this report), which lies entirely within the boundary of the exploration survey area. The avian surveys in the exploration survey area were conducted to support exploration permit applications. We report here the results of the aerial surveys for eiders and swans, as well as the results for other selected species of waterbirds and mammals within the NPRA Study Area. In addition to aerial surveys in 2001, ground searches for nests and broods were conducted on 3 types of plots that were distributed throughout the NPRA Study Area: ground-search areas, breeding-bird plots, and Red-throated Loon plots.

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

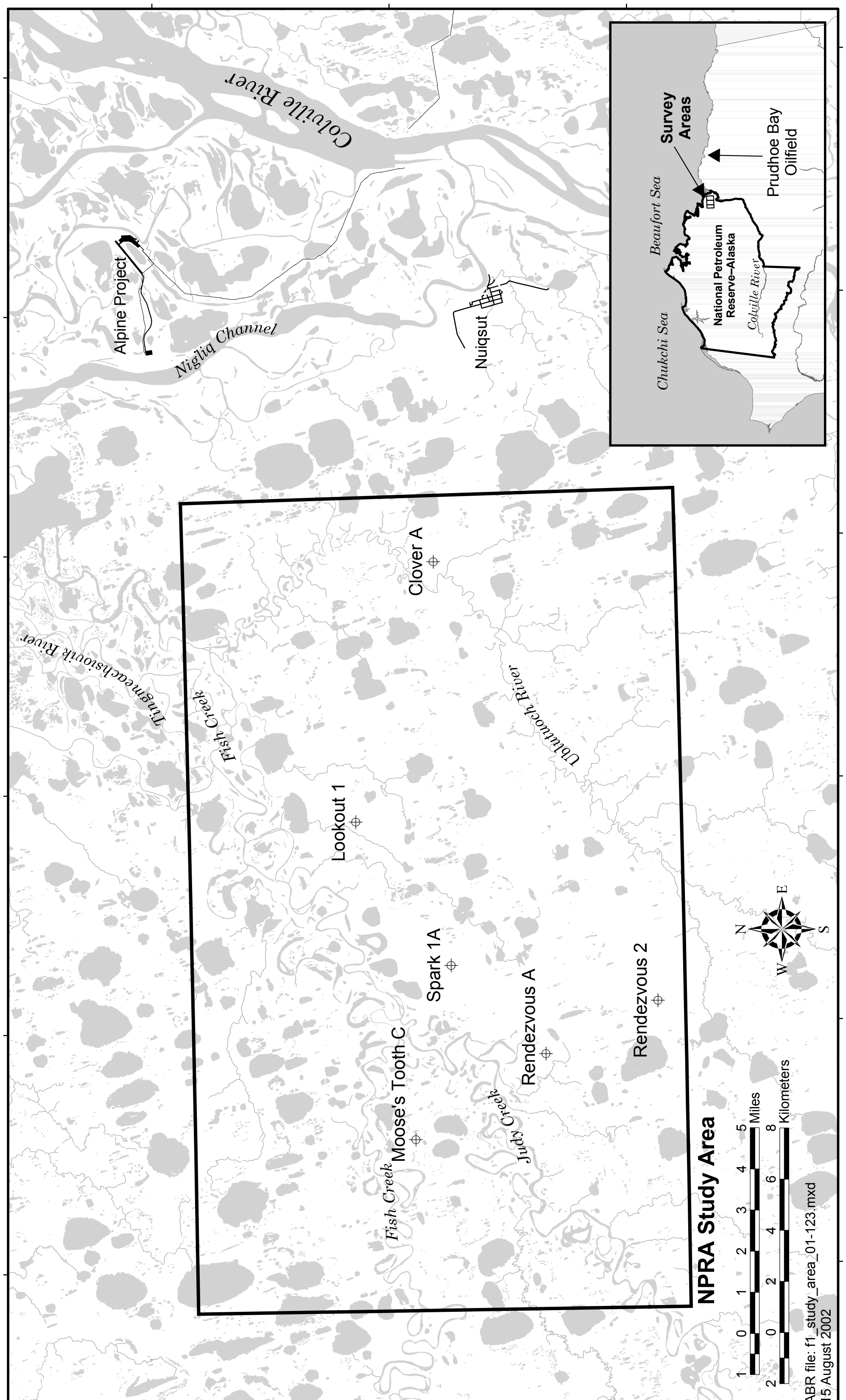


Figure 1. Boundaries of the NPRA Study Area and locations of exploratory well sites drilled in the northeastern planning area of the National Petroleum Reserve–Alaska in 2001.

- 8 May 2001 – met with the Kuukpik Subsistence Oversight Panel (KSOP) in Nuiqsut to discuss NPRA exploration and pre–development baseline study program
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Surveys in the NPRA Study Area in 2001 were designed to provide baseline information on the distribution, abundance, and habitat use of 10 focal species (Tables 1 and 2): Spectacled Eider, King Eider, Tundra Swan, Brant, Yellow-billed Loon, Red-throated Loon, Glaucous Gull, caribou, and arctic and red foxes. 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). The following criteria were used to select the focal species and groups: (1) threatened or sensitive status (Spectacled Eider); (2) suspected to have declining populations (King Eider and Red-throated Loon); (3) restricted breeding range (Yellow-billed Loon); (4) concern of regulatory agencies for development impacts (Brant, Tundra Swan, shorebirds, and passerines); (5) nest predators (foxes and Glaucous Gull), or (6) subsistence species (caribou and geese). During surveys, information was collected opportunistically on Pacific Loons, Steller’s Eiders, Sabine’s Gulls, Arctic Terns, muskoxen, grizzly bears, and other mammals.

Six specific objectives were identified for wildlife surveys in the NPRA Study Area in 2001:

- describe the distribution, abundance, and productivity of selected species of waterfowl, loons, and gulls;
- calculate nest density and determine habitat associations of shorebirds and passerines in representative portions of the study area;
- describe the distribution and abundance of caribou during the calving season, post-calving period (including the insect-harassment season), and late summer through early winter;
- document the distribution, abundance, and occupancy of fox dens and the production of young foxes;
- record the locations and numbers of muskoxen, grizzly bears, and other mammals encountered opportunistically during surveys; and
- gather information for future evaluations of habitat use and preferences of key wildlife species in the study area.

Table 1. Descriptions of avian surveys conducted in the NPRA Study Area, 2001.

| AREA SURVEYED<br>Survey Type | Season | Dates | Aircraft[a] | Transect Width (km) | Transect Spacing (km) | Aircraft Altitude (m) | Notes |
|---|---|---|---|---|---|---|---|
| NPRA GROUND-SEARCH AREAS | | | | | | | |
| Large Waterbird Ground Searches[b] | Nesting | 17–25 June | - | - | - | - | 4 ground-search areas (6.2 km²) |
| BREEDING-BIRD PLOTS | | | | | | | |
| Breeding-bird Ground Searches[c] | Nesting | 7 June–2 July | - | - | - | - | 24 breeding-bird plots (2.4 km²) |
| RED-THROATED LOON PLOTS | | | | | | | |
| Large Waterbird Ground Searches[b] | Nesting | 28 June–15 July | - | - | - | - | 16 plots (shoreline areas searched) |
| | Brood-rearing | 21 August | - | - | - | - | Revisit plots with known Red-throated Loon nests |
| NPRA STUDY AREA | | | | | | | |
| Eider Survey | Pre-nesting | 11–12 June | C185 | 0.4 | 0.8 | 30–35 | 50% coverage |
| Yellow-billed Loon Survey[d] | Nesting | 26–27 June | 206L | - | - | 60 | All lakes ≥10 ha |
| | Brood-rearing | 24 August | 206L | - | - | 60 | Lakes with known Yellow-billed Loon nests |
| Tundra Swan Survey | Nesting | 19 June | C185 | 1.6 | 1.6 | 150 | 100% coverage |
| | Brood-rearing | 20 August | C185 | 1.6 | 1.6 | 150 | 100% coverage |
| Brant Survey | Nesting | 18 June | 206L | - | - | 60 | Lake-to-lake survey |
| Goose Survey | Brood-rearing | 25 July | C185 | 0.8 | 1.6 | 90 | 50% coverage |
| | Fall staging | 20 August | C185 | 0.8 | 1.6 | 90 | 50% coverage |

[a] Dash indicates ground search, no aircraft used. C185 = Cessna 185 fixed-wing airplane; PA18 = Piper "Super Cub" fixed-wing airplane; 206L = Bell "Long Ranger" helicopter.
[b] Nest searches included loons and grebes, waterfowl, gulls, terns, jaegers, ptarmigan, and large shorebirds (Whimbrel and Bar-tailed Godwit).
[c] Nest searches included all species, but plot design targeted shorebirds and passerines.
[d] Glaucous Gull nests also were surveyed during both nesting and brood-rearing surveys for Yellow-billed Loons. Pacific and Red-throated loons and colonies of Sabine's Gulls were recorded incidentally.

Table 2. Descriptions of mammal surveys conducted in the NPRA Study Area, Alaska, 2001.

| Survey Type | Season | Date | Aircraft [a] | No. of Transects | Transect Width (km) | Transect Spacing (km) | Aircraft Altitude (ft) | Area Sampled ($km^2$) |
|---|---|---|---|---|---|---|---|---|
| Caribou Strip-transect Surveys | Precalving | 20 May | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| | Calving | 9 June | C206 | 23 | 0.8 | 1.6 | 300 | 473.8 |
| | Calving | 17 June | C206 | 23 | 0.8 | 1.6 | 300 | 473.8 |
| | Postcalving | 23 June | C206 | 23 | 0.8 | 1.6 | 300 | 473.8 |
| | Insect season | 12 July | C206 | 11 | 1.6 | 3.2 | 500 | 453.2 |
| | Insect season | 23 July | C206 | 11 | 1.6 | 3.2 | 500 | 453.2 |
| | Insect season | 4 August | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| | Late summer | 14 August | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| | Fall | 28–30 August | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| | Fall | 29 September | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| | Fall (rut) | 12 October | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| | Fall (postrut) | 24 October | C206 | 12 | 1.6 | 3.2 | 500 | 494.4 |
| Caribou Composition Count | Calving | 15 June | 206B | – | – | – | 100–200 | – |
| Fox Den Search & Status Check | Denning | 1–2, 12 July | 206B | – | – | – | 200–300 | – |
| Fox Den Observations (pup counts) | Denning | 12, 14, 16 July | 206B, 206L | – | – | – | – | – |

[a] C206 = Cessna 206 airplane; 206B = Bell "Jet Ranger" helicopter; 206L = Bell "Long Ranger" helicopter. Den observations relied on helicopter access.

## STUDY AREA

The NPRA Study Area (615 km²) encompassed 6 exploratory sites that were drilled during winter 2000–2001: Clover A, Lookout 1, Spark 1A, Rendezvous A, Rendezvous 2, and Moose's Tooth C (Figure 1). The area surveyed is located in the northeastern section of the NPRA, 6–39 km west of the village of Nuiqsut and 6–43 km southwest of the Alpine Study Area.

Landforms, vegetation, and wildlife habitats in the northeastern NPRA were described in the recent Environmental Impact Statement for the lease area (BLM 1998) and are similar to those of the western Kuparuk Oilfield and the Alpine Transportation Corridor (Johnson et al. 1997, Jorgenson et al. 1997). Landforms in the northeastern section of the NPRA are predominantly associated with the development of oriented thaw lakes in ice-rich terrain and with meandering floodplains along small rivers (BLM 1998). Vegetative cover within the northeastern NPRA has been analyzed by satellite imagery (Landsat TM). Large-scale cover classes include water, aquatic (*Carex* or *Arctophila* dominant), flooded tundra (nonpatterned, low-centered polygons), wet tundra, moist tundra (sedge/grass meadow, tussock tundra, moss/lichen), shrub (dwarf, low, tall), and barren ground (sparsely vegetated, dunes/dry sand, other) (BLM 1998). An ecological land survey is currently in progress and will be reported under separate cover (Jorgenson et al., in prep.). That effort will provide maps of wildlife habitat for use in a more detailed evaluation of habitat use and wildlife distribution in the area.

The climate of the northeastern NPRA is typical of other coastal areas in the Arctic. Winters are cold and summers are cool; 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). Mean summer precipitation is under 7.5 cm (3 in), 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 0–10º C (32–50º F) during the growing season.

## METHODS

### LARGE WATERBIRD GROUND SEARCHES

Ground-search areas comprised wetland basins where Spectacled Eiders were sighted during aerial surveys for pre-nesting eiders and nesting Brant (see following sections). Each ground-search area comprised an entire wetland basin. Basin wetland complexes were the primary habitat used by pre-nesting eiders in the Kuparuk Oilfield (Anderson et al. 2001), which has similar habitat features to the NPRA Study Area.

Nest searches were conducted between 17 and 25 June 2001 in 4 ground-search areas ranging in size from 0.3 to 2.2 km² (Figure 2). A team of 3–6 people systematically searched each area by walking zig-zag paths with ~10-m spacing between observers. Observers recorded nests of all waterfowl, loons, gulls, terns, jaegers, large shorebirds (godwits, Whimbrels), and ptarmigan. Locations of all bird nests found were marked on aerial photos; coordinates also were determined for some nests with a GPS receiver. Habitat information was recorded at each waterbird nest, including distance to waterbody, waterbody class, habitat type, and landform and vegetation at the nest site.

Observers attempted to not flush incubating birds from nests, but when a bird was flushed, the observer counted the eggs and covered them with down or vegetation before leaving the nest site. If a nest was unattended and could not be identified to species, samples of down and feathers (as well as egg measurements) were collected from the nest. Such nests subsequently were identified to species (when possible) by 10 waterfowl biologists, who compared the down and feather samples and egg measurements with samples from known nests. Nests receiving ≥75% agreement among experts were assigned to that species with the modifier "probable." Other nests retained the designation "unidentified."

Eider nests (King or Spectacled eiders) found in the ground-search areas were revisited on 17 July after hatching to assess nest success. Nests were classified as successful if thickened egg membranes that had detached from the shell were found in the nest bowl.

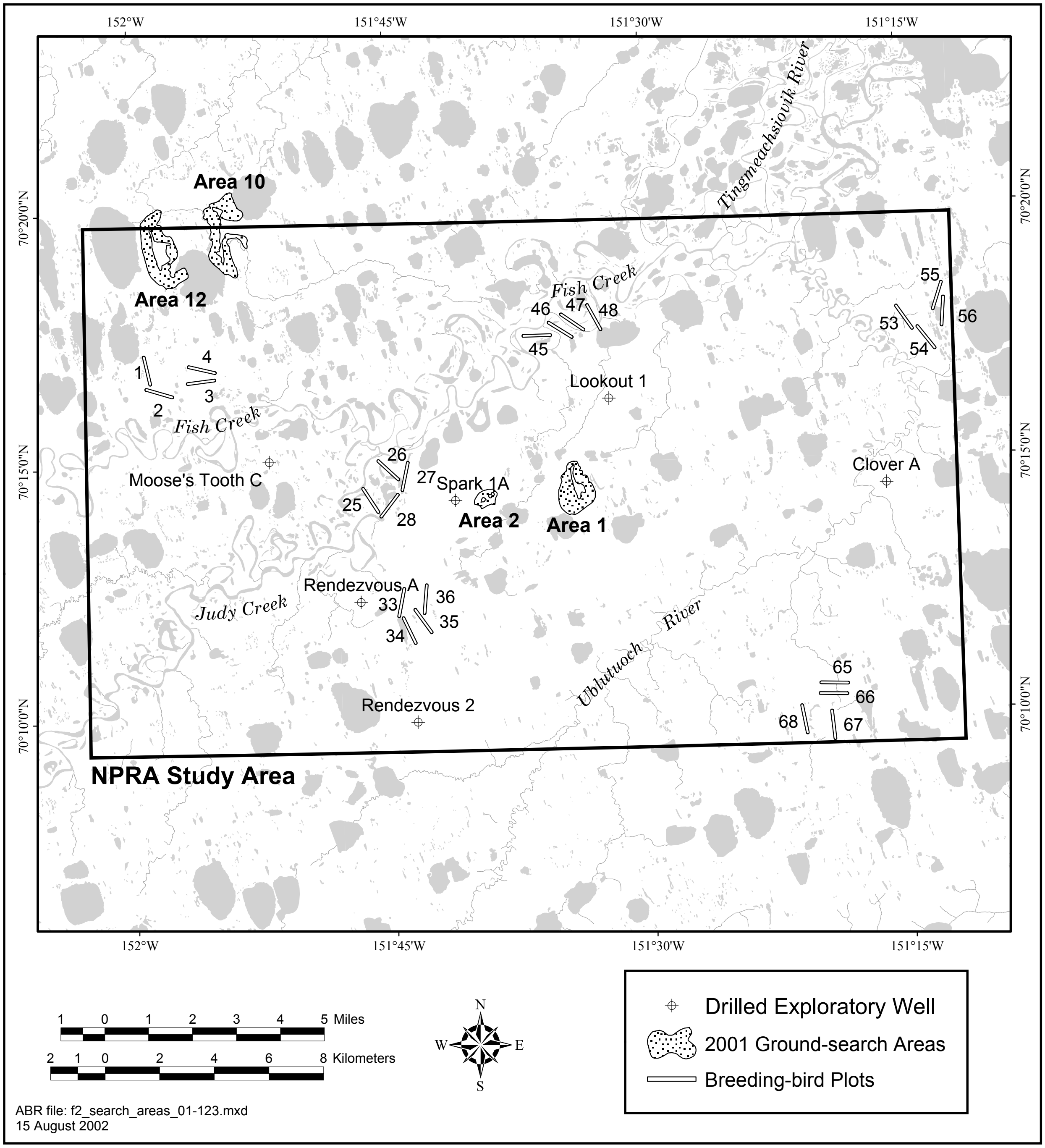


Figure 2. Ground-search areas (4) and breeding-bird plots (24), NPRA Study Area, Alaska, 2001.

## BREEDING-BIRD PLOTS

In June 2001, 24 breeding-bird plots were established in representative habitats in the NPRA Study Area to determine nest densities and habitat associations of tundra-nesting birds (Figure 3, Appendix B). Breeding-bird plots were arranged in 6 clusters of 4 plots each (Figure 2). Each cluster of plots was located to sample representative habitats (as portrayed on the BLM cover map [Ducks Unlimited Inc 1998]) in each of 3 general areas: the Fish and Judy creek floodplain, north of Fish Creek, and south of Judy Creek.

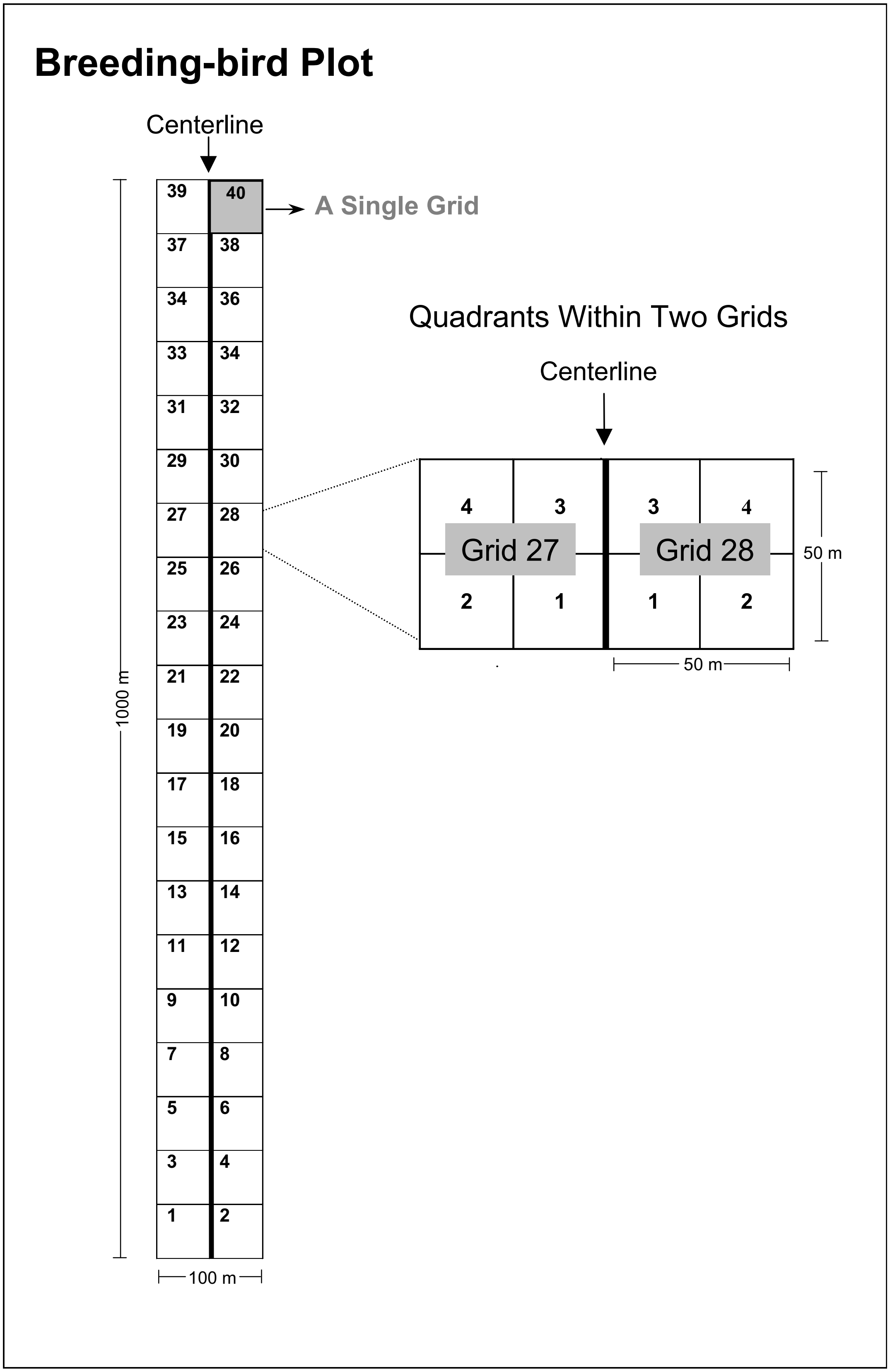


Figure 3. Typical breeding-bird plot grid system used in the NPRA Study Area, Alaska, 2001.

Breeding-bird plots measured 100 m x 1000 m (0.1 km² [10 ha]) and were marked with 1 row of survey lath that delineated 50 m x 50 m grids (40 grids/plot) (Figure 3). Each grid was subdivided into 4 quadrants. Plots were visited 4 times after set-up, with approximately 1 week between visits. Plot set-up occurred 7–11 June, and sampling occurred 12 June–2 July. On the first and third visits, 2 people dragged a 53-m rope through each plot to flush birds from their nests. During the second and fourth visits, one person walked a "W" pattern through each plot. If a bird flushed and the nest was not immediately located, the observer moved farther away or used nearby terrain features as cover until the bird returned and the nest could be located.

For each nest found, the observer recorded the species, the number of birds present, the number of eggs or young, the surface form (e.g., polygon rim or center, island, nonpatterned) and habitat at the nest, and its location by grid number, distance from centerline, and quadrant within the grid (Figure 3). Known nests were checked on subsequent visits to monitor egg loss, hatching, and fledging. To assist in locating known nests, a small orange marker (~2.5 x 15 cm) was placed in the ground on the plot centerline perpendicular to the nest and a white marker (~1 x 10 cm) was placed 1 m from the nest toward the plot centerline. Each centerline marker was labeled in indelible ink indicating the perpendicular distance to the nest location. White markers were placed low in vegetation so that they were visible when walking from the centerline, but concealed from other directions.

## EIDER SURVEYS

One aerial survey for pre-nesting eiders was conducted on 11–12 June 2001. Methods were similar to those used previously in NPRA (Anderson and Johnson 1999, Murphy and Stickney 2000) and on the Colville delta (Johnson et al. 2000a), except coverage was 50% that of the earlier surveys. During the survey, the pilot navigated a Cessna 185 aircraft along east–west transect lines using a GPS receiver. An observer on each side of the aircraft counted eiders in fixed-width strips (200 m) on each side of the transect line. Transect lines were spaced 800 m apart for 50% coverage of the study area (Figure 4). Observers used marks on the airplane's struts and windows to visually delimit the outer edges of the transect strip (Pennycuick and Western 1972). Flight altitude for each survey was 30–35 m above ground level (agl) and flight speed was approximately 145 km/h.

For each eider group location, observers noted on tape recorders the species of eider, number of each sex, number of identifiable pairs, transect number, and whether the birds were flying or on the ground. Each observer also marked their eider locations on 1:63,360 USGS maps of the study area. All observations were digitized and added to a geographical information system (GIS) database.

Densities were calculated based on the actual number of birds observed and the total area covered during the survey. Total indicated birds was calculated by the procedures of the U.S. Fish and Wildlife Service (USFWS) survey protocol (USFWS 1987a) and a second estimate of density was calculated based on the total indicated birds.

To evaluate the potential for nesting by Spectacled Eiders in the study area, 4 ground-searches (in which all large waterbird nests were censused) were conducted in wetland basins where eiders were observed during the pre-nesting survey. Search methods were similar to those used on the Colville River delta (Johnson et al. 2000b) and are presented above (under Large Waterbird Ground Searches). The boundaries of each ground-search area were the natural borders of wetland basins.

## LOON SURVEYS

Aerial surveys for nesting Yellow-billed Loons were conducted on 26–27 June 2001 and for brood-rearing loons on 24 August 2001. The nesting survey was conducted in a helicopter flying a lake-to-lake pattern that covered all lakes ≥10 ha in size (typical nesting lakes for Yellow-billed Loons [Sjolander and Agren 1976, North and Ryan 1989]) and adjacent smaller lakes (Figure 5). Tapped lakes with low-water connections to river channels were excluded, as Yellow-billed Loons are not known to use such lakes for nesting (North 1986, Johnson et al. 2000b). During the brood-rearing survey, we surveyed only lakes where Yellow-billed Loons were observed during the nesting survey. Observations of Pacific and

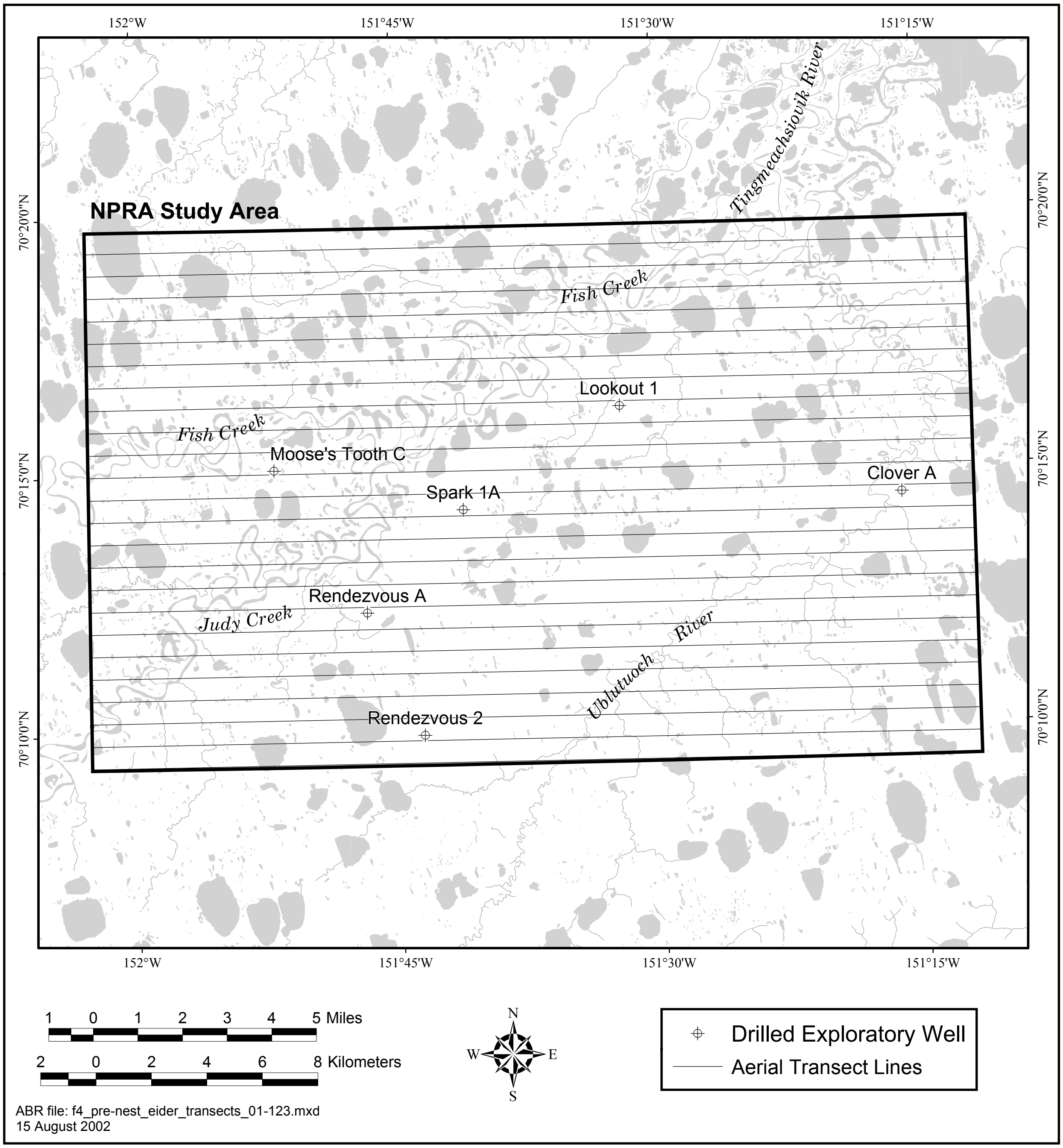


Figure 4. Transect lines for pre-nesting eider aerial surveys, NPRA Study Area, Alaska, 11–12 June 2001.

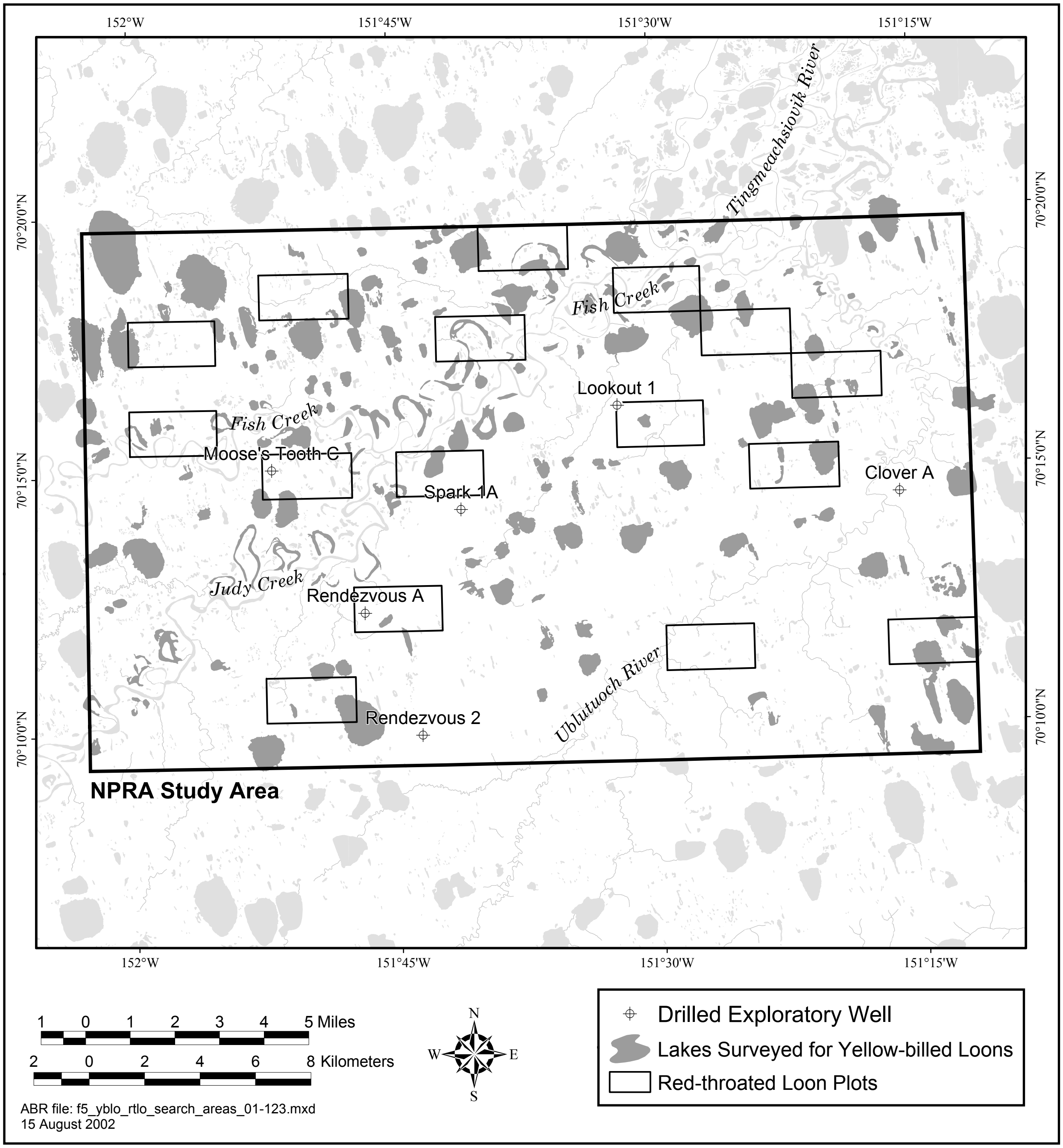


Figure 5. Lakes included in the aerial survey for nesting Yellow-billed Loons and Red-throated Loon plot locations, NPRA Study Area, Alaska, 2001.

Red-throated loons were recorded incidentally. Loon locations were recorded on 1:63,360-scale USGS maps.

The aerial survey was not suitable for determining the density of Red-throated Loons because smaller lakes are used by this species and because their nests are not easily detected from the air. Therefore, we conducted ground searches for Red-throated Loon nests on 16 plots in the NPRA Study Area (Figure 5). Each plot measured 1.6 × 3.2 km (5.2 km²) and comprised a pair of USGS sections. Initially, 25 plots were selected randomly from a 1:63,360-scale USGS map, but, due to logistical constraints, the 16 plots searched were subjectively selected to be representative of 3 local terrains: the Fish and Judy creek floodplain, north of Fish Creek, and south of Judy Creek (as portrayed on the BLM cover map [Ducks Unlimited Inc. 1998]). During 2 sample periods, 28 June–3 July and 10–15 July 2001, 2 observers searched for nests of loons, waterfowl, predatory birds, and ptarmigan by walking the edge of every waterbody within the plot and part or all of the waterbodies (extent depended on waterbody size) that fell on the plot boundary. Observers used aerial photos, 1:63,360-scale USGS maps, and GPS units to locate plot boundaries. Locations of nests were marked on aerial photos and coordinates stored in GPS units. We searched for broods of Red-throated Loons on 21 August only in plots where Red-throated Loons or their nests were found during the nesting survey.

From the aerial surveys, we calculated the total number of adults, nests, broods, and young by season for all species of loons and density of Yellow-billed Loon adults, nests, and broods (coverage was not adequate to calculate densities for other species). From the ground-based plot searches, we calculated the total number of adults, nests, broods, and young for all species (loons, waterfowl, gulls, terns, jaegers, and ptarmigan); nest density of loons, gulls, and terns; and brood density of Red-throated Loons.

## TUNDRA SWAN SURVEYS

Aerial surveys for Tundra Swans followed the USFWS Tundra Swan Survey Protocol (USFWS 1987b, 1991) and these methods were identical to those used previously in NPRA (Anderson and Johnson 1999, Murphy and Stickney 2000), in the Kuparuk Oilfield (Ritchie et al. 1990, 1991; Stickney et al. 1992, 1993, 1994; Anderson et al. 1995, 1996, 1997, 1998, 1999, 2000, 2001), and on the Colville River delta (Smith et al. 1993, 1994; Johnson et al. 1996, 1997, 1998, 1999, 2000a).

Tundra Swan aerial surveys were conducted in a Cessna 185 aircraft flying along fixed-width, east–west transects. Transects were oriented along township and section lines. Air speed was 145 km/h and altitude was 150 m agl. Each of 2 observers scanned an 800-m wide strip on their side of the aircraft, yielding 100% coverage, while the pilot navigated and scanned ahead of the aircraft. The age (adult or young) and number of swans seen and whether the adults were attending a nest or with a brood were recorded on 1:63,360-scale USGS maps. When observers located a nest, the aircraft left the transect line and circled the nest so that they could plot an accurate location and take photographs of the nest site with a 35-mm camera. During the brood-rearing survey, we used an identical procedure for recording data but did not circle or photograph broods.

The Tundra Swan nesting survey was flown on 19 June 2001 and the brood-rearing survey was flown on 20 August 2001. All observations were digitized and added to a GIS database. Summary statistics for nesting surveys followed the format established for the Kuparuk Oilfield in 1988 and modified in 1990 (Ritchie et al. 1989, 1991), which categorizes adults as either with nests or broods or without nests or broods. The latter 2 categories include nonbreeding subadults, as well as failed or nonbreeding adults. These individuals will be referred to collectively as "nonbreeders."

## GOOSE SURVEYS

The aerial survey for nesting Brant followed similar flight patterns used for surveys of Brant from the Sagavanirktok River to the Colville River between 1989 and 1998 (Ritchie et al. 1990, Anderson et al. 1999). Using a Bell 206L helicopter and 2 observers, 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 6). Flight altitude for each survey was 60 m agl and flight speed was approximately 105 km/h. The survey was conducted on 18 June 2001. Nests were recorded wherever a down-filled bowl or an adult in incubation posture was sighted, and nests were mapped on 1:63,360-scale USGS maps. 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. In addition, other species such as eiders, Canada Geese, and swans were recorded incidentally during the survey, although the nests

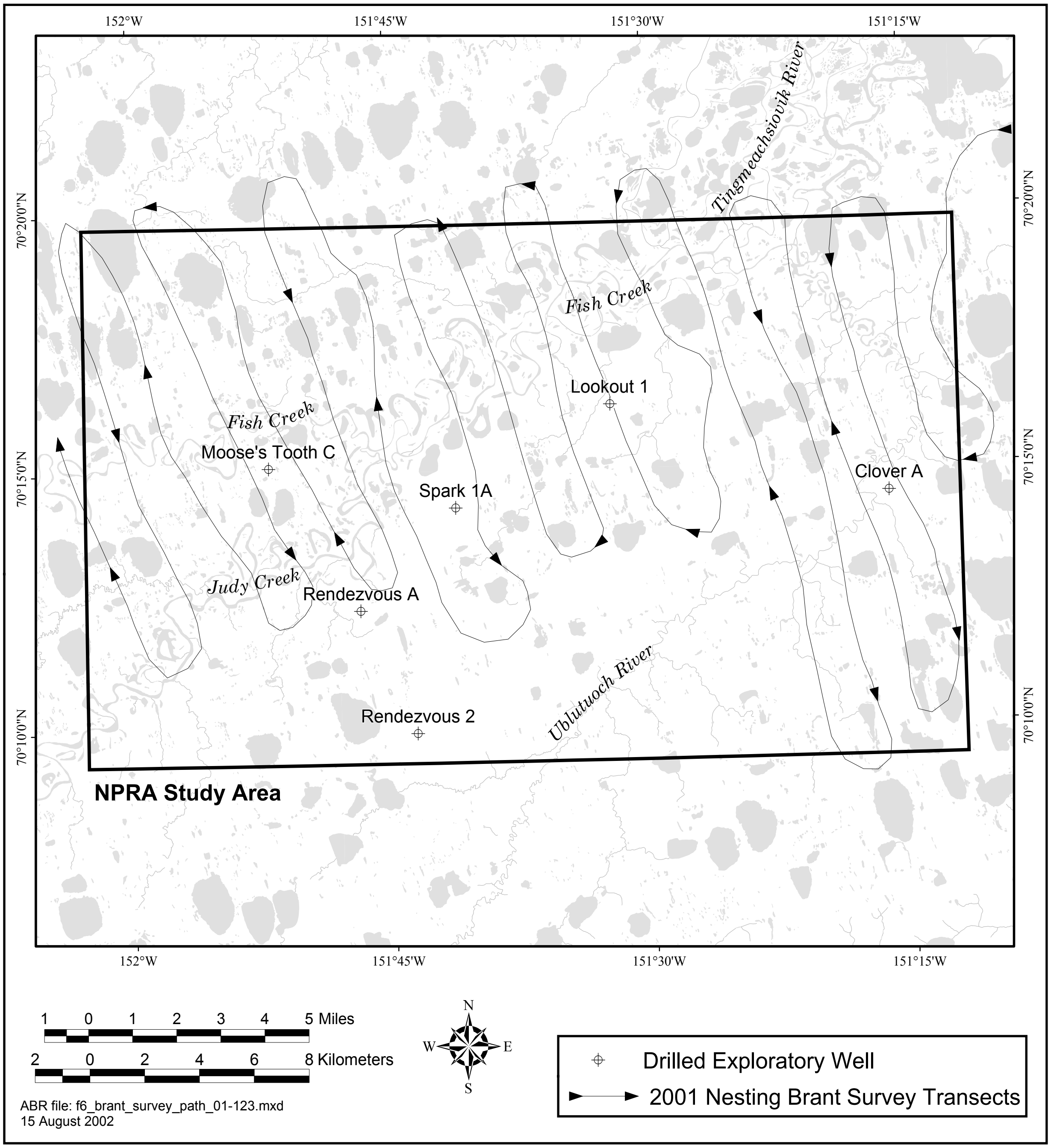


Figure 6. Flight path for the nesting Brant aerial survey, NPRA Study Area, Alaska, 18 June 2001.

of all but swans are also difficult to see from the air.

For all species of geese, systematic aerial surveys were conducted during the brood-rearing and fall-staging seasons. These surveys were flown in a Cessna 185 aircraft at 90 m agl on east-west flight lines that were 1.6 km apart, similar to those for the Tundra Swan surveys. Two observers searched a 400-m-wide strip, one on each side of the plane, yielding 50% coverage of the survey area. The brood-rearing survey was conducted on 25 July 2001 and the fall-staging survey on 20 August 2001. During these surveys, we recorded species, numbers of adults and young, and their locations on 1:63,360-scale USGS maps. All observations were digitized and added to a GIS database.

## GULL SURVEYS

Glaucous Gulls nests and broods were recorded during the nesting and brood-rearing aerial surveys of Yellow-billed Loons in the NPRA Study Area (see Loon Surveys). All Glaucous Gull nests and broods were recorded on 1:63,360-scale USGS maps. Colonies of Sabine's Gulls also were recorded and the number of nests at each colony was estimated (Sabine's Gull nests are difficult to confirm in aerial surveys).

Additional information on the abundance of gulls and Arctic Terns was obtained from results of the various ground-searches. During ground searches on breeding-bird plots, Red-throated Loon plots, and in ground-search areas, nest locations of Glaucous Gulls, Sabine's Gulls, and Arctic Terns were recorded on aerial photos and/or the coordinates stored in GPS units.

## CARIBOU SURVEYS

### AERIAL SURVEYS

Twelve aerial surveys of the NPRA Study Area were conducted in 2001, beginning on 20 May and ending on 24 October (Table 2). Surveys were flown along north–south-oriented transect lines that were 26 km (16 mi) long, in a survey area located between 70.113° and 70.343° N latitude and 151.243° and 152.176° W longitude. Thus, the caribou survey transects encompassed a somewhat larger area (952.8 km$^2$) than the NPRA Study Area described earlier.

All surveys were conducted with 2 observers viewing from opposite sides of a Cessna 206 airplane. During each survey, the pilot navigated along the transect lines using endpoint coordinates programmed into a Global Positioning System (GPS) receiver. On the surveys before (20 May) and after (July through August) complete snowmelt, the pilot maintained an altitude of 150 m agl using a radar altimeter; the same altitude was used in September and October after the new seasonal snow cover became established. On the calving season surveys (9 June and 23 June), when visibility was generally low due to patchy snow cover and when calves were small, the survey altitude was 90 m agl.

Transect lines were spaced at intervals of 1.6 km for the 90-m altitude and at 3.2 km for the 150-m altitude surveys, following section lines on USGS topographic maps (scale 1:63,360). Observers counted caribou within a 400-m-wide strip on each side of the transect centerline when flying at 90 m and within an 800-m-wide strip when flying at 150 m. Thus, the sampling intensity was ~50% of the area (0.8 km of each 1.6 km and 1.6 km of each 3.2 km) at each altitude. 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 a caribou group was observed within the transect strip, the location on the transect centerline was recorded using a GPS receiver, the numbers of adults and calves were recorded, and the distance was estimated to the nearest 100 m (for 400 m transects) or 200 m (for 800 m transects). For plotting on maps, the group location was shifted perpendicularly off the transect centerline to the midpoint of the appropriate distance interval (e.g., 250 m for the 200–300 m interval). Thus, the mapping error is ≤50 m for the calving surveys and ≤100 m for the other surveys.

### COMPOSITION COUNT

We used a Bell 206B "Jet Ranger" turbine helicopter to sample the sex and age composition of caribou (adult cows, calves, yearlings, adult bulls, or unclassified) in and near the study area on 15 June 2001. Helicopter speed ranged from 40 to 100 km/h and altitude ranged from 30 to 60 m agl to allow accurate identification of sex and age classes. A nonsystematic survey path was followed on this survey to maximize the number of groups encountered and a GPS receiver was used to avoid duplicate counts. Two observers sampled independently and a third observer recorded the data.

## FOX SURVEYS

We used aerial and ground-based surveys to evaluate the distribution and status of arctic and red fox dens in the NPRA Study Area in 2001, applying the same methods used in the annual monitoring effort begun in 1993 for the Alpine wildlife studies on the Colville River delta (Johnson et al. 2001). Aerial survey by helicopter (Table 2) was the principal method used to search for den sites at the beginning of July, supplemented with several reports of dens from avian nest searches conducted in June. Most of the study area was searched in 2001, except for the northernmost portion and the riverine dunes and banks of Fish and Judy creeks. More survey effort will be required to search those drainages adequately due to the abundance of ground squirrel burrow complexes (which interfere significantly with survey efficiency), so the intensive search effort was deferred until 2002 and the effort in this first year of baseline surveys concentrated instead on searching tundra habitats away from the major streams.

We conducted an aerial search for dens and evaluated their status on helicopter-supported ground visits during 1–2 July and 12 July, and then returned to active dens during 12–16 July to count pups. 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. 1983a). 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. Thus, late June–early July is a good time to locate den sites from the air.

During ground visits, we evaluated evidence of use by foxes and confirmed the species using the den. 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 are considered here 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 (determination made 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. We invested a fair amount of effort to confirm den occupancy and to count pups. Based on the initial assessment of den activity, our observations during 12–16 July were devoted to counting pups at as many active dens as possible. Observers were dropped off by helicopter at suitable vantage points several hundred meters from den sites, from which they conducted observations with binoculars and spotting scopes over periods of 2.5–4 hr. Observations usually were conducted early and late in the day, when foxes tend to be more active.

## RESULTS AND DISCUSSION

### LARGE WATERBIRD GROUND SEARCHES

The 4 ground-search areas ranged in size from 0.36 to 2.15 km² (Figures 7 and 8, Table 3). Basins for nest searches were selected on the basis of prior observations of pre-nesting Spectacled Eiders during aerial surveys: 2 pairs of eiders were observed in each of Areas 1, 10, and 12 during the pre-nesting eider survey (described below) (Figures 7 and 8) and a single male was observed in Area 2 during the nesting Brant survey. Due to logistical constraints, no searches were conducted in the basin associated with the pair of eiders sighted about 6.5 km N of Spark 7 during the pre-nesting eider aerial survey (see Figure 9).

Sixty-seven nests of 14 bird species were located in the 4 ground-search areas (Table 3, Figures 7 and 8). The most common nesting large waterbirds were Greater White-fronted Geese

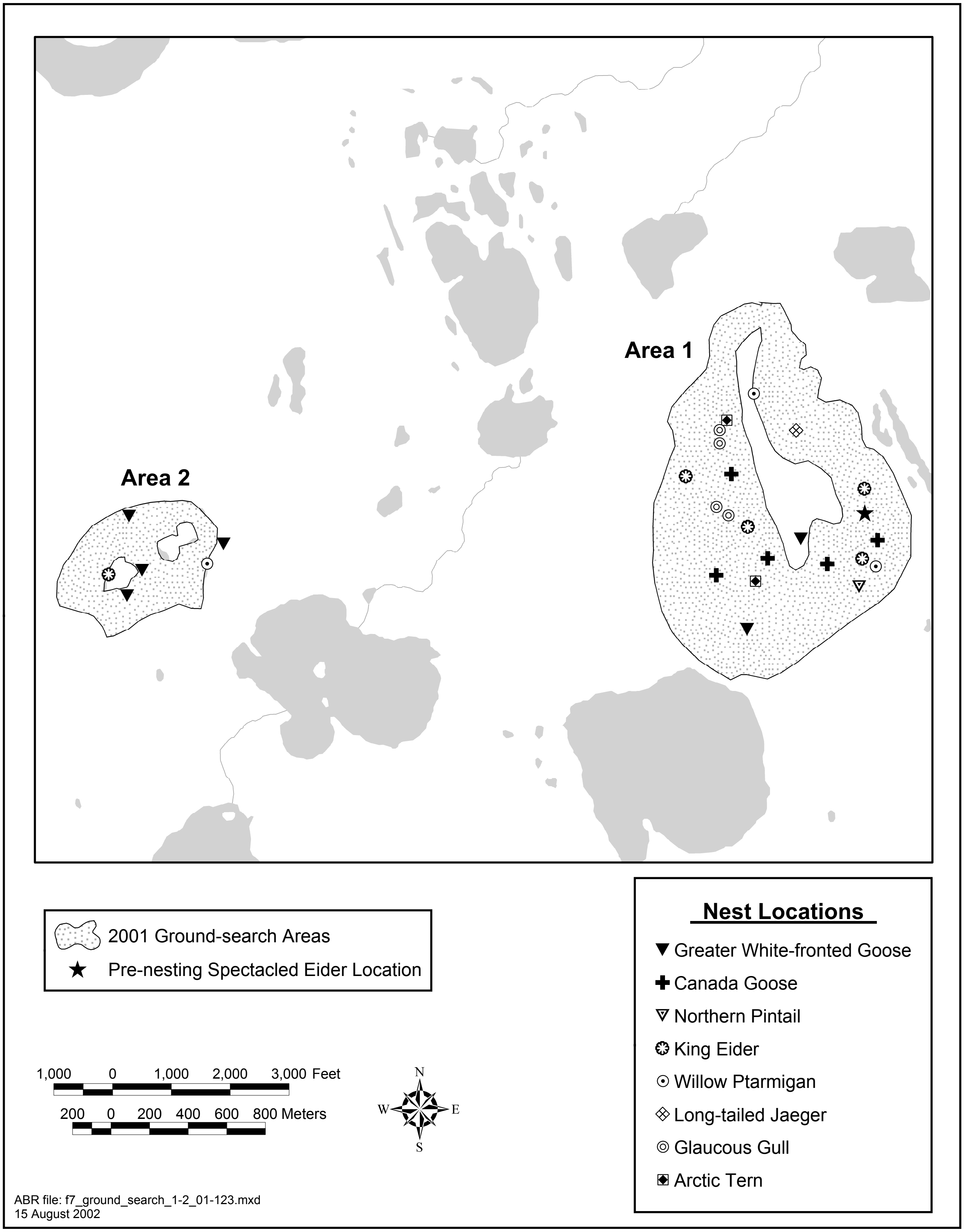


Figure 7. Nests of eiders and other waterbirds in Ground-search Areas 1 and 2, NPRA Study Area, Alaska, 2001.

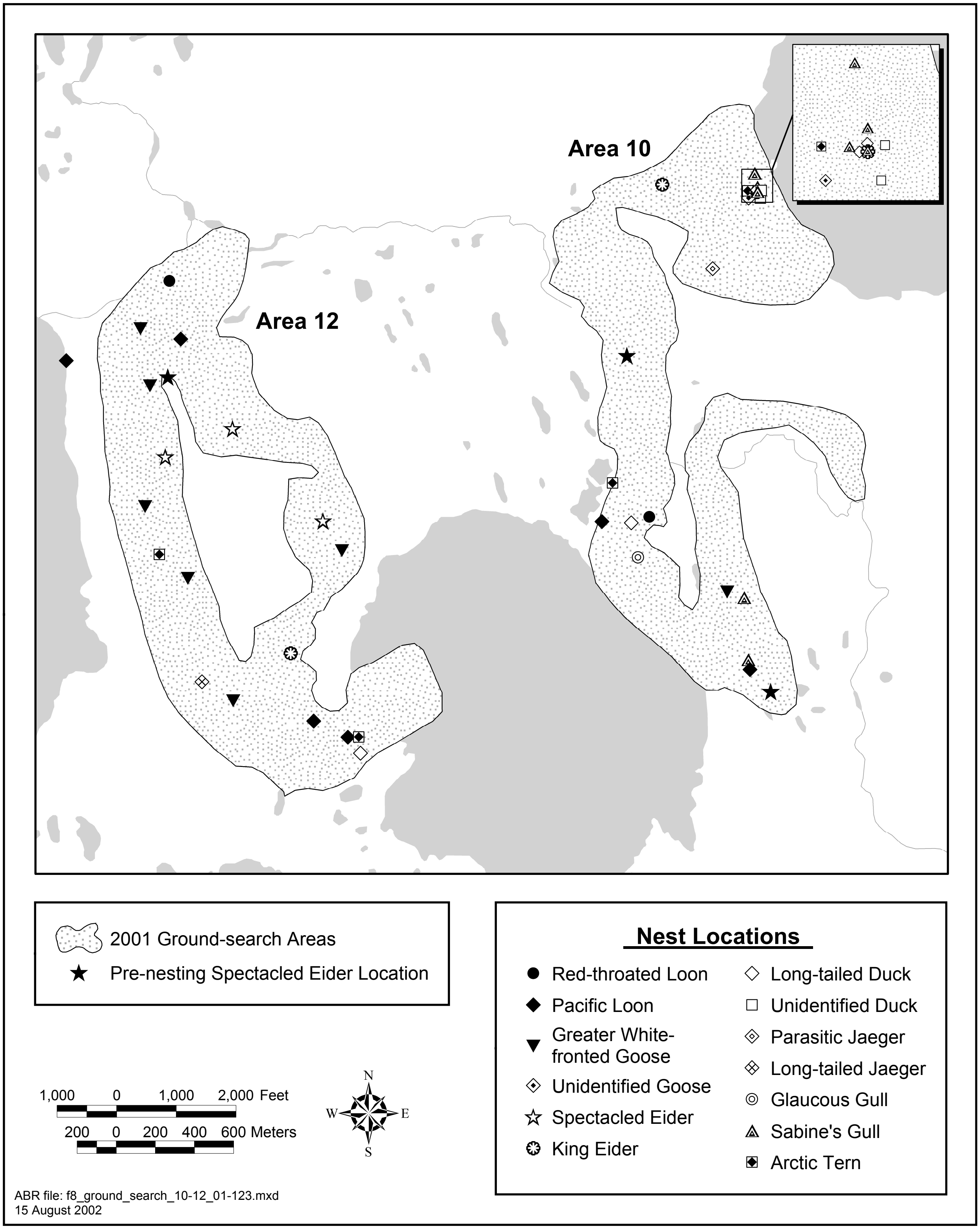


Figure 8. Nests of eiders and other waterbirds in Ground-search Areas 10 and 12, NPRA Study Area, Alaska, 2001.

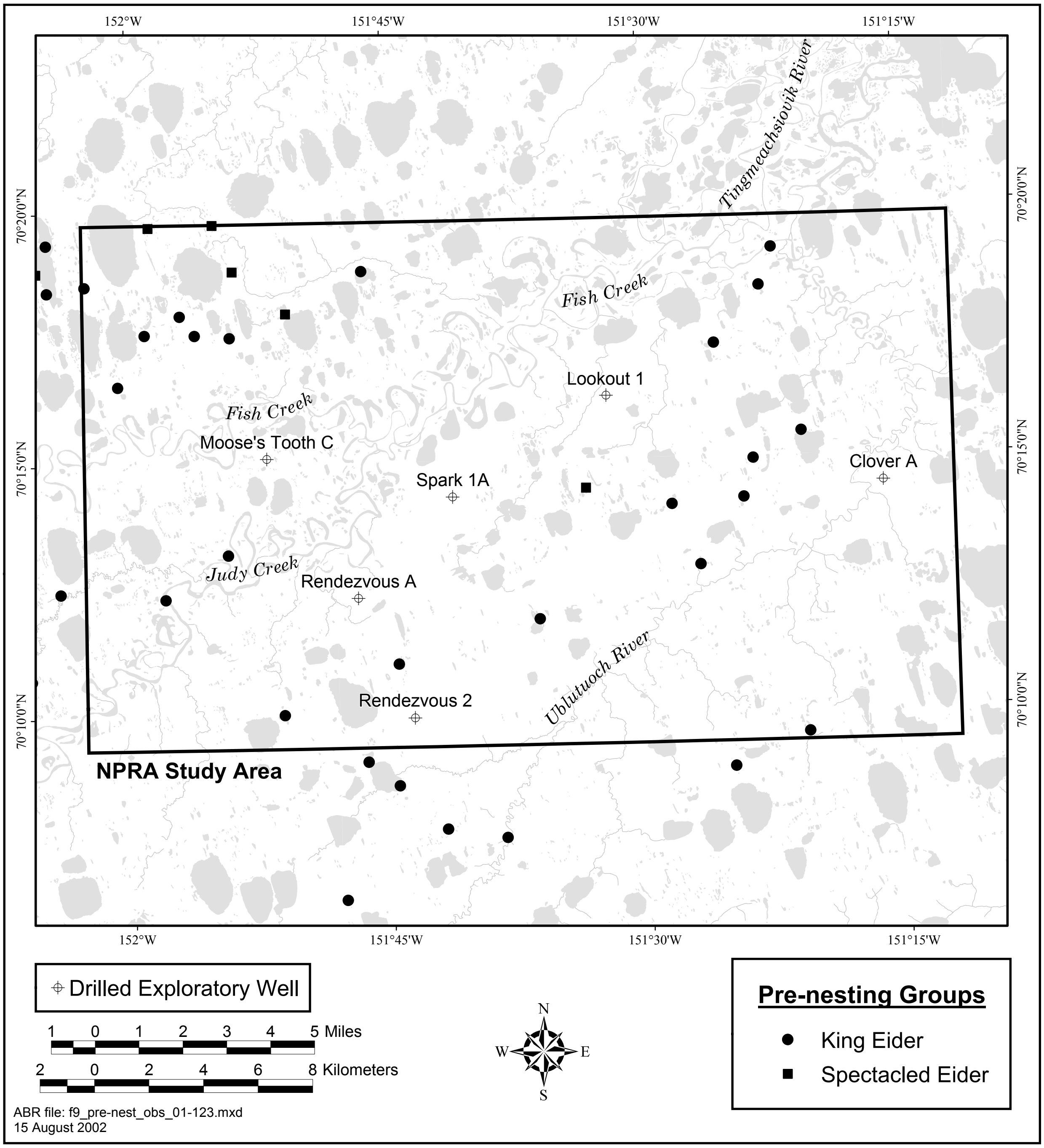


Figure 9. Groups of Spectacled Eiders and King Eiders during pre-nesting aerial surveys, NPRA Study Area, Alaska, 11–12 June 2001.

Table 3. Number and density of nests in 4 ground-search areas in the NPRA Study Area, 2001.

| Species | Number of Nests | | | | | Nest Density (no./km²) |
|---|---|---|---|---|---|---|
| | Area 1 | Area 2 | Area 10 | Area 12 | Total | |
| Red-throated Loon | 0 | 0 | 1 | 1 | 2 | 0.32 |
| Pacific Loon | 0 | 0 | 2 | 3 | 5 | 0.81 |
| Greater White-fronted Goose | 2 | 4 | 1 | 6 | 13 | 2.11 |
| Canada Goose | 5 | 0 | 0 | 0 | 5 | 0.81 |
| Unknown Goose | 0 | 0 | 1 | 0 | 1 | 0.16 |
| Northern Pintail | 1 | 0 | 0 | 0 | 1 | 0.16 |
| Spectacled Eider | 0 | 0 | 0 | 3[a] | 3 | 0.49 |
| King Eider | 4 | 1 | 2[b] | 1 | 8 | 1.30 |
| Long-tailed Duck | 0 | 0 | 3[c] | 1 | 4 | 0.65 |
| Unknown Duck | 0 | 0 | 2 | 0 | 2 | 0.32 |
| Willow Ptarmigan | 2 | 1 | 0 | 0 | 3 | 0.49 |
| Parasitic Jaeger | 0 | 0 | 1 | 0 | 1 | 0.16 |
| Long-tailed Jaeger | 1 | 0 | 0 | 1 | 2 | 0.32 |
| Glaucous Gull | 4 | 0 | 1 | 0 | 5 | 0.81 |
| Sabine's Gull | 0 | 0 | 6 | 0 | 6 | 0.97 |
| Arctic Tern | 2 | 0 | 2 | 2 | 6 | 0.97 |
| TOTAL | 21 | 6 | 22 | 18 | 67 | - |
| Area Searched | 1.57 | 0.36 | 2.09 | 2.15 | 6.16 | - |
| Nest Density (no./km²) | 13.40 | 16.81 | 10.55 | 8.37 | 10.87 | - |

[a] Includes one probable Spectacled Eider nest identified by feather and down sample.
[b] Includes one probable King Eider nest identified by feather and down sample.
[c] Includes one nest identified as Long-tailed Duck by feather and down sample.

(13 nests, 2.1 nests/km²) and King Eiders (8 nests, 1.3 nests/km²); followed by Arctic Terns, and Sabine's Gulls, each with 6 nests (1.0 nests/km² per species); these surveys excluded nests of shorebirds and passerines. Nest densities were low for other focal species: Spectacled Eider (3 nests, 0.5 nests/km²), Red-throated Loon (2 nests, 0.3 nests/km²), Glaucous Gulls (5 nests, 0.8 nests/km²), and Brant (0 nests). Area 2 had the highest total nest density (16.8 nests/km²), but it was considerably smaller than the other plots, which probably inflated its density estimate (Figure 7). The relatively high density in Area 1 can be attributed to the presence of lakes with many small islands, which attracted island-nesting birds such as Canada Geese and Glaucous Gulls. Area 10 hosted a colony of Sabine's Gulls mixed with Arctic Tern and duck nests. The overall nest density for the ground-search areas (6.2 km² surveyed) was 10.9 nests/km². Because ground-search areas were selected on the basis of prior observations of Spectacled Eiders and specifically targeted concentration areas (wetland basins) of waterbirds, the density of nests reported here probably overestimates the actual density in the NPRA Study Area as a whole, and direct comparison with densities in other areas also should be made with caution.

Three Spectacled Eider nests were located in Area 12, approximately 12 km from the Beaufort Sea, where aerial observers had reported 2 pairs of pre-nesting eiders (Table 3, Figure 8). No Spectacled Eider nests were found in the other ground-search areas, each of which contained 1–4 Spectacled Eiders during aerial surveys. Eight King Eider nests also were found in the ground-search areas (including one nest identified from feather samples as probable King Eider). Further discussion of the distribution and abundance of Spectacled and King eiders is presented under Eider Surveys, below.

Five Canada Goose nests were found in Area 1 in the NPRA Study Area (Table 3), but none were found in the other 3 ground-search areas. Canada Goose nests were relatively rare to the west of the Kuparuk River before the early-1990s, but have been increasing in numbers since then (Ritchie et al. 1990; unpubl. data). Before 1996, the Canada Goose was considered a common visitor but not a breeder in NPRA (Derksen et al. 1981). In the late 1970s, Derksen et al. (1981) reported no evidence of Canada Goose nesting at 5 sites in NPRA, and no broods were observed during extensive aerial surveys. However, local residents have observed Canada Geese nesting in NPRA since at least the 1980s (J. Helmericks, pers. comm.). Ten Canada Goose nests were spotted just outside the NPRA Study Area during the 1996 aerial surveys for Brant on the Colville delta (Johnson et al. 1997). On the Colville River delta, 1–2 nests were found annually during aerial surveys or in ground-search areas near Alpine, 1997–2001 (Johnson et al. 1999, 2000b, 2001). Nesting Canada Geese are common in the Prudhoe Bay Oilfield (Troy 1985, Murphy and Anderson 1993).

Red-throated Loon pairs were observed in 3 ground-search areas (Areas 1, 10, and 12) and Pacific Loon pairs were observed in all 4 areas. However, loon nests (both species) were located only in Areas 10 and 12 (Table 3). Nest searches in Areas 1 and 2 may have occurred before many loons began to lay eggs.

No Tundra Swan nests were observed within the 4 ground-search areas (2 nests were located outside of Areas 10 and 12). A single Brant nest was reported in 1999, on a lake within Area 1 (Anderson and Johnson 1999), but no Brant nests were found in 2001. Previous investigations have established that Brant are uncommon nesters in the NPRA Study Area (Anderson and Johnson 1999, Murphy and Stickney 2000, Ritchie and Wildman 2000a).

## BREEDING-BIRD PLOTS

During 4 visits to 24 breeding-bird plots in 2001, we found 172 nests belonging to 20 species of birds (Table 4). The proportion of total nests in 4 categories of bird species was 59% shorebird, 31% passerine, 5% waterfowl, and 5% other groups. The most common breeding birds were Lapland Longspur (49 nests, 28.5% of total nests), Semipalmated Sandpiper (28 nests, 16.3%), Pectoral Sandpiper (19 nests, 11.0%), Long-billed Dowitcher (19 nests, 11.0%), and Red-necked Phalarope (14 nests, 8.1%). The total number of nests per plot ranged from 3–12 (30–120 nests/km²) and averaged 7.2 nests per plot (72 nests/km²) (Table 4). Lapland Longspur was the only species found nesting on all 24 plots, and the number of longspur nests per plot ranged from 1–5 (mean = 2 nests/plot). For the other 3 common species, the Semipalmated Sandpiper, Long-billed Dowitcher, and Red-necked Phalarope, the maximal number of nests found on a plot was 4. The mean density of all nests in breeding-bird plots in the NPRA Study Area in 2001 (72 nests/km²) was similar to mean densities in the Kuparuk Oilfield (76 and 71 nests/km² on 2 plots, $n = 5$ years; Moitoret et al. 1996) and Pt. McIntyre area (64 nests/km², $n = 10$ years; TERA 1993), but lower than densities reported for the Atkasook study area near the Meade River (105 nests/km², $n = 3$ years; Myers et al. 1978c, 1979b, 1980b), the Barrow area (93 nests/km², $n = 5$ years; Myers and Pitelka 1975a, 1975b; Myers et al. 1977a, 1977b, 1978a, 1978b, 1979a, 1979c, 1980a, 1980c), and in the Alpine project area on the Colville River Delta (163 nests/km²; $n = 4$ years; Johnson et al., in prep.).

In 2001, 11 shorebird species nested in the 24 plots. The species diversity of breeding-bird plots in the NPRA Study Area was similar to that in other Arctic Coastal Plain studies: 9 species at Inigok (Cotter and Andres 2000); 9 species at Atkasook (Myers et al. 1978c, 1979b, 1980b); 11 species in the Kuparuk Oilfields (Moitoret et al. 1996); 14 species at Pt. McIntrye (TERA 1993); and 11 species in the Alpine Study Area (Johnson et al., in prep.).

The overall density of shorebird nests in the NPRA Study Area in 2001 (42 nests/km²) was similar to the mean density at Pt. McIntyre (43 nests/km², $n = 10$ years; TERA 1993), and at Kuparuk (45 and 44 nests/km², $n = 5$ years; Moitoret et al. 1996), but higher than at Inigok (21 nests/km²; Cotter and Andres 2000). However, higher shorebird nest densities were reported at Atkasook (59 nests/km², $n = 3$ years; Myers et al.1978c, 1979b, 1980b), Barrow (68 nests/km², $n = 5$ years; Myers and Pitelka 1975a, 1975b;

Table 4. Number and density of nests on 24 breeding-bird plots in the NPRA Study Area, 2001. (Each plot was 10 hectares, see Figure 2.)

| | Plot Number | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | 1 | 2 | 3 | 4 | 25 | 26 | 27 | 28 | 33 | 34 | 35 | 36 |
| Greater White-fronted Goose | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| Northern Pintail | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long-tailed Duck | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Willow Ptarmigan | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| Rock Ptarmigan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Black-bellied Plover | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| American Golden Plover | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bar-tailed Godwit | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Semipalmated Sandpiper | 1 | 1 | 0 | 3 | 0 | 0 | 2 | 4 | 2 | 1 | 0 | 0 |
| Baird's Sandpiper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Pectoral Sandpiper | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 3 | 0 | 2 |
| Dunlin | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stilt Sandpiper | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Long-billed Dowitcher | 0 | 1 | 1 | 4 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |
| Red-necked Phalarope | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 1 |
| Red Phalarope | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Long-tailed Jaeger | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yellow Wagtail | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| Savannah Sparrow | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| Lapland Longspur | 5 | 2 | 2 | 4 | 1 | 2 | 3 | 1 | 5 | 2 | 1 | 2 |
| Total Nests | 7 | 5 | 5 | 12 | 3 | 8 | 10 | 6 | 10 | 11 | 4 | 5 |
| Density (nests/km²) | 70 | 50 | 50 | 120 | 30 | 80 | 100 | 60 | 100 | 110 | 40 | 50 |
| Number of Species | 3 | 4 | 4 | 4 | 4 | 6 | 7 | 3 | 4 | 8 | 3 | 4 |

Table 4. (Continued).

| Species | Plot Number | | | | | | | | | | | | Total Nests | Mean Density (nests/km²) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 45 | 46 | 47 | 48 | 53 | 54 | 55 | 56 | 65 | 66 | 67 | 68 | | |
| Greater White-fronted Goose | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | 2.50 |
| Northern Pintail | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.42 |
| Long-tailed Duck | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0.83 |
| Willow Ptarmigan | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 2.50 |
| Rock Ptarmigan | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0.42 |
| Black-bellied Plover | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 2.50 |
| American Golden Plover | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.42 |
| Bar-tailed Godwit | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.42 |
| Semipalmated Sandpiper | 1 | 1 | 1 | 4 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 2 | 28 | 11.67 |
| Baird's Sandpiper | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.42 |
| Pectoral Sandpiper | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 19 | 7.92 |
| Dunlin | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1.67 |
| Stilt Sandpiper | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 4 | 1.67 |
| Long-billed Dowitcher | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 2 | 0 | 2 | 2 | 0 | 19 | 7.92 |
| Red-necked Phalarope | 0 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 1 | 0 | 0 | 0 | 14 | 5.83 |
| Red Phalarope | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 4 | 1.67 |
| Long-tailed Jaeger | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.42 |
| Yellow Wagtail | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.42 |
| Savannah Sparrow | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | 1.67 |
| Lapland Longspur | 2 | 2 | 1 | 1 | 4 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 49 | 20.42 |
| Total Nests | 4 | 5 | 4 | 10 | 11 | 8 | 11 | 9 | 4 | 6 | 6 | 7 | 172 | |
| Density (nests/km²) | 40 | 50 | 40 | 100 | 110 | 80 | 110 | 90 | 40 | 60 | 60 | 70 | | 71.67 |
| Number of Species | 3 | 4 | 4 | 6 | 6 | 7 | 6 | 6 | 4 | 4 | 4 | 5 | 20 | |

Myers et al. 1977a, 1977b, 1978a, 1978b, 1979a, 1979c, 1980a, 1980c), and in the Alpine study area on the Colville River delta (98 nests/km², $n = 4$ years; Johnson et al., in prep.). Much of the difference in density among sites can be attributed to differences in habitats sampled in each study. For example, Cotter and Andres (2000) reported that among their plots in NPRA, drained-lake basins or lowland tundra sites had nest densities nearly 8 times greater (80 nests/km²) than the upland tussock/ridge tundra sites (12 nests/km²). The density of shorebirds in the Alpine study area on the Colville River delta was about twice that in the NPRA Study Area and the Alpine study plot comprised primarily Wet Sedge–Willow Meadow, a diverse and productive nesting habitat. In addition, the abundance of wet and aquatic habitats on the Colville River delta attracts high densities of nesting shorebirds (Johnson et al. 2000b). The Atkasook study site, in the northwest corner of NPRA, was 1.5 km from the Meade River, also was located in moist lowland tundra (Myers et al 1978c) and the Barrow study area was in wet tundra (Myers and Pitelka 1975a, 1975b). Shorebird nest densities in the NPRA Study Area appear to be in the mid-range among values reported for the NPRA (21–59 nests/km²; Cotter and Andres 2000; Myers et al. 1978c, 1979b, 1980c), reflecting the variety of habitats sampled (wet, moist, and dry) by the breeding-bird plots in this study.

Among the 3 species of passerines that nested in the NPRA breeding-bird plots (Lapland Longspur, Savannah Sparrow, and Yellow Wagtail), 91% of nests (49 of 54 nests, 22.5 nests/km²) belonged to Lapland Longspurs. Lapland Longspurs are the most common nesting passerine on the Arctic Coastal Plain (Johnson and Herter 1989), with mean nest densities ranging from 15 nests/km² ($n = 10$ years, TERA 1993) at Pt. McIntyre to 45 nests/km² at the Alpine study area in the Colville River delta ($n = 4$ years, Johnson et al., in prep.). Nest densities of Savannah Sparrow and Yellow Wagtail in the NPRA breeding-bird plots were 1.7 and 0.4 nests/km², respectively, in 2001. In general, the nest density of passerines, other than longspurs, is <2 nests/km² on the Arctic Coastal Plain (TERA 1993; Moitoret et al. 1996; Myers and Pitelka 1975a, 1975b; Myers et al. 1977a, 1977b, 1978a, 1978b, 1979a, 1979c, 1980a, 1980c) except in the Alpine Study Area, where densities are greater (Johnson et al., in prep.).

Only 3 waterfowl species nested in NPRA breeding-bird plots: Greater White-fronted Goose, Northern Pintail, and Long-tailed Duck. However, 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. The nest density of all waterfowl species in breeding-bird plots in the NPRA Study Area was 3.8 nests/km², which is similar to that reported for the Kuparuk Oilfields (3.7 nests/km², $n = 5$ years, Moitoret et al. 1996). Higher nest densities for waterfowl have been reported from Atkasook (5.3 nests/km², $n = 3$ years; Myers et al.1978c, 1979b, 1980b), Barrow (5.4 nests/km², $n = 5$ years; Myers and Pitelka 1975a, 197b; Myers et al. 1977a, 1977b, 1978a, 1978b, 1979a, 1979c, 1980a, 1980c), Pt. McIntyre (5.7 nests/km², $n = 10$ years, TERA 1993), and the Alpine Study Area (13.8 nests/km², $n = 4$ years; Johnson et al., in prep.).

The most abundant waterfowl species nesting in the NPRA breeding-bird plots was the Greater White-fronted Goose. The density of Greater White-fronted Goose nests in NPRA Study Area (2.5 nests/km²) was similar to that in the Kuparuk Oilfield (2.1 nests/km², $n = 5$ years; Moitoret et al. 1996) but twice that found at Pt. McIntyre (1.1 nests/km², $n = 10$ years, TERA 1993) and less than a third of the nest density found in the Alpine study area on the Colville River delta (9.2 nests/km², $n = 4$ years; Johnson et al., in prep.). No goose nests were reported in the Atkasook study area (Myers et al. 1978c, 1979b, and 1980b).

## EIDER SURVEYS

### BACKGROUND

The Alaska population of Spectacled Eiders declined sharply between the 1970s and 1992, primarily due to a decline in western Alaska on the Yukon-Kuskokwim Delta (Stehn et al. 1993; USFWS 1999). In 1993, the Spectacled Eider was listed by U.S. Fish and Wildlife Service (USFWS) as "threatened" under the Endangered Species Act

(58 FR 27474–27480). This special status mandates habitat protection on their breeding grounds in areas of development and in areas of oil exploration, such as within the NPRA. Recent surveys estimate the current northern breeding population of Spectacled Eiders to be at least 6,000–7,000 birds (Larned et al. 2001). Results of statewide surveys suggest that the Arctic Coastal Plain now supports the main breeding population of Spectacled Eiders in Alaska (USFWS 1996).

Spectacled Eiders are uncommon nesters (i.e., they occur regularly but are not found in all suitable habitats) on Alaska's Arctic Coastal Plain, and tend to concentrate on large river deltas (Johnson and Herter 1989). Their breeding range extends east to Bullen Point and Barter Island, near the western edge of the Arctic National Wildlife Refuge. Derksen et al. (1981) described them as common breeders in the NPRA, but uncommon east of there at Storkersen Point. Recent studies have shown, however, that Spectacled Eiders also are relatively frequent breeders in the Prudhoe Bay and Kuparuk oilfields and on the Colville River delta, although they do not use all available habitats (TERA 1996, Burgess et al. 2002, Anderson et al. 2002, Johnson et al., in prep.).

Spectacled Eiders arrive on the coastal plain in late May-early June and initiate nests by mid-June (Warnock and Troy 1992, Anderson and Cooper 1994). Males do not participate in incubation or rearing of young and leave the area by late June. Eggs begin hatching in early to mid-July, and brood-rearing continues until late August or early September, when the young can fly. Spectacled Eider broods have been seen in the Prudhoe Bay area until late August (TERA 1996). No data are available on departure dates from the Arctic Coastal Plain, but most birds probably leave by mid-September, when lakes and ponds begin to freeze. Pre-nesting habitats used by Spectacled Eiders vary somewhat among areas, but observations suggest that eiders primarily use open water, including both flooded tundra and permanent waterbodies, as well as salt-affected habitats, particularly on the Colville River delta (Johnson et al. 2000a, Anderson et al. 2001). Spectacled Eiders also use a variety of habitats for nesting, including Aquatic Sedge Marsh, Aquatic Sedge with Deep Polygons, Wet Sedge–Willow Meadow, Salt-killed Tundra, Brackish Water, Basin Wetland Complexes, and Nonpatterned Wet Meadow (Johnson et al. 2000a, Anderson et al. 2001).

The Alaska breeding population of Steller's Eider was listed as threatened in 1997 (62 FR 31748) because it had declined substantially on the Yukon-Kuskokwim Delta in recent years (Kertell 1991, Quakenbush and Cochrane 1993). Steller's Eiders breed in extremely low numbers on the Yukon-Kuskokwim Delta, and the breeding range has contracted elsewhere in Alaska, likely contributing to the overall population decline. On the Arctic Coastal Plain, Steller's Eiders historically nested across most or all of the coastal plain (Kertell 1991, Quakenbush and Cochrane 1993), but currently, they nest primarily around Barrow, although the total breeding range probably extends from Point Lay to near the Colville River delta (Day et al. 1995, Quakenbush et al. 1995). The Steller's Eider has been recorded periodically in the Prudhoe Bay and Kuparuk oilfields and on the Colville River delta (USFWS 1998; ABR, unpubl. data).

In arctic Alaska, Steller's Eiders nest and raise broods in areas dominated by low-centered polygons and shallow ponds with emergent grasses and sedges, flooded tundra (i.e., wet meadows), lakes, and drained-lake basins; the presence of emergent plants seems to be important during brood-rearing (Quakenbush and Cochrane 1993). In the Barrow area, waterbodies with pendant grass (*Arctophila fulva*) received considerable use (greater than their availability) during the pre-nesting, nesting, and brood-rearing periods (Quakenbush et al. 1995). Timing of breeding activities for Steller's Eiders is similar to that of other eiders.

Although King Eiders are not listed as threatened in Alaska, their breeding population does appear to be declining at the eastern edges of their breeding range, primarily in western Canada (Dickson et al. 1997). King Eiders nest at high densities in the Prudhoe Bay area (Troy 1988) and at Storkersen Point (Bergman et al. 1977). In the late 1970s, Derksen et al. (1981) suggested that King Eider densities appeared to decline west of the Colville River, but BLM (1998) reported that some of the highest densities of King Eiders on the coastal plain occurred in the NPRA planning area. Larned et al. (2001) reported that the number of

King Eiders on the Alaska Coastal Plain has remained stable over the last 9 years. On the Colville River delta, they are common visitors but uncommon or rare nesters (Simpson et al. 1982, North et al. 1984, Johnson et al. 2000a). Nesting phenology is similar to that of the Spectacled Eider, but King Eiders tend to nest in drier tundra habitats farther from waterbodies (Anderson et al. 2000). As with other eiders, males usually leave soon after incubation has been initiated (Kellett and Alisauskas 1997).

SPECTACLED EIDER

Seven pairs of Spectacled Eiders were observed in the NPRA Study Area during the pre-nesting aerial survey on 11–12 June 2001 (Table 5, Figure 9). Both the densities of indicated birds (USFWS 1987a) and of observed birds were 0.05 birds/km² (Table 5) and both were lower than densities recorded in other areas on the Arctic Coastal Plain. For example, the 8-year mean density of pre-nesting Spectacled Eiders in the CD North study area on the Colville River delta was 0.20 birds/km² (Johnson et al., in prep.). The 8-year mean in the Kuparuk Oilfield was 0.08 birds/km²; Anderson et al. 2002), and the 9-year mean density across the Arctic Coastal Plain was 0.23 birds/km²; Larned et al. 2001). Earlier studies in northeastern NPRA also have reported low densities (0.03–0.09 birds/km²) for this species (BLM 1998, Anderson and Johnson 1999, Murphy and Stickney 2000). The low densities of Spectacled Eiders in the NPRA Study Area may reflect low availability of nesting habitat, a possibility that will be evaluated in 2002, when habitat classification has been completed.

As reported above, several of the wetland basins where pre-nesting Spectacled Eiders occurred were searched for nests. At one of these basins (Ground-search Area 12, ~9 km north of Spark 7 and 8), one group of 2 pairs was sighted on the pre-nesting aerial survey, and later, 3 Spectacled Eider nests (including one identified by feathers in the nest) were found during the nest search (Figures 8 and 9). In the other 3 wetland basins searched (where 1–4 Spectacled Eiders were sighting during aerial surveys), no Spectacled Eider nests were found. A similar degree of association between pre-nesting locations and nest sites was reported in the Kuparuk Oilfield, where Anderson et al. (2001) annually found nests at 36–56% of the locations where pre-nesting pairs were observed. No Spectacled Eider nests were located in similar ground searches in the NPRA in 1999 and 2000 (Anderson and Johnson 1999, Murphy and Stickney 2000).

The 3 Spectacled Eider nests were located in wet sedge meadows (habitats were described in the field and may be redefined when the habitat classification is completed) in a basin wetland complex near the northwest corner of the study area (Ground-search Area 12, Figure 2). Two nests

Table 5. Number and density of eiders during a pre-nesting aerial survey in the NPRA Study Area, 11–12 June 2001. Coverage was 50% of the 615 km² survey area (Figure 2).

| | Number | | | | | | Density (birds/km²) | | |
|---|---|---|---|---|---|---|---|---|---|
| SPECIES Activity | Males | Females | Total Birds | Observed Pairs | Groups | Indicated Total Birds[a] | Breeding Pairs[b] | Total Birds[c] | Indicated Total Birds |
| SPECTACLED EIDER | | | | | | | | | |
| On Ground | 7 | 7 | 14 | 7 | 5 | 14 | 0.02 | 0.05 | 0.05 |
| KING EIDER | | | | | | | | | |
| On Ground | 27 | 24 | 51 | 23 | 21 | 54 | 0.09 | 0.17 | 0.18 |
| Flying | 13 | 13 | 26 | 11 | 8 | 26 | 0.04 | 0.08 | 0.08 |
| All Birds | 40 | 37 | 77 | 34 | 29 | 80 | 0.13 | 0.25 | 0.26 |

[a] Indicated Total Birds is calculated according to the standard USFWS protocol (USFWS 1987b), flying birds are not counted.
[b] Density of breeding pairs = total males/307.5 km².
[c] Unadjusted density of total birds = total birds/307.5 km².

were on low strangmoor ridges, one of which was ~10 m from a deep lake and the other was ~30 m from a shallow lake with islands. The third nest was on a peninsula <1 m from a deep lake with islands. Similar habitats and nest sites are used by Spectacled Eiders on the nearby Colville River delta (Johnson et al., in prep.). Sample sizes are small, but clutch size and hatching success both were high in the NPRA Study Area. Mean clutch size was 5.5 eggs/nest in 2 nests, which was slightly larger than the mean reported on the delta (4.1 eggs/nest, $n = 25$ nests). The hens at 2 nests were flushed, but both hatched their eggs (66% success), and the third nest, which was not flushed, failed to hatch. One of the successful nests suffered partial predation, apparently losing one egg to an avian predator. For comparison, mean hatching success on the Colville River delta was 34% (1992–2001, $n = 35$ nests of known fate; Johnson et al., in prep.), and it was 39% over 9 years in the Kuparuk Oilfield ($n = 118$ nests; Anderson et al. 2002).

### STELLER'S EIDER

One male Steller's Eider was seen flying approximately 7.8 km south of the NPRA Study Area during the pre-nesting aerial survey in 2001 (Johnson and Stickney 2001). Two other investigations reported Steller's Eider sightings in the region in 2001: one confirmed sighting of a pair of Steller's Eiders was reported on the Colville River delta (Johnson et al., in prep.) and an unconfirmed sighting was made in the Kuparuk Oilfield (ABR, unpubl. data). In 2000, a confirmed sighting was made in the Kuparuk Oilfield. Observations of Steller's Eiders are rare in the general area of the NPRA Study Area. No Steller's Eiders were seen during the pre-nesting aerial surveys in either 1999 or 2000 (Anderson and Johnson 1999, Murphy and Stickney 2000). However, 2 Steller's Eiders observations were recorded during the early 1990s—one to the south of the NPRA Study Area in 1993 and one to the northeast in 1995 (BLM 1998).

### KING EIDER

King Eiders were 3–4 times more abundant than Spectacled Eiders in the NPRA Study Area during pre-nesting in 2001 (Table 5, Figure 9). The density of King Eiders was 0.18 indicated birds/km² (Table 5), which was lower than densities in the Kuparuk Oilfield (mean = 0.40 indicated birds/km², $n = 7$ years; Anderson et al. 2001) and the Alpine Transportation Corridor in 1997 (0.47 indicated birds/km²; Johnson et al. 1998), but higher than densities in the CD North area on the Colville River delta (0.05 indicated birds/km², $n = 8$ years; Johnson et al., in prep.). The density of King Eiders in the NPRA Study Area in 2001 was within the range of densities (0.07–0.47 birds/km²) previously reported for the northeast planning area of NPRA (BLM 1998). Maps of King Eider density indicate that the highest concentrations (1.00–4.32 birds/km²) of King Eiders in the northeast planning area are north of the NPRA Study Area and southeast of Teshekpuk Lake (BLM 1998). The NPRA Study Area supports higher numbers of King Eiders than the Colville River delta, but not at the levels found east of the Colville River or southeast of Teshekpuk Lake.

Just as King Eiders outnumbered Spectacled Eiders during pre-nesting in the NPRA Study Area, King Eider nests were about 3 times more abundant than Spectacled Eider nests. The King Eider was the second most abundant nesting species found in the 4 ground-search areas in the NPRA Study Area (Table 3), areas that were chosen because Spectacled Eiders were observed there during pre-nesting surveys. The relative abundance of these species suggests that the study area is important for breeding King Eiders, but less important for Spectacled Eiders. King Eider nests were found in all 4 ground-search areas (Figures 7 and 8), yielding a density of 1.3 nests/km² ($n = 8$ nests). The density of King Eider nests in the NPRA ground-search areas appears to be similar to areas east of the Colville River but greater than on the Colville River delta itself, where they rarely nest (Johnson et al., in prep.). However, the density of nests in the search areas is probably an overestimate for the NPRA Study Area, because only wetland basins were searched, and drier areas are likely to support fewer nests. King Eiders are reported as common nesters to the east of the Colville River delta, especially in the Kuparuk Oilfield (Anderson et al. 2002), at Storkersen Point (Bergman et al. 1977), near Point McIntyre (TERA 1993), and near Prudhoe Bay (Troy 1988). The density of King Eider nests in the ground-search areas in NPRA was similar to the mean density at Point McIntyre (1.3 nests/km², $n$ = 10 years; 1981–1992; TERA 1993).

Six of the 8 King Eider nests found in the NPRA ground-search areas were in wet sedge meadows (habitats were described in the field and may be redefined when the habitat classification is completed), 1 nest was on an island in a deep lake, and another was in an aquatic sedge meadow. Two nests were on islands, 2 were on strangmoor ridges, 3 were on hummocks or mounds that were on shorelines, and 1 was on a peninsula. Two nests were near shallow lakes or ponds with islands, and the other 6 nests were near deep lakes (all but one with islands). The mean distance of nests from waterbodies (i.e., ponds and lakes) was 16 m, but all nests were immediately adjacent to permanent water (including, for example, flooded polygon centers and aquatic sedge, as well as ponds and lakes). The mean distance to permanent water was 0.8 m. The mean clutch size was 4.2 eggs/nest ($n$ = 5 nests at which females were flushed). Only 2 nests were checked for fate, 1 of which hatched.

## LOON SURVEYS

### BACKGROUND

On the Arctic Coastal Plain of Alaska, Yellow-billed Loons nest primarily between the Colville and Meade rivers, with the highest densities found south of Smith Bay (Brackney and King 1992). The Colville River delta, adjacent to the NPRA Study Area, also is an important nesting area for Yellow-billed Loons (North and Ryan 1988a). Yellow-billed Loons arrive on the delta just after the first spring meltwater accumulates on the river channels, usually during the last week of May (Rothe et al. 1983) and they use openings in rivers, tapped lakes, and in the sea ice before nesting lakes are available in early June (North and Ryan 1988a). Nest initiation begins in the second week of June, hatching occurs in mid-July, and broods usually are raised in the nesting lake (Rothe et al. 1983); however, broods occasionally move to different, nearby lakes (North 1986). Yellow-billed Loons defend large territories and, in most areas, only one pair occupies any single lake (Sjolander and Agren 1976, Derksen et al. 1981); however, large complex lakes on the Colville River delta can support 2–3 nesting pairs (in addition to ≤6 Pacific Loon nests) (North and Ryan 1989, North 1994, Johnson et al. 2001).

The Pacific Loon is a common breeder and the most abundant species of loon nesting along the Arctic Coastal Plain of Alaska (Johnson and Herter 1989). Pacific Loons arrive during the first week of June, feeding in open water of river deltas while waiting for nesting lakes to thaw. The breeding phenology of Pacific Loons on the Arctic Coastal Plain is similar to that of the Yellow-throated Loon. Pacific Loons prefer to nest on islands and generally nest on larger (~3.0 ha) and deeper waterbodies than those used by Red-throated Loons (Bergman and Derksen 1977, Dickson 1994). On the Colville River delta, many pairs of Pacific Loons may nest on the same large lake (≥77 ha) and also share the lake with nesting Yellow-billed Loons (North and Ryan 1989, North 1994, Johnson et al. 2001). Pacific Loons feed their young mostly invertebrates from the nesting lake or the wetlands that they inhabit (Bergman and Derksen 1977).

The Red-throated Loon is a common breeder along the Beaufort Sea coast in Alaska (Johnson and Herter 1989). The breeding cycle and habitat use of Red-throated Loons differs from that of other loons. Red-throated Loons arrive on the coastal plain later than the other species, usually not until early June when open water appears in tundra ponds. Upon arrival in early June, Red-throated Loons use open water in the river deltas and along adjacent flooded areas of the Beaufort Sea before moving to their nesting grounds (Bergman and Derksen 1977). Red-throated Loons nest on small tundra ponds (~0.4 ha) that have a moderate amount of vegetative cover, and the timing of occupation of these sites depends on when thawing occurs (Bergman and Derksen 1977, Dickson 1994). Egg-laying typically begins during the third week of June, hatch occurs in mid-late July, and young fledge in September (Rothe et al. 1983; ABR, unpubl. data). The Red-throated Loon is restricted to nesting near the coast or near large lakes due to its reliance on large waterbodies for fish to feed its young (Bergman and Derksen 1977, Douglas and Reimchen 1988, Dickson 1994).

## YELLOW-BILLED LOONS

### Nesting

During the nesting aerial survey in 2001, 44 Yellow-billed Loons and 19 nests were recorded in the NPRA Study Area (Table 6). An additional 3 nests were found during ground searches, yielding a total of 22 nests (Figure 10). 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 10). From aerial survey data, the density of loons was 0.07 birds/km² in the NPRA Study Area. Densities of Yellow-billed Loons were ~2 times higher on the Colville River delta during 7 years of surveys (mean = 0.14 birds/km², range 0.11–0.17 birds/km²), with the highest density recorded in 2001 (ABR, unpubl. data). Previously recorded densities in other nesting areas on the Arctic Coastal Plain appear to be similar to those observed on the Colville River delta: 0.14 birds/km² at Square Lake in the NPRA (Derksen et al. 1981) and 0.16 birds/km² in the Alaktak region south of Smith Bay (McIntyre 1990).

From aerial survey data in 2001, the nest density of Yellow-billed Loons was 0.03 nests/km² in the NPRA Study Area (Table 6). Using the same aerial survey methods, nest density on the Colville River delta was estimated to be 0.06 nests/km² in 2001 (ABR, unpubl. data). Higher densities of loons and nests on the Colville River delta reflect the greater abundance of large, deep waterbodies, which are preferred for nesting and brood-rearing (Burgess et al. 2000). A second, and higher, estimate of nest density (0.07 nests/km²) for Yellow-billed Loons in the NPRA Study Area was

Table 6. Numbers and densities (number/km²) of loons and their nests, broods, and young on aerial surveys and on 16 Red-throated Loon plots in the NPRA Study Area, 2001.

| | Number | | | Density[a] | |
|---|---|---|---|---|---|
| SURVEY TYPE[b] Species | Adults | Nests/ Broods | Young | Adults | Nests/ Broods |
| NESTING AERIAL SURVEY | | | | | |
| Red-throated Loon | 10 | 0 | – | – | – |
| Pacific Loon | 369 | 100 | – | – | – |
| Yellow-billed Loon | 44 | 19 | – | 0.07 | 0.03 |
| BROOD-REARING AERIAL SURVEY | | | | | |
| Red-throated Loon | 6 | 0 | 0 | – | – |
| Pacific Loon | 94 | 10 | 10 | – | – |
| Yellow-billed Loon | 47 | 5 | 5 | 0.08 | 0.01 |
| RED-THROATED LOON PLOTS (NESTING) | | | | | |
| Red-throated Loon | 8 | 6 | – | 0.10 | 0.07 |
| Pacific Loon | 55 | 31 | – | 0.66 | 0.37 |
| Yellow-billed Loon | 8 | 6 | – | 0.10 | 0.07 |
| RED-THROATED LOON PLOTS (BROOD-REARING) | | | | | |
| Red-throated Loon | – | 1 | 1 | – | 0.01 |
| Pacific Loon | – | 5 | 5 | – | – |
| Yellow-billed Loon | – | 2 | 2 | – | – |

[a] Densities were calculated only for species adequately censused by a particular survey type: for aerial surveys, Yellow-billed Loons; for ground searches, Red-throated and Pacific loons; during brood-rearing, aerial surveys included only nesting lakes of Yellow-billed Loons and ground searches included only plots with nesting Red-throated Loons.

[b] Aerial surveys covered the entire NPRA Study Area, 615 km² (Figure 1). Red-throated Loon plots were each 10 ha (Figure 2).

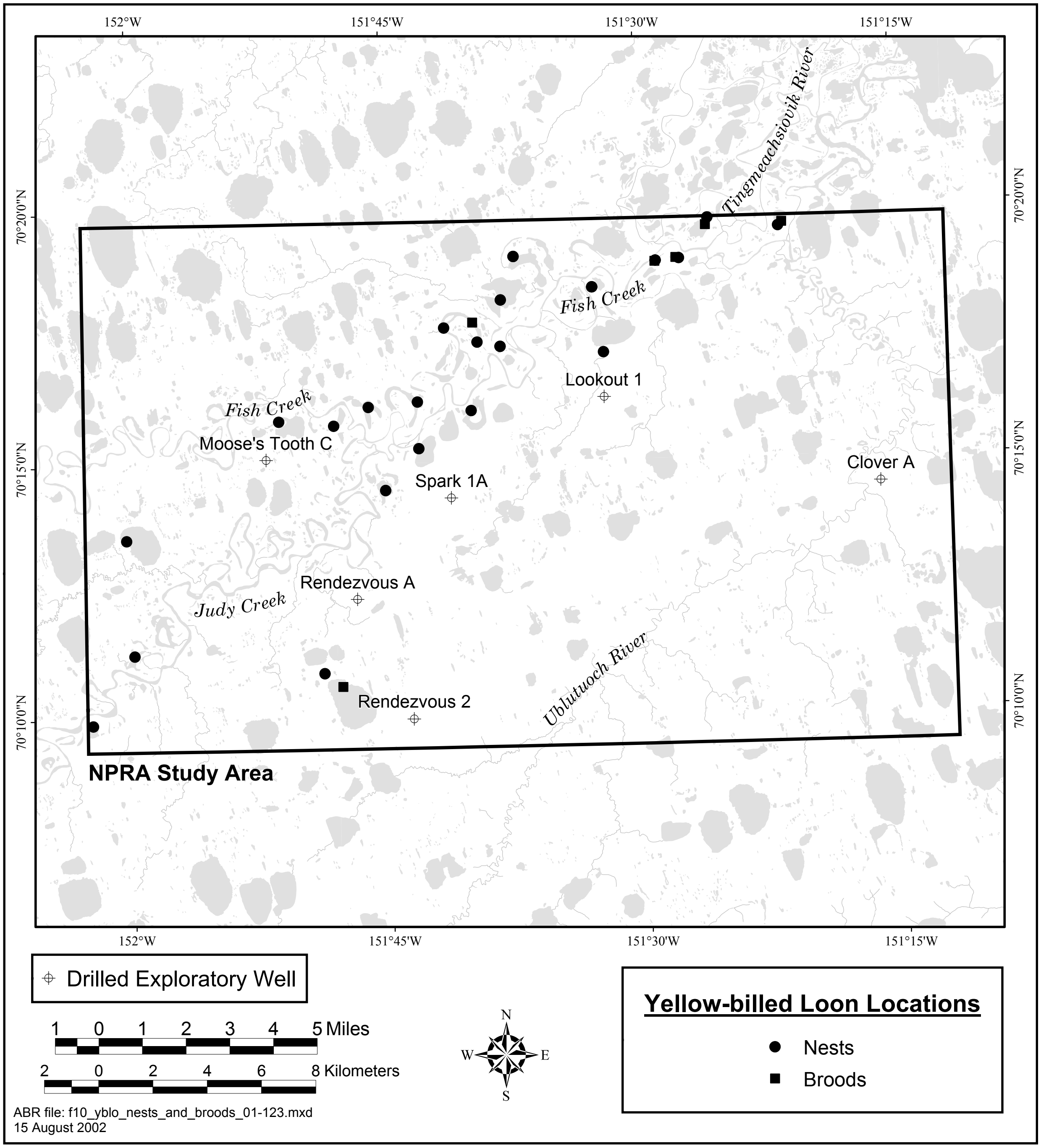


Figure 10. Yellow-billed Loon nests and broods during aerial and ground surveys, NPRA Study Area, Alaska, 2001.

derived from data collected during ground searches on the Red-throated Loon plots (Table 6). We believe that this estimate is inflated, and it is not directly comparable to the aerial survey estimate, which was based on the entire study area (615 km²). Ground-searches would be expected to yield higher densities than aerial surveys, because fewer nests are missed. However, the plot locations, which were randomized until logistic constraints interfered, appear to disproportionately sample the Fish and Judy creek drainages (Figure 5), where Yellow-billed Loons are concentrated in the study area. We suspect that if the plots had randomly sampled the area, the resulting density estimate would be closer to the estimate from the aerial survey.

Although the NPRA Study Area supports a low overall density of nesting Yellow-billed Loons, the concentration of 22 nests in the Fish Creek area comprises a larger number of nests than typically occurs on the entire Colville River delta (mean = 18 nests, range 13–23 nests, $n = 7$ years; ABR, unpubl. data), indicating that the Fish Creek area is an important breeding area for the species. The mean distance of nests to Fish or Judy creek was 0.9 km (range 0.1–4.0 km) and the mean distance of nest lakes to either creek was 0.4 km (range 0.1–4.0 km). Each nest lake contained one pair of Yellow-billed Loons, except for one large lake that contained 2 nests, which were 1.2 km apart. Most nests (14 of 22, 64%) in the NPRA Study Area were located on islands, and all but 3 pairs of Yellow-billed Loons nested on large lakes (>10 ha). One Yellow-billed Loon nest found during a ground search was in a small (about 0.5 ha), shallow wetland (~1 m deep). On the Colville River delta, North and Ryan (1989) reported 19 of 26 Yellow-billed Loon pairs nesting on large lakes (>10 ha).

### Brood-rearing

During the brood-rearing aerial survey in 2001, 47 adult Yellow-billed Loons and 5 broods (1 young each) were seen in the NPRA Study Area (Table 6). An additional brood (1 young) was seen during ground searches on the Red-throated Loon plots, yielding 6 broods total (Figure 10). Each brood was seen in a lake with a known nest location. The density of adult loons on the brood-rearing survey (0.08 loons/km²) was similar to the density of adult loons on the nesting survey (0.07 loons/km²). North and Ryan (1988a, 1989) found that adults with young remain on or near the nest lake during brood-rearing, and non-nesting and failed breeders also maintain their territories throughout the summer.

## RED-THROATED LOONS

### Nesting

Six Red-throated Loon nests were found on 3 of 16 Red-throated Loon plots in the NPRA Study Area in 2001 (Table 6, Appendix C). A single adult Red-throated Loon was seen on a fourth plot but no nest was found. Two additional Red-throated Loon nests were found in Ground-search Areas 10 and 12 (Table 3), yielding 8 nests total (Figure 11); one of these nests was just north of the study area boundary (Figure 8). Using data from the 16 plots, the density of Red-throated Loons was 0.10 birds/km² and 0.07 nests/km² (Table 6). (The nest density computed from the 4 combined ground-search areas (0.32 nests/km², Table 3) is probably an overestimate of the nest density in the entire NPRA Study Area because only wetland basins were searched.) The nest density in the Red-throated Loon plots was near the bottom of the range that has been reported in most other studies in the region (0–0.82 nests/km², see below). In order of nest density, other studies have reported 0 and 0.10 nests/km² in 2000 and 2001, respectively, at CD South (inland Colville River delta; Burgess et al. in prep.); 0.09–0.57 nests/km² (1996–2000) in the Alpine project area (central Colville River delta; ABR, unpubl. data); 0.40 nests/km² (1972–1975) at Storkersen Point (Bergman and Derksen 1977); and 0.82 and 0.50 nests/km² in 2000 and 2001, respectively, at CD North (coastal Colville River delta; Johnson et al., in prep.).

Eberl and Picman (1993) found that both nest density and fledging success of Red-throated Loons increases with decreasing distance to the ocean. In the NPRA Study Area, the distance of Red-throated Loon nests to the coast ranged from 10.4–20.6 km (mean = 13.3 km, $n = 8$ nests). All 8 Red-throated Loon nests and the single adult were found in the northern part of the study area, within 8 km of Fish Creek (Figure 11). On the Colville River delta, mean distance to coast for

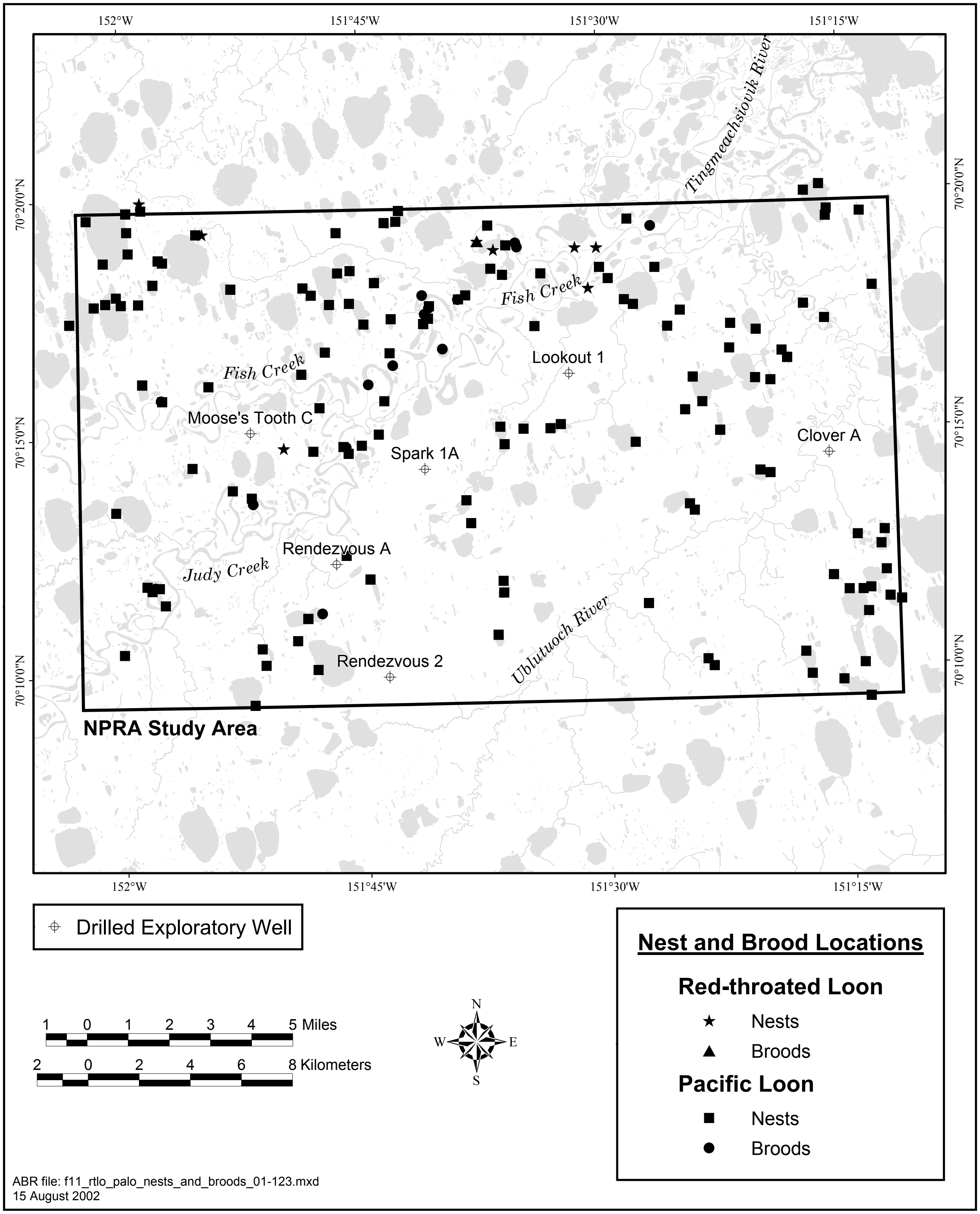


Figure 11. Red-throated Loon and Pacific Loon nests and broods during aerial and ground surveys, NPRA Study Area, Alaska, 2001.

Red-throated Loon nests was 3.0 km ($n$ = 12 nests) in the CD North ground-search area and 7.4 km ($n$ = 18 nests) in the Alpine project area (ABR, unpubl. data). Lower nesting density in the NPRA Study Area may be attributable to the greater distance to the Beaufort Sea, which is probably an important feeding area for Red-throated Loons on the Arctic Coastal Plain (Bergman and Derksen 1977).

Aside from the distance to coast, nest sites used by Red-throated Loons in NPRA were similar to that reported elsewhere on the Arctic Coastal Plain. Nests were located on islands or shorelines of small ponds (mean size = 0.3 ha, $n$ = 8 nests). Use of ponds of similar size was reported at Storkersen Point, AK (0.4 ha; Bergman and Derksen 1977), and at Toker Point, NWT (0.5 ha; Dickson 1994).

Brood-rearing

One Red-throated Loon brood with one young was seen during the ground search for broods in the 3 Red-throated Loon plots that contained nests (Table 6, Figure 11). Signs of a probable hatch (based on the presence of an egg membrane) were found at another nest but no adults or young were seen in the area. On the brood-rearing aerial survey, 6 Red-throated Loons and no broods were seen (Table 6).

PACIFIC LOONS

Pacific Loons were the most abundant and widespread loon species breeding in the study area (Figure 11). Pacific Loons and their nests were counted opportunistically during surveys for Yellow-billed Loons, during both nesting and brood-rearing. On the nesting aerial survey, 369 adult Pacific Loons and 100 nests were found (Table 6). Including nests found during ground searches, 132 Pacific Loon nests were found in the NPRA Study Area in 2001 (Figure 11). On the brood-rearing survey, which included only those lakes on which Yellow-billed Loons nested, 94 Pacific Loons and 10 broods (of one young each) were counted.

During searches of the Red-throated Loon plots, 31 Pacific Loon nests were found on 15 of the 16 plots, yielding densities of 0.37 nests/km² and 0.66 birds/km² (Table 6, Appendix C). One plot had 5 Pacific Loon nests, and 2 plots had 4 nests each. Five Pacific Loon nests were found on 2 of the 4 ground-search areas (Table 3), yielding a density of 0.8 nests/km². Neither of these estimates is unbiased as plots were subjectively located to sample specific habitats; in particular, the density estimate from the ground-search areas probably is biased high, as only wetland basins were searched. However, both density estimates are low relative to those that have been reported by most other studies in the region. For example, nest density of Pacific Loons was 0.74 and 0.61 nests/km² in 2000 and 2001, respectively, in the CD North ground-search area (coastal Colville River delta; Johnson et al., in prep.) and the mean nest density over 4 years of study (1972–1975) was 0.8 nests/km² at Storkersen Point (Bergman and Derksen 1977). Derksen et al. (1981) reported densities of 0.6–2.1 birds/km² for Pacific Loons on 5 study plots within the NPRA (nest densities were not reported).

OTHER BIRDS

Nests or broods of 18 species of birds were found during searches of the 16 Red-throated Loon plots in the NPRA Study Area (Appendix C, Appendix D). The following species had more than 5 nests: Greater White-fronted Goose (24), Arctic Tern (19), King Eider (13), Long-tailed Duck (12), Tundra Swan (11), Glaucous Gull (7), and scaup spp. (6). Greater White-fronted Geese were the most common broods (6 broods; 21 young) of waterbirds seen, followed by Pacific Loons (5; 5 young) and Tundra Swans (5; 10 young). Densities were not calculated for any of these species because the plots were not searched completely; their nests and broods were recorded incidentally to those of loons during searches of waterbodies and shorelines.

**TUNDRA SWAN SURVEYS**

BACKGROUND

Tundra Swans are common breeders across the Arctic Coastal Plain of Alaska and, because they are sensitive to human disturbance, they have been used as indicators of the general ecosystem health within the region (Anderson et al. 1998). Tundra Swans mate for life and pairs defend a nesting territory to which they return annually. Because of their fidelity to nesting territories, changes in the distribution and abundance of swans can be used as a measure of the effects of development projects on waterbird populations (King 1973, Ritchie et al. 1990).

Swans begin arriving on the Arctic Coastal Plain while the ground is mostly snow-covered (late-May) and, as snow melt progresses, breeding pairs move to territories and begin nesting by early June. After eggs hatch in early July, the family groups remain together during brood-rearing, although they may range widely to find suitable foraging habitat (Johnson and Herter 1989). While the young are flightless, adults molt their flight feathers and also become flightless for about 3 weeks. Swans are most vulnerable to predators and broods are sensitive to disturbance during this flightless period. Although brood-rearing swans remain in single-family flocks until departure in fall, nonbreeding swans may form large staging flocks of up to several hundred birds during September (Rothe et al. 1983, Smith et al. 1994, Johnson et al. 1998). The young are ready to fledge by mid-to-late September, and fall migration peaks along the Beaufort Sea coast in late September and early October (Johnson and Herter 1989).

NESTING

During the aerial survey for nesting Tundra Swans on 19 June 2001, 97 non-breeding swans were observed and 36 adults were associated with 21 nests (Table 7); an additional 20 nests were found during the eider aerial survey and during ground searches (for comparability with other estimates by the same aerial survey methods, these additional nests are not included in totals or comparisons). Tundra Swan nests were distributed throughout the NPRA Study Area (Figure 12). Based on the aerial survey results, densities of breeding adults (0.06 birds/km²), nonbreeders (0.16 birds/km²), and total swans (0.22 birds/km²) were similar or slightly higher than densities in the Kuparuk Oilfield in 2001 (0.06, 0.12, and 0.17 birds/km², respectively) (Anderson et al. 2002). The density of adult swans in the NPRA Study Area during the nesting season was within the range (0–0.59 birds/km²) reported by BLM for the northeastern NPRA (BLM 1998).

Based on the aerial survey results, the density of swan nests in the NPRA Study Area in 2001 was 0.03 nests/km² (Table 7), similar to the mean density in the Kuparuk Oilfield (0.04 nests/km², range 0.01–0.05 nests/km², $n$ = 13 years; Anderson et al. 2002) and about half the mean nest density recorded on the Colville River delta

Table 7. Number and density (number/km²) of Tundra Swans and nests during an aerial survey in the NPRA Study Area, 19 June 2001.

| | Number | Density[a] |
|---|---|---|
| NESTS | 21 | 0.03 |
| BREEDING SWANS | | |
| Singles | 6 | 0.01 |
| Pairs | 15 | 0.05 |
| Total Adults | 36 | 0.06 |
| NON-BREEDING SWANS | | |
| Singles | 17 | 0.03 |
| Pairs | 31 | 0.10 |
| In Flocks | 18 | 0.03 |
| Total Adults | 97 | 0.16 |
| TOTAL SWANS | 133 | 0.22 |

[a] Density based on a survey area of 615 km².

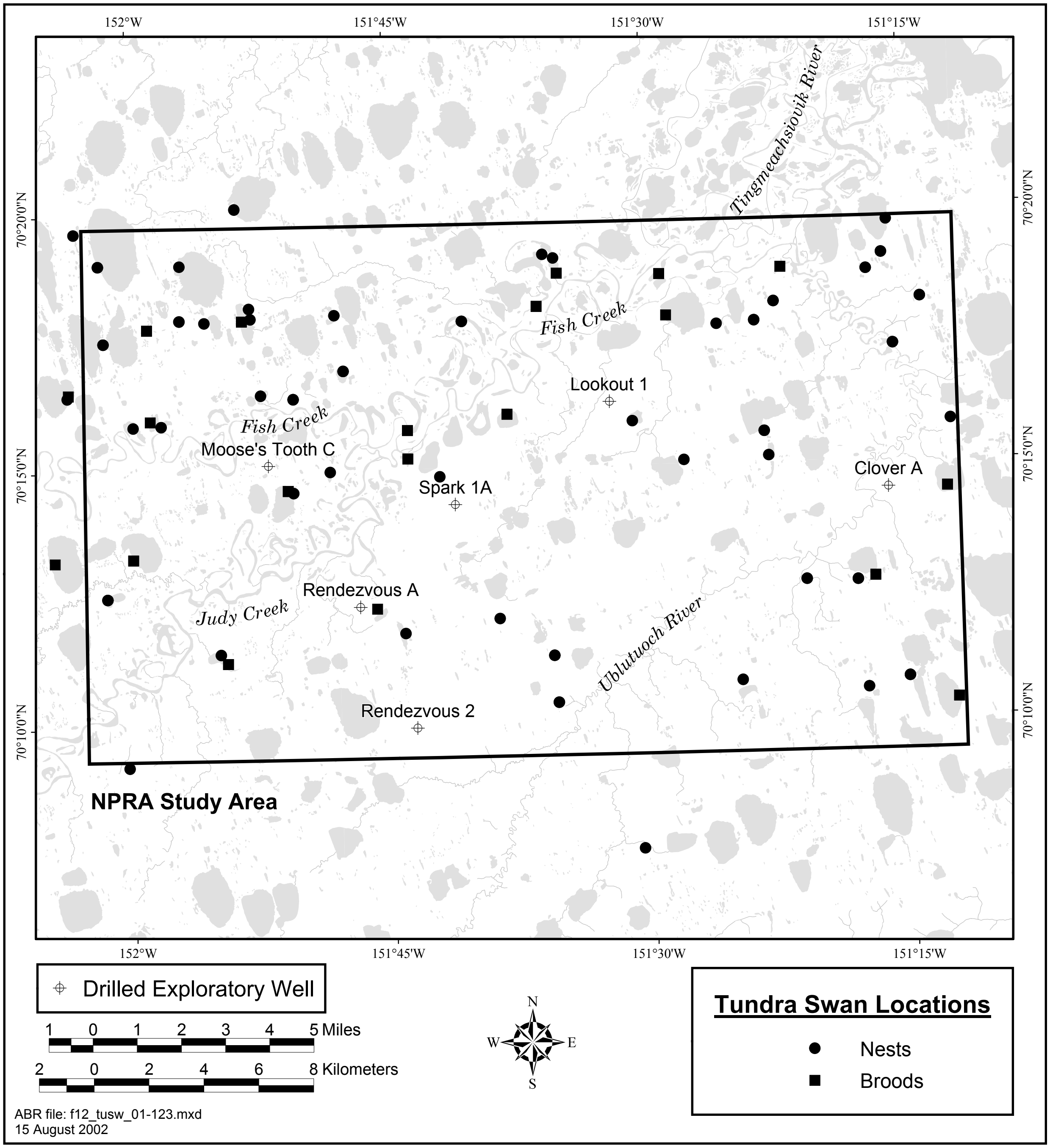


Figure 12. Tundra Swans nests during nesting aerial surveys on 19 June and broods during brood-rearing aerial surveys on 20 August in the NPRA Study Area, Alaska, 2001.

(0.06 nests/km², range 0.03–0.08 nests/km², $n = 8$ years; Johnson et al., in prep.). The density of Tundra Swan nests in the NPRA Study Area also was slightly lower than that recorded on the eastern Arctic Coastal Plain (0.04–0.06 nests/km²; Platte and Brackney 1987).

BROOD-REARING

During the brood-rearing aerial survey on 20 August 2001, 179 Tundra Swans (110 nonbreeding adults, and 30 adults with 39 young in 16 broods) were counted in the NPRA Study Area (Table 8). Most broods were located north of Judy and Fish creeks (Figure 12). Swans without broods

Table 8. Number and density (number/km²) of Tundra Swans and broods during an aerial survey in the NPRA Study Area, 20 August 2001.

| | Number | Density[a] |
|---|---|---|
| BROODS | 16 | 0.03 |
| BREEDING SWANS | | |
| Singles | 2 | <0.01 |
| Pairs | 14 | 0.05 |
| Young | 39 | 0.06 |
| Total Adults | 30 | 0.05 |
| NON-BREEDING SWANS | | |
| Singles | 9 | 0.01 |
| Pairs | 34 | 0.11 |
| In Flocks | 33 | 0.05 |
| Total Adults | 110 | 0.18 |
| TOTAL SWANS | | |
| Adults | 140 | 0.23 |
| Young | 39 | 0.06 |
| Total Swans | 179 | 0.29 |

[a] Density based on a survey area of 615 km².

were primarily in pairs and appeared to be more concentrated in the northern portion of the NPRA Study Area.

The mean brood size for Tundra Swans in the NPRA Study Area was 2.4 young/brood (range = 1–4 young/brood) in 2001, which was higher than the mean brood size (1.6 young/brood) recorded in 2000 (Murphy and Stickney 2000). The mean brood size in the Kuparuk Oilfield over 12 years was 2.5 young/brood (Anderson et al. 2001), which was similar to the brood size in the study area in 2001

Based on the total numbers of nests and broods in the 2 aerial surveys, nesting success of Tundra Swans in the NPRA Study Area was estimated to be 76% in 2001 (16 of 21 nests), up from 42% recorded in 2000 (Murphy and Stickney 2000). These estimates may be affected by movements of broods into or out of the survey area. Also, weather conditions for the brood-rearing survey in 2001 were not optimal (low cloud ceilings, precipitation, and fog), so the number of broods may have been slightly undercounted. Comparable surveys in the Kuparuk Oilfield and on the Colville delta yielded higher estimates of nesting success in both 2000 and 2001: 64% and 88% in the Kuparuk Oilfield and 66% and 79% on the Colville River delta, respectively (ABR, unpubl. data.). These estimates suggest that the NPRA Study Area is not as productive for Tundra Swans as areas to the east.

## GOOSE SURVEYS

### BACKGROUND

Nesting colonies of Brant and their brood-rearing areas have received special consideration during oilfield planning because of declining populations of this species throughout its range in Alaska. Brant are traditional in their selection of nesting and brood-rearing areas and, hence, potentially vulnerable to changing conditions in those areas. Brant arrive in the region in late May and early June, and nest initiation begins as soon as suitable nesting habitat is available (Kiera 1979, Rothe et al. 1983). After eggs hatch in early July, most brood-rearing birds move from nesting areas to salt marshes along the coast. The fall migration of Brant along the arctic coast of Alaska usually begins in mid-to-late

August (Johnson and Herter 1989). Salt marshes and major river deltas, such as on the Colville River delta, provide important resting and feeding areas for Brant at that time (Johnson and Richardson 1981). Fall-staging Brant tend to use areas along the coast that are similar to those used by brood-rearing and molting groups (Smith et al. 1994).

Greater White-fronted Geese commonly breed along the Beaufort Sea coast (Johnson and Herter 1989) and were reported to be the most abundant nesting goose in the vicinity of Point Barrow in the early 1900s (Anderson 1913, see Johnson and Herter 1989). In earlier investigations in 1977–1978, weekly ground censuses of large birds in 6 locations in the NPRA yielded mean seasonal densities of Greater White-fronted Geese ranging from 0.7 birds/km² at Meade River near the coast to 2.7 birds/km² at Singiluk, 140 km inland (Derksen et al. 1981). On the Colville River delta in the early 1980s, the USFWS recorded mean densities during June of 6.3 birds/km² and 1.8 nests/km² in scattered plots across the delta, and a maximum of 6.6 nests/km² at one site on the western delta, which were among the highest densities recorded for these geese and their nests on the Arctic Coastal Plain of Alaska (Simpson and Pogson 1982, Rothe et al. 1983, Simpson 1983). More recently, nest densities of 2.0–9.9 nests/km² have been recorded on the delta in the Alpine project area and the proposed CD North and CD South project areas (Johnson et al., in prep.; Burgess et al. 2002.).

Greater White-fronted Geese arrive on the breeding grounds by mid-late May, and will nest singly or in small loose colonies (Johnson and Herter 1989), usually initiating nests by early June. Hatching typically occurs by the last week of June or first week of July, and the young are taken almost immediately to water. Greater White-fronted Geese usually rear their broods in groups and are often found in or near larger lakes. These geese begin fall-staging and migration earlier than observed in other arctic-nesting geese, and will have gathered into flocks by mid-August, often staging on deltas or along rivers (Johnson and Herter 1989).

The Canada Goose is a regular breeding and molting bird along the Beaufort Sea coast, but does not occur in all suitable habitat. Canada Geese nest in scattered locations on the Arctic Coastal Plain east of the Colville River, and are more common east of the Kuparuk River (Ritchie et al. 1990; ABR, unpubl. data). They commonly nest on islands in wetlands in the Prudhoe Bay area (Troy 1985, Murphy and Anderson 1993). Several hundred Canada Geese nest along the banks and bluffs of the upper Colville River (Kessel and Cade 1958). Prior to 1996, Canada Geese were not reported nesting either in NPRA (Derksen et al. 1981) or on the Colville delta (Simpson et al. 1982, North et al. 1984), although local residents have observed Canada Geese nesting in the NPRA since at least the 1980s (J. Helmericks, pers. comm.). In 1996, a colony of 10 Canada Goose nests was found just outside the eastern boundary of the study area (see Johnson et al. 1997: Figure 14). The number of Canada Geese nesting in the Kuparuk Oilfield has been increasing in the last decade (B. Anderson, ABR, unpubl. data), and since 1998, 1–2 nests have been found in the vicinity of the Alpine project area on the Colville delta (Johnson et al. 2001). Canada Geese arrive on the Arctic Coastal Plain by late May and usually initiate their nests by early to mid-June. Hatching occurs in late June to early July and family groups coalesce into brood-rearing flocks (Johnson and Herter 1989). A major molting area for these geese is located near Teshekpuk Lake, west of the Colville delta (Derksen et al. 1981). Fall migration may start by mid- to late August and places, such as the Colville delta, that are not important during molting or brood-rearing, may be used heavily during fall staging (Smith et al. 1994).

### DISTRIBUTION AND ABUNDANCE

During the nesting survey on 18 June 2001, 19 Brant and 9 nests were recorded in 8 locations within the NPRA Study Area (Figure 13). All of the nesting locations were in the northeastern section of the study area in the vicinity of Fish Creek. In addition, 2 nesting locations were just north of the study area near the Tingmeachsiovik River and Fish Creek (Figure 13), one of which had an estimated 50 adults and 20 nests present. Although suitable habitats for nesting Brant exist in the vicinity of Fish and Judy creeks, much of the remainder of the study area lacks suitable habitats and is farther inland than Brant typically are found nesting (Anderson et al. 1999, Johnson et al. 1999,

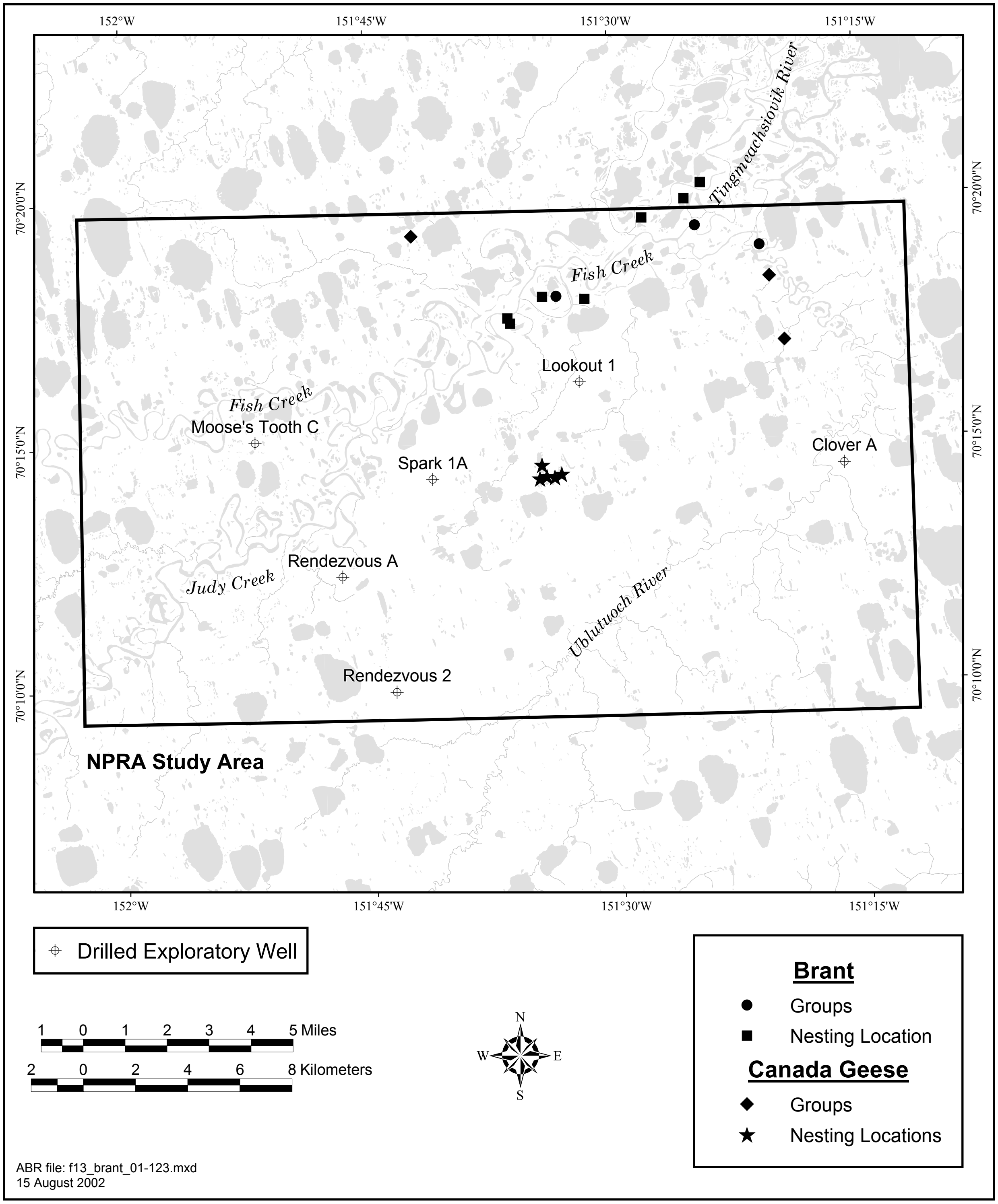


Figure 13. Brant and Canada Goose groups and nests during nesting aerial and ground surveys, NPRA Study Area, Alaska, 19 June 2001.

Ritchie and Wildman 2000a). During the same nest survey, 7 Canada Geese were recorded incidentally at 4 locations, including one at a nest. During later ground searches, this nest, plus an additional 4 nests were found in Area 1 (Figures 7 and 13).

The only geese observed during the brood-rearing and fall-staging aerial surveys in the NPRA Study Area were Greater White-fronted Geese (Figure 14). Although both Brant and Canada Geese were observed in the area during the nesting survey in June, these species usually move

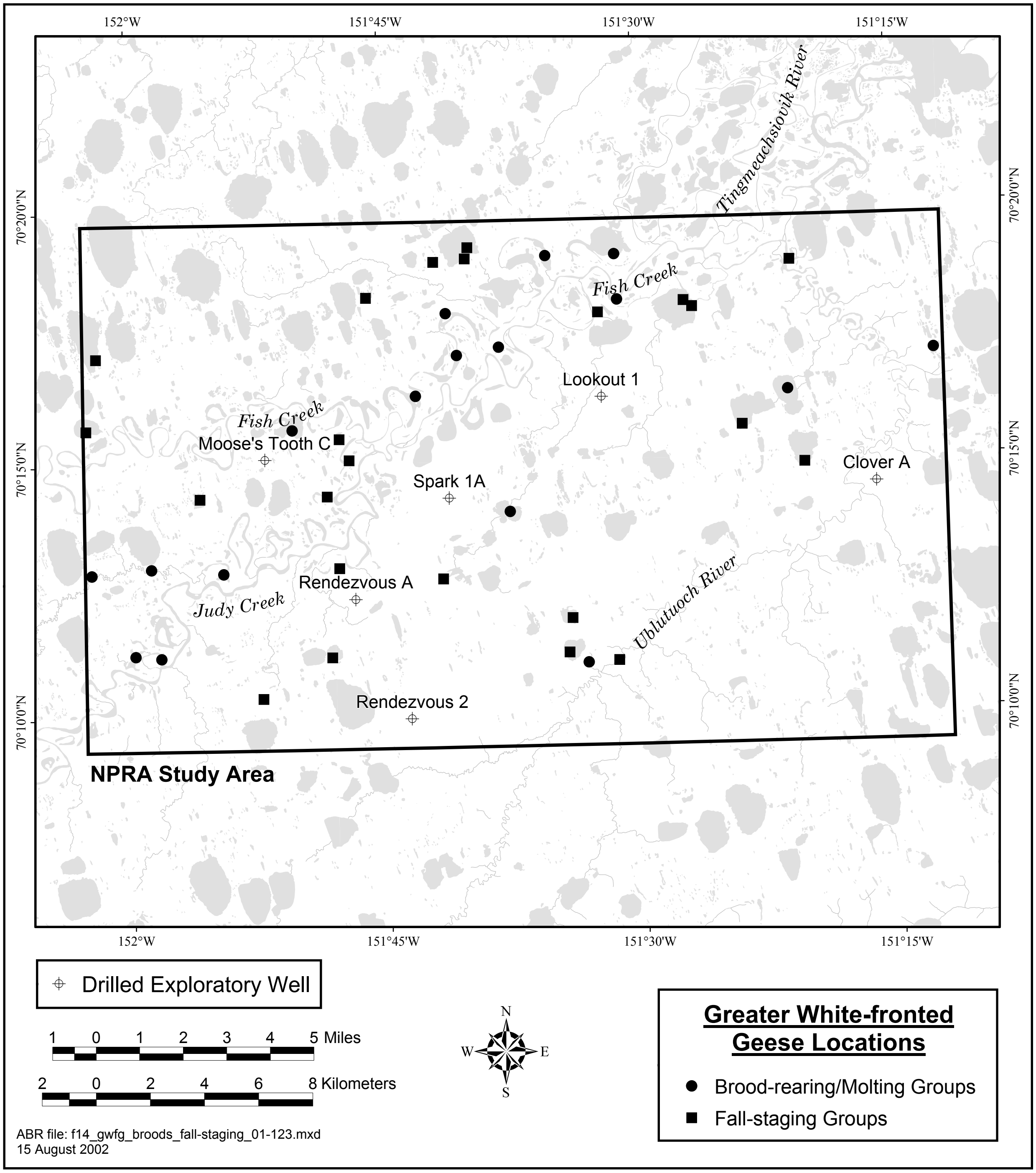


Figure 14. Greater White-fronted Goose broods and fall-staging groups during aerial surveys, NPRA Study Area, Alaska, 25 July and 20 August 2001.

to coastal areas during July and August. During the brood-rearing survey on 25 July 2001, 508 Greater White-fronted Geese were observed in 17 groups (mean = 29.9 birds/group, range = 7–65) that were distributed throughout the study area. Most groups were located in large lakes along the corridors of the creeks and rivers in the area. During the fall-staging survey, 620 Greater White-fronted Geese were observed in 23 groups (mean = 27.0 birds/group, range = 4–120). The distribution of geese during fall staging was similar to that during brood-rearing (Figure 14).

## GULL SURVEYS

### BACKGROUND

The Glaucous Gull is a common migrant and breeder in the Beaufort Sea area (Johnson and Herter 1989). Glaucous Gulls arrive in mid-May and are commonly found near offshore leads and along island and mainland shorelines (Richardson and Johnson 1981). Pairs nest either solitarily or colonially on islands and cliffs on or near the coast (Larson 1960), on inland river bars (Sage 1974), or on tundra lakeshores or small islands in lakes (Martin and Moitoret 1981). Egg-laying begins by mid-June and continues into the last week of June (Johnson and Herter 1989). Hatching begins in mid-July and fledging occurs in late August to early September (Bergman et al. 1977). Glaucous Gulls are omnivorous and their diet includes fish, marine invertebrates, and garbage, but during the breeding season, gulls prey heavily on the eggs and chicks of other birds, especially those of waterfowl (Johnson and Herter 1989). Some studies have found that waterfowl nesting in association with predatory gulls have higher nesting success, but the broods from these nests are often taken by the gulls (Vermeer 1968, North and Ryan 1988b).

The Sabine's Gull is an uncommon migrant and breeder in the Beaufort Sea area (Johnson and Herter 1989). On the Arctic Coastal Plain, Sabine's Gulls arrive on their nesting grounds during the first week of June (Bergman et al. 1977, Rothe et al. 1983, North et al. 1984). Egg-laying begins in mid-June and continues until early July (Day et al. 2001, ABR, unpubl. data). Sabine's Gulls nest solitarily or in small colonies on the mossy edges of small ponds, on islands within ponds, or on low-lying marshy tundra near shore (Day et al. 2001). Sabine's Gulls often nest with Arctic Terns, whose aggressiveness against predators may provide a benefit (Larson 1960) or whose nesting habitats and food requirements are similar enough to result in an association (Abraham 1986). During the breeding season, Sabine's Gulls primarily forage for invertebrates in freshwater ponds and lakes, and secondarily in brackish water (Rothe et al. 1983, Abraham and Ankney 1984).

The Arctic Tern is a common breeder across the Arctic Coastal Plain of Alaska (Johnson and Herter 1989). Arctic Terns arrive on their nesting grounds during the first week of June and begin egg-laying in mid-late June when the ground is free of snow (Bergman et al. 1977, Rothe et al. 1983, North et al. 1984). Arctic Terns nest solitarily or in small colonies on islands or peninsulas of shallow ponds and deep lakes (Rothe et al. 1983). Arctic Terns feed singly or in large groups mostly on fish in shallow and deep waterbodies (Rothe et al. 1983); however, they also rely on aquatic invertebrates for feeding chicks (Abraham and Ankney 1984).

### DISTRIBUTION AND ABUNDANCE

Thirty Glaucous Gull nests were found in the NPRA Study Area; 22 nests were found during the aerial survey and an additional 8 were found during ground searches (Table 9, Figure 15). Aerial surveys were not comprehensive for Glaucous Gulls because the surveys focused on larger lakes suitable for Yellow-billed Loons. However, based on these counts, nest density for Glaucous Gulls was at least 0.05 nests/km² in the NPRA Study Area. On similar aerial and ground surveys conducted on the Colville River delta in 2001, nest density for Glaucous Gulls was at least 0.04 nests/km² (ABR, unpubl. data).

Glaucous Gull nests were distributed throughout the NPRA Study Area (Figure 15). One small colony of 4 Glaucous Gulls nests was found in a ground-search area in the middle of the study area. All other nest locations consisted of single nesting pairs and most of those nests (>85%) occurred on islands in lakes.

Nesting lakes of Glaucous Gulls were not revisited during the brood-rearing loon survey. On lakes that were included in the aerial survey, however, 2 Glaucous Gull broods were seen

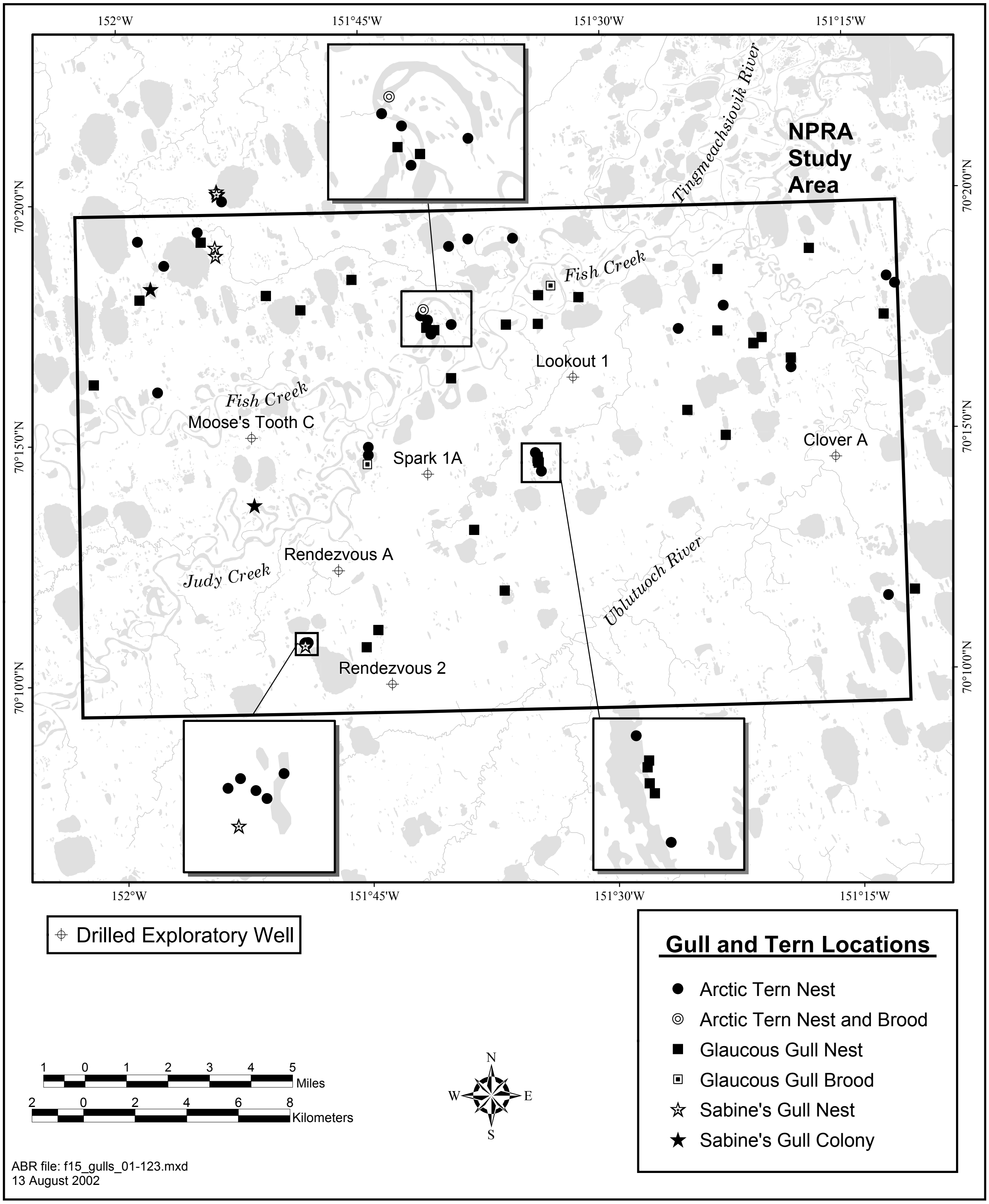


Figure 15. Glaucous Gull, Sabine's Gull, and Arctic Tern nests and broods during aerial and ground surveys, NPRA Study Area, Alaska, 2001.

Table 9. Number and density (nests/km²) of Glaucous Gull, Sabine's Gull, and Arctic Tern nests located during aerial surveys and in ground-search areas of the NPRA Study Area, 2001.

| Species | Number of Nests by Survey | | | | | Nest Density[a] | |
|---|---|---|---|---|---|---|---|
| | Aerial Survey[b] | Red-throated Loon Plots | Ground-search Areas | Breeding-bird Plots[c] | Total Nests[a] | Aerial Survey[b] | Ground Searches[d] |
| Glaucous Gull | 22 | 8 | 5 | 2 | 30 | 0.05 | 0.14 |
| Sabine's Gull | 10 | 1 | 6 | 0 | 13 | – | 0.08 |
| Arctic Tern | – | 19 | 6 | 3 | 27 | – | 0.28 |

[a] Excludes duplicate sightings of nests in aerial and ground surveys, and nests outside the boundaries of the study area.
[b] Densities calculated for the NPRA Study Area (615 km²). Data on gull and tern nests were collected during the Yellow-billed Loon nesting aerial survey. Densities were calculated only for Glaucous Gulls and this number represents a minimum estimate, as surveys did not provide 100% coverage.
[c] These nests were recorded incidentally just outside of the breeding-bird plots.
[d] Density based on combined data from Red-throated Loon plots and Ground-search Areas (30.2 km²). Habitats in these search areas are not a random selection of habitats available and density estimates, therefore, reflect densities in the habitats searched.

(Figure 15). Both broods were located in lakes where no Glaucous Gull nest was found during the nesting survey. One brood contained 1 chick and the other contained 2 chicks.

Thirteen Sabine's Gull nests were found in the NPRA Study Area, either as single nests or in colonies (Table 9). Ten of the 13 Sabine's Gull nests in the study area were located in 2 nesting colonies that were identified during the aerial survey (Figure 15; 10 adults were observed at each colony); 2 Sabine's Gull nests were found inside the study area boundary in Ground-search Area 10 (Figure 15, see also Figure 8); and one nest was found near a colony of 5 Arctic Tern nests on a Red-throated Loon plot (Figure 15). Four additional Sabine's Gull nests were located in a colony <1 km north of the NPRA Study Area boundary (in a portion of Ground-search Area 10, a basin whose edges span the study area boundary, Figure 8). All colonies and single nests were located on islands in lakes and ponds in the western part of the study area. The density of Sabine's Gull nests in the combined areas searched on the ground was 0.08 nests/km² (Table 9).

Arctic Tern nests were distributed throughout the NPRA Study Area. During ground searches, we found 27 Arctic Tern nests and one brood (Figure 15). Nineteen of the 27 nests were found on 8 of the Red-throated Loon plots (Table 9, Appendix D), 6 nests were found in 3 of 4 ground-search areas (one of these was outside the study area boundary in Ground-search Area 10, see Figure 8), and 2 nests were found adjacent to breeding-bird plots. The density of Arctic Tern nests in the combined areas searched on the ground was 0.28 nests/km² (Table 9).

## OTHER AVIAN SPECIES

In addition to surveys conducted specifically to collect information about avian use of the NPRA Study Area, regional surveys have been conducted to collect information about the presence of Peregrine Falcons on the Arctic Coastal Plain, including the NPRA. In 1999, Ritchie and Wildman (2000b) found a Peregrine Falcon pair with a nest approximately 3.5 km northwest of Spark 7 on the bank of Fish Creek. In a similar location, a single Peregrine Falcon was seen roughly 5 km northwest of Spark 7 during a Brant aerial survey in 2001. Ritchie and Wildman (2000b) also found Peregrine Falcon nests in the transition area between the Arctic Coastal Plain and the Brooks Range foothills. Nests in this transition area tended to be on top of streambanks cut by meandering rivers and occasionally on high-relief banks along lake shorelines. The Peregrine Falcon population in NPRA apparently is expanding (Ritchie and Wildman 2000b), and suitable substrates for nesting occur within the study area.

## CARIBOU SURVEYS

### BACKGROUND

Caribou are the most important terrestrial species used for subsistence by local residents on the North Slope (Brower and Opie 1997, Fuller and George 1997, BLM 1998). The NPRA Study Area is within the annual hunting range of residents of Nuiqsut (Pedersen 1995, Prichard et al. 2001), the nearest community, and the continued availability of caribou for local subsistence harvest is a prominent issue in planning for oil and gas development (Lawhead et al. 2001).

The NPRA Study Area is used by caribou from 2 adjacent herds: the Teshekpuk Lake Herd (TLH) and the Central Arctic Herd (CAH) (BLM 1998). The 2 herds are similar in size, judging from the latest Alaska Department of Fish and Game (ADFG) photocensuses, which counted 28,113 caribou in the TLH in July 1999 (Bente 2000) and 27,128 caribou in the CAH in July 2000 (E. Lenart, pers. comm.). The degree of use of the study area by each herd varies according to the season and year, but the available data indicate that TLH caribou use the area more consistently than do CAH caribou. The TLH calves and summers in a core area surrounding Teshekpuk Lake in the NPRA, about 80 km west of the Colville River delta, 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 NPRA Study Area is within the year-round range of the TLH on the coastal plain (BLM 1998). The eastern extent of early surveys of the TLH was the western bank of the Nechelik (Nigliq) Channel on the Colville River delta (Reynolds 1982), and subsequent telemetry data corroborated that TLH caribou seldom move eastward across the Colville River.

Previous caribou studies in the NPRA have focused on the Teshekpuk Lake area to the west, the heart of the annual range of the TLH (BLM 1998, Prichard et al. 2001) and relatively little data has been collected in the 2001 NPRA Study Area. Specific information reported recently for the study area comes from satellite tracking of a few collared caribou (Philo et al. 1993, Prichard et al. 2001), aerial transect surveys that covered the northern portion of the area in 1999, 2000, and 2001 (Noel 2000; Noel et al. 2001; L. Noel, pers. comm.), and anecdotal reports from tracking animals fitted by ADFG with standard VHF radio-collars (G. Carroll, pers. comm.; E. Lenart, pers. comm.).

Caribou of the CAH also use the study area, albeit less frequently than do TLH caribou. Telemetry studies since the 1970s (e.g., Lawhead and Curatolo 1984, Cameron et al. 1995) have shown little use of the area west of the Colville River by CAH caribou during the calving and insect seasons, the periods of greatest use of the coastal plain by that herd. In June 2001, however, a radio-collared female of the CAH was found in the northeastern part of the NPRA, providing the first record of a CAH cow there during the calving season in >20 years of radio-tracking (E. Lenart, ADFG, pers. comm.).

On the central North Slope, caribou movements during midsummer are influenced predominantly by the occurrence of harassment by mosquitoes (*Aedes* spp.) and oestrid flies (*Hypoderma tarandi* and *Cephenemyia trompe*) (White et al. 1975, Roby 1978, Lawhead and Curatolo 1984). Mosquitoes typically emerge near the coast by the end of June or beginning of July and persist for at least a month until the end of July or early August. Mosquito activity is lowest at the Beaufort Sea coast due to low ambient air temperature and elevated wind speeds there (White et al. 1975, Dau 1986), so caribou normally move northward to the coast to escape mosquito harassment. Mosquito-harassed caribou will move coastward and upwind, but only as far as is necessary to reach insect-free habitat (Lawhead and Curatolo 1984, Dau 1986). River deltas provide important insect-relief habitat (Cameron 1983, Lawhead and Curatolo 1984), and the Colville delta is used by both the CAH and TLH, with the former predominating (Cameron et al. 1995, Johnson et al. 1998, Prichard et al. 2001, Lawhead and Prichard 2002).

Harassment of caribou by oestrid flies typically lasts from mid-July into August on the North Slope (Dau 1986). Fly-harassed caribou use unvegetated and elevated sites, such as pingos, mud flats, and river bars, as relief habitat. By August, insect harassment abates and coastal habitats become less important as caribou begin to disperse southward (Lawhead and Curatolo 1984, Prichard et al. 2001). This inland dispersal continues through fall migration in September and into the breeding season (rut) in October.

The majority of the CAH migrates south off the coastal plain to winter in the foothills and mountains of the Brooks Range (Cameron and Whitten 1979, Carruthers et al. 1987), but a large proportion of the TLH winters on the coastal plain in most years (Prichard et al. 2001). The location and extent of winter range use on the coastal plain appears to be a fundamental difference between the CAH and the TLH.

DISTRIBUTION AND ABUNDANCE

The precalving survey on 20 May 2001 was conducted to investigate reports of numerous caribou in the study area by hydrologists and helicopter pilots. The survey located 319 caribou in 55 groups (Figure 16, upper; Table 10), resulting in an estimate of more than 600 caribou in the entire area. The groups were widely scattered in small bands (averaging ~6 caribou per group), and tracks visible in the snow indicated little movement in the preceding days. No indications of migration to the west (toward Teshekpuk Lake) were observed, and no calves were seen on that date.

The 2 calving surveys on 9 and 17 June (Figure 16, lower; Table 10) revealed little use of the study area by calving females in 2001. A total of 123 total caribou and only 6 calves were recorded during the first survey and 459 total caribou and only 12 calves were recorded during the second survey. This finding was confirmed by the sex- and age-composition survey on 15 June (Figure 17, upper), which located 294 caribou comprising 101 cows (34%), 7 calves (2%), 73 yearlings (25%), 109 bulls (37%), and 4 adult-sized caribou that could not be classified (1%). The proportion of calves in the composition survey area was low (~7 calves: 100 cows) and the proportion of yearlings was high (~72 yearlings: 100 cows), suggesting that the survey area was outside (or at least at the periphery) of the concentrated calving area used by the TLH. The 2001 results corroborate the low use of the area found by transect surveys in 1999 (Noel 2000) and by satellite telemetry in 1990–1999 (Prichard et al. 2001). The survey results to date indicate that the NPRA Study Area is used by small numbers of parturient caribou during the calving season. The study area is located at the southeastern periphery of the TLH calving grounds and does not appear to be an important calving area.

The number of caribou using the area increased in the postcalving period before the start

Table 10. Number and density of caribou observed during 12 systematic aerial strip-transect surveys, NPRA Study Area, 20 May–24 October 2001.

| Date | No. of Large [a] | No. of Calves | Total No. | Density (caribou/km$^2$) | Mean Group Size |
|---|---|---|---|---|---|
| 20 May | 319 | 0 | 319 | 0.65 | 5.8 |
| 9 June | 117 | 6 | 123 | 0.26 | 3.6 |
| 17 June | 447 | 12 | 459 | 0.97 | 3.5 |
| 23 June | 654 | 43 | 697 | 1.47 | 4.3 |
| 12 July | 302 | 24 | 326 | 0.72 | 8.4 |
| 23 July | 636 | nr [b] | 636 | 1.40 | 127.2 |
| 4 August | 10 | 0 | 10 | 0.02 | 2.0 |
| 14 August | 59 | 3 | 62 | 0.13 | 2.1 |
| 28 & 30 August | 139 | 8 | 147 | 0.30 | 1.7 |
| 29 September | 652 | 36 | 688 | 1.39 | 10.6 |
| 12 October | 826 | 30 | 856 | 1.73 | 10.7 |
| 24 October | 377 | 35 | 412 | 0.83 | 5.7 |
| Total | 4,538 | 197 | 4,735 | 0.82 | 6.2 |

[a] Adults + yearlings.
[b] nr = calves present, but numbers not recorded.

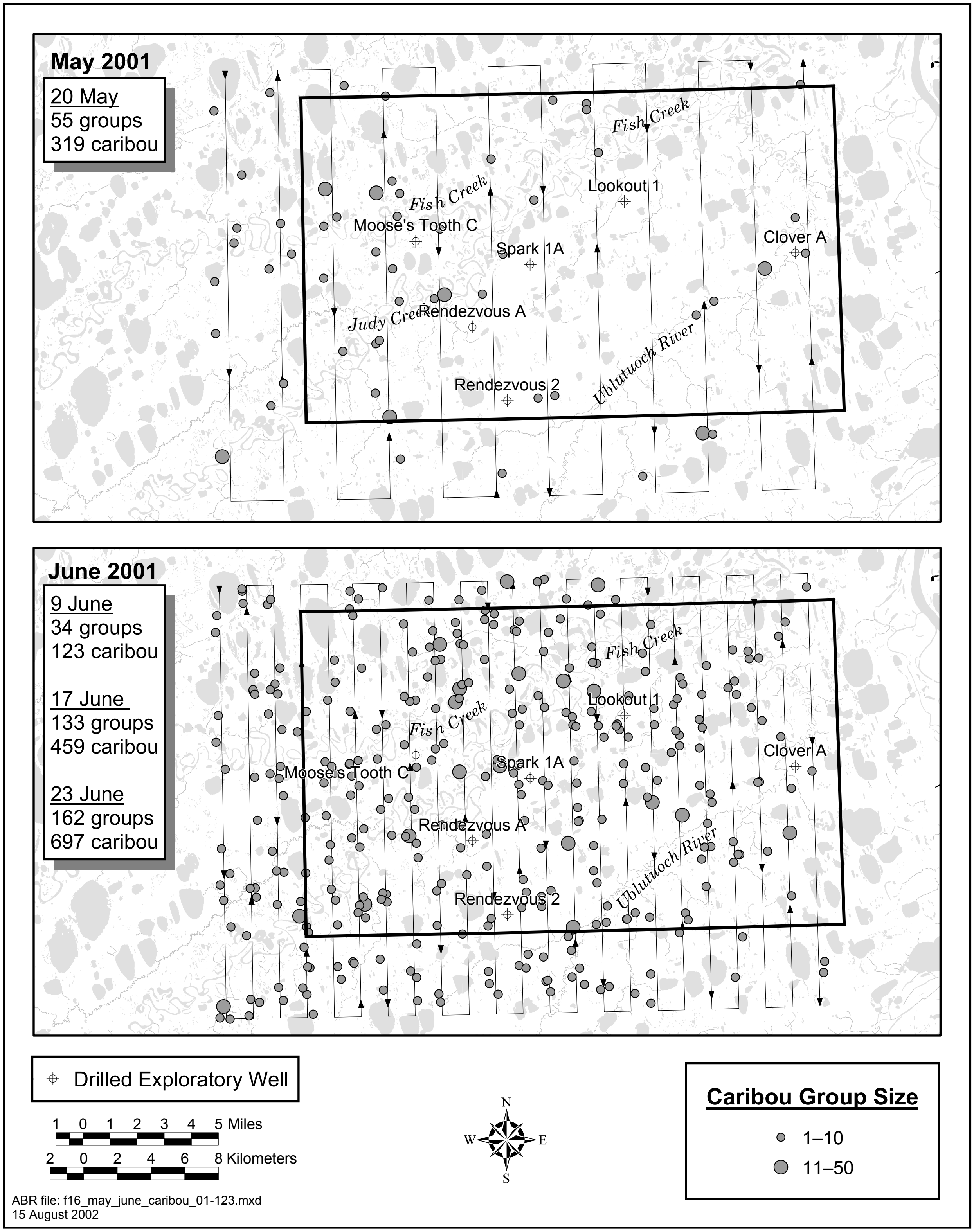


Figure 16. Distribution and group size of caribou observed during aerial strip-transect surveys in May (upper) and June (lower), NPRA Study Area, 2001.

of insect harassment; the 697 caribou recorded on 23 June was the second highest of all 12 surveys in 2001 (Table 10). This increase may represent a tendency for caribou to begin moving coastward as mosquito emergence proceeds farther inland, as has been reported for the CAH (Lawhead and Prichard 2002).

Surveys during the insect season found variable numbers of caribou in the study area (Figure 17, lower; Table 10), as would be expected from the fluctuating occurrence of insect activity in response to changing weather conditions. The study area is located inland from the coastal relief habitats likely to be used by mosquito-harassed caribou in early July. Incidental observations during the fox den survey in the southern half of the study area on 2 July, the first day of severe mosquito harassment, revealed only a single bull caribou. The second week of July 2001 was unusually cool, so virtually no insect harassment was recorded (Lawhead and Prichard 2002).

The number of caribou increased later in July, however. At least 10,700 CAH caribou, constituting the majority of the western segment of the herd, moved west from the Kuparuk River onto the Colville delta in the third week of July during a period of warm temperatures and persistent westerly winds (Lawhead and Prichard 2002). Many of those caribou continued west into NPRA while others remained on the delta. The rate of westward movement was rapid at times. The most notable example occurred on 23 July, when at least 6,000 CAH caribou were seen moving west through the study area, moving upstream along Fish Creek (P. Del Vecchio, ADFG, pers. comm.). When we conducted a transect survey later that same day, only 636 caribou remained in the northern portion of the study area (Figure 17, lower; Table 10). Many CAH caribou appeared to remain west of the Colville River well into August, as indicated by subsequent telemetry locations west and south of the study area, when radio-collared animals were distributed far inland (J. Hamilton, pers. comm.; S. Arthur, pers. comm.).

Late summer and fall are the seasons when the subsistence harvest of caribou by Nuiqsut residents typically reaches its annual peak. The majority of caribou harvested by Nuiqsut hunters are taken from July through October (Pedersen 1995, Brower and Opie 1997, Fuller and George 1997). The unusually large numbers of CAH caribou on the delta in the third week of July afforded excellent hunting opportunities to Nuiqsut residents. Surveys in August, however, found the lowest numbers of caribou in our entire study period, at 10, 62, and 147 caribou on 4, 14, and 28–30 August, respectively (Figure 18; Table 10), when caribou presumably were farther inland (as described above). This pattern of low numbers reversed dramatically by late September and October, however, when the highest (856 caribou on 12 October) and third highest numbers (688 caribou on 29 September) among all seasons were seen. The number of caribou using the study area peaked during the rut in mid-October, when 1,700 caribou were estimated to be present.

## FOX SURVEYS

### BACKGROUND

Both arctic and red foxes occur in northern Alaska on the Arctic Coastal Plain. Arctic foxes are common on the coastal plain. Red foxes are common in the foothills and mountains of the Brooks Range, but on the coastal plain are found primarily along major rivers (such as the Colville and Sagavanirktok rivers), where they are much less common than the arctic fox (Eberhardt 1977). Arctic and red foxes have similar denning requirements and sometimes use the same den sites in different years, although there appears to be a tendency for arctic foxes to avoid sites that have been used (and often enlarged) by red foxes. For both arctic and red foxes, lemmings and voles are the most important year-round prey, supplemented by carcasses of caribou and marine mammals and, in summer, by ground squirrels and nesting birds and their eggs; garbage is eaten when available (Chesemore 1968, Eberhardt 1977, Garrott et al. 1983b).

### Arctic Fox

Found throughout the coastal tundra of northern and western Alaska, the arctic fox is the most common predatory mammal on the Arctic Coastal Plain. The arctic fox is an important predator of nesting birds and small mammals, is a carrier of rabies, and is readily attracted to areas of human activity and artificial food sources (Eberhardt et al. 1982). Population estimates are

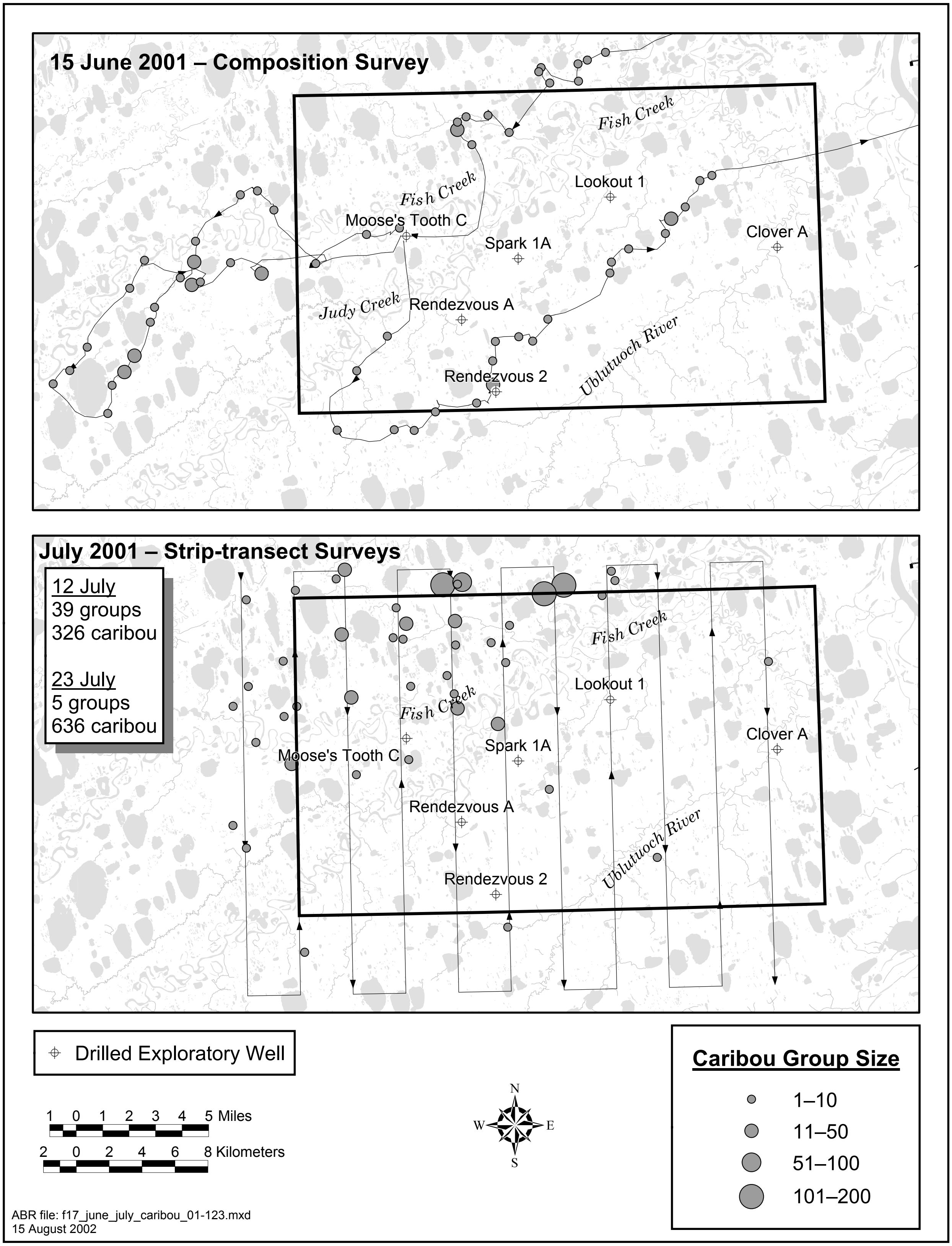


Figure 17. Survey route and caribou group locations during a sex- and age-composition survey on 15 June (upper), and distribution and group size of caribou observed during aerial strip-transect surveys in July (lower), NPRA Study Area, 2001.

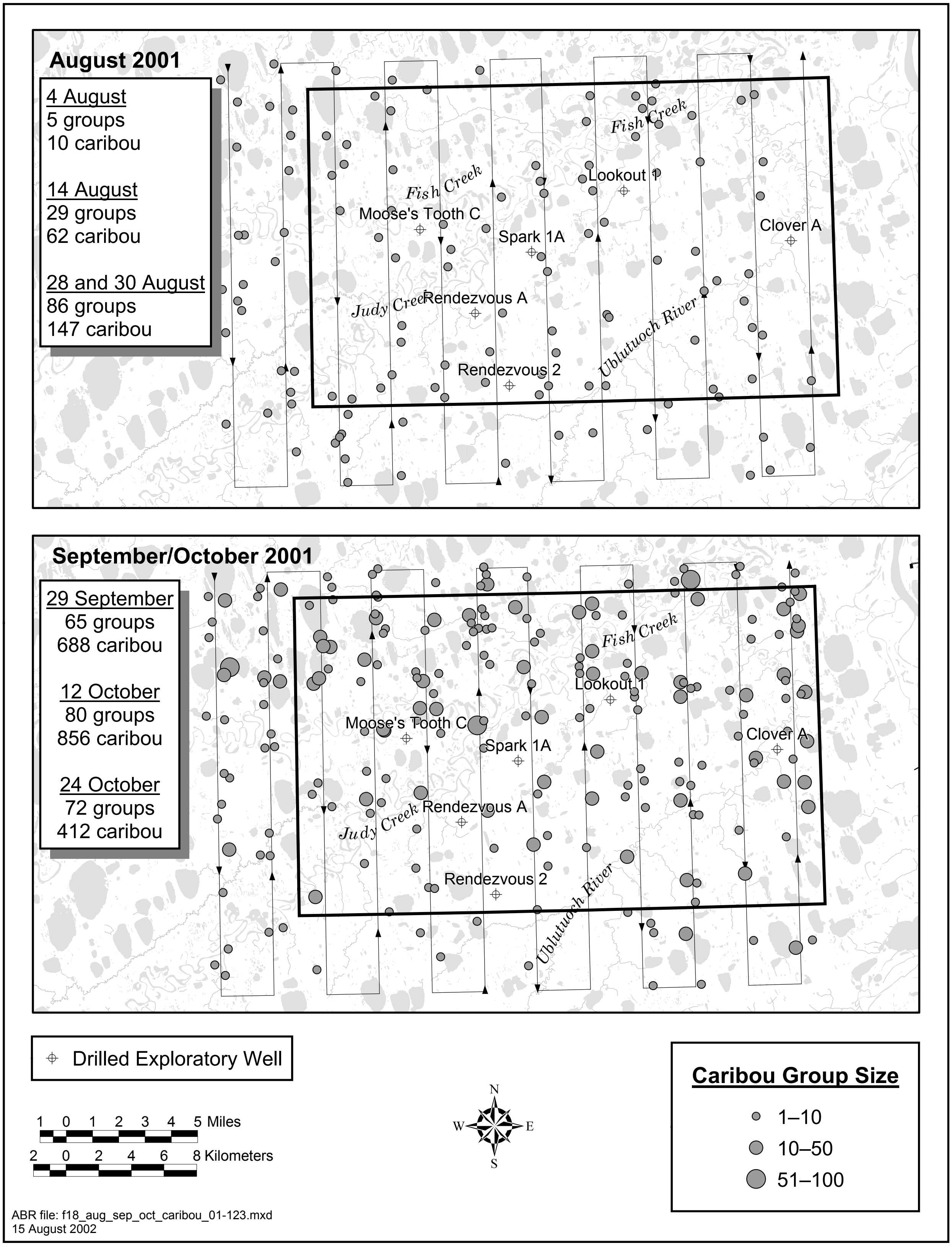


Figure 18. Distribution and group size of caribou observed during aerial strip-transect surveys in August (upper) and September–October (lower), NPRA Study Area, 2001.

difficult to derive for this species, but the population is known to undergo cycles in response to fluctuating populations of prey species (Follmann and Fay 1981, Burgess 2000). A prominent issue for oil and gas development in arctic areas is the well-documented attraction of foxes to artificial food sources, especially at areas of human activity, which creates the potential for fox population increases and associated negative effects on prey populations (Martin 1997, Day 1998, Burgess 2000).

In the winter, many foxes disperse widely from their summer territories (Chesemore 1975, Eberhardt and Hanson 1978), although recent satellite telemetry has demonstrated that some remain in the oilfield region throughout the winter (P. D. Martin, USFWS, pers. comm.). In late winter and spring, foxes move to summer territories to mate (March–April) and den.

Most pups are born in late May or June after a gestation period of ~52 days, and dens are occupied from late spring until pups disperse in August (Chesemore 1975). Pups first emerge from dens at 3–4 weeks of age (Garrott et al. 1984). Litters average 4–8 pups, but can range up to 15 pups in years when food is abundant (Chesemore 1975, Follmann and Fay 1981, Johnson et al. 1997). Survival of arctic fox pups to weaning is highest in years when small mammals (primarily lemmings) are abundant (Macpherson 1969). Causes of pup mortality include predation (mostly by Golden Eagles and grizzly bears), starvation, and sibling aggression (Macpherson 1969, Garrott and Eberhardt 1982, Burgess et al. 1993).

Home ranges of adult arctic foxes in the Prudhoe Bay Oilfield averaged 21 km² (8 mi²) (Eberhardt et al. 1982), but probably are larger outside the oilfields (away from artificial food sources). The density and occupancy rate of dens and the litter size and survival of pups is higher in oilfield areas than in undeveloped areas nearby (Burgess 2000). More den sites are available each year than are used (Macpherson 1969, Burgess 2000) and the rate of den occupancy is highest when food is abundant (Chesemore 1975, Eberhardt et al. 1983, Johnson et al. 2001). Foxes may return to the same den site in successive years.

Surveys conducted since 1992 have located ~75 fox dens in the area east of the NPRA Study Area, extending from the western Colville delta east to the Kuparuk Oilfield (Johnson et al. 2001, in prep.). Foxes dig dens in raised landforms with relatively well-drained soil and greater depth to frozen ground, such as ridges, dunes, lake and stream shorelines, and pingos (Chesemore 1969, Eberhardt et al. 1983, Burgess et al. 1993, Johnson et al. 2001). The habitats preferred by foxes for denning are the Riverine or Upland Shrub and the Moist Sedge–Shrub Meadow types (Johnson et al. 1999, 2001, in prep.). Most dens are located on microsites with higher topographic relief than their immediate surroundings.

### Red Fox

The red fox is much less abundant than the arctic fox on the Arctic Coastal Plain, where its distribution is restricted largely to major drainages such as the Colville and Sagavanirktok rivers (Eberhardt 1977, Johnson et al. 2001). Four to 6 red fox dens have been used annually on the Colville delta in recent years (Johnson et al. 2001, in prep.); all were located in sand dunes in the Riverine or Upland Shrub habitat type.

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 delta and adjacent coastal plain tundra (Johnson et al. 2001, in prep.). Red foxes have been seen using culverts in the northwestern Kuparuk Oilfield (A. Stickney, ABR, pers. comm.), so use of development infrastructure in NPRA by this species is a possibility.

## DISTRIBUTION AND ABUNDANCE

This first year of fox surveys in the NPRA Study Area located 24 dens (4 of which were reported by avian nest search crews), including both active and inactive sites (Figure 19, upper; Table 11) in ~15 hr of helicopter survey effort (including data recording at dens). This number of dens is minimal because the study area was not searched completely in 2001; thus, more dens will be found in future years with additional effort. All but one of the 24 sites were arctic fox dens (96% of the total); the sole exception was an inactive red fox den on a sand dune bordering Fish Creek. In comparison, 65 (87%) of 75 fox dens examined in

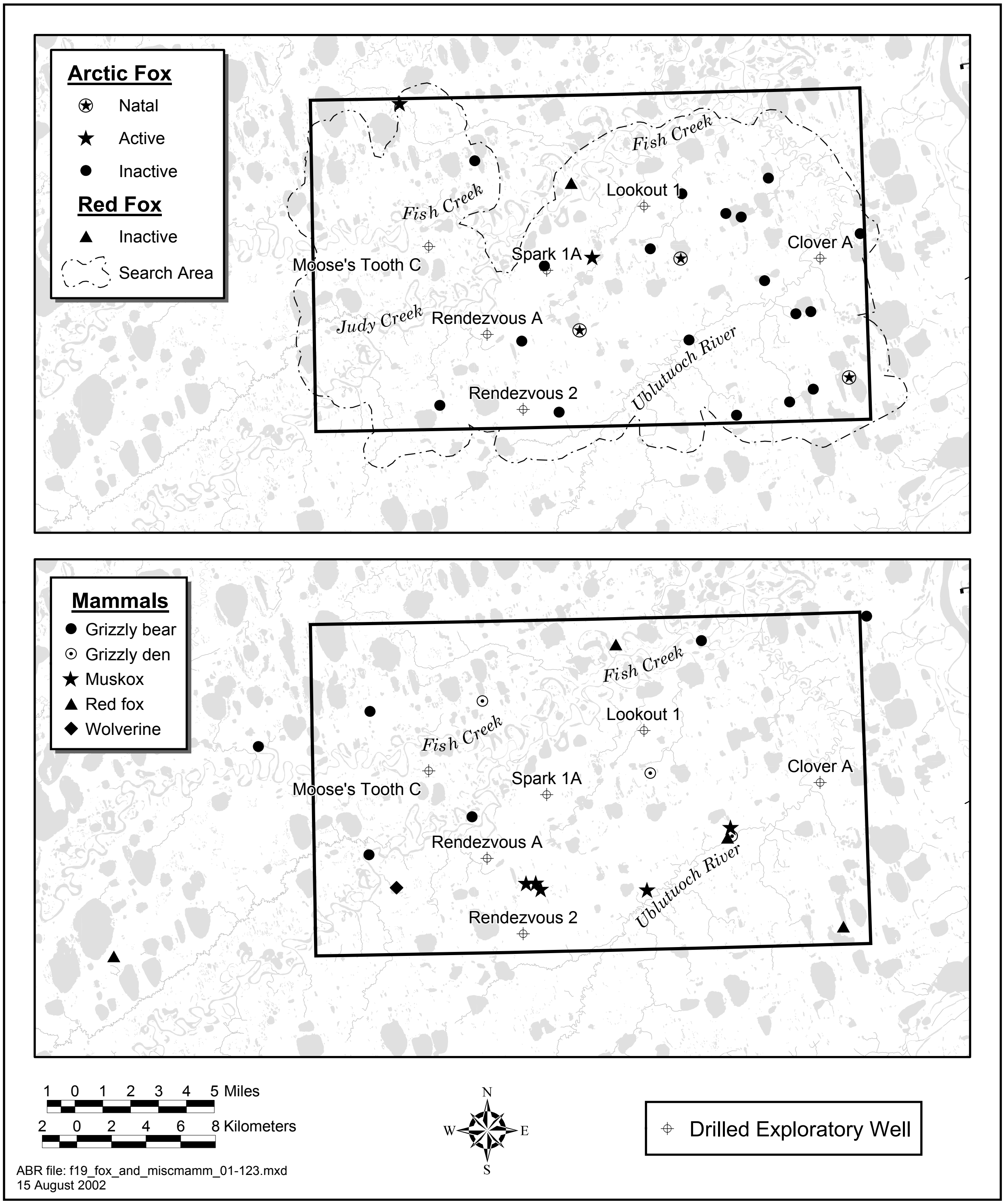


Figure 19. Distribution and activity status of fox dens observed in June–July (upper) and incidental sightings of other mammals (muskox, grizzly bear, red fox, wolverine) during aerial strip-transect surveys in May–October (lower), NPRA Study Area, 2001.

Table 11. Landforms, activity status, and number of pups counted at arctic and red fox den sites in the NPRA Study Area, June-July 2001.

| Species | Site No. | Landform | Status | Pup Count [a] |
|---|---|---|---|---|
| Arctic Fox | 200 | DLB bank [b] | Inactive | – |
| | 201 | DLB bank | Inactive | – |
| | 202 | Lake bank | Natal | 2 |
| | 203 | Low ridge | Inactive | – |
| | 204 | Lake bank | Inactive | – |
| | 205 | River bank | Inactive | – |
| | 206 | Stream bank | Inactive | – |
| | 207 | DLB bank | Inactive | – |
| | 208 | Lake bank | Natal | ≥2 |
| | 209 | Low mound | Inactive? | 0 |
| | 210 | Pingo | Inactive | – |
| | 211 | Lake bank | Inactive? | – |
| | 212 | Lake bank | Inactive | – |
| | 213 | Lake bank | Inactive | – |
| | 214 | DLB bank | Inactive | – |
| | 215 | Lake bank | Natal | 5 |
| | 216 | Stream bank | Inactive | 0 |
| | 218 | Low ridge | Inactive | 0 |
| | 219 | DLB bank | Inactive | – |
| | 220 | Low ridge | Active | 0 |
| | 221 | Low ridge | Inactive | – |
| | 222 | DLB bank | Active | 0 |
| | 223 | Lake bank | Inactive | – |
| Red Fox | 217 | Sand dune | Inactive | – |

[a] Zero indicates den was observed but no pups were seen.
[b] DLB = drained-lake basin.

2001 between the western edge of the Colville delta and the Kuparuk Oilfield were classified as arctic fox dens and the remaining 10 dens (13%) were classified as red fox dens; 4 of the latter sites were former arctic fox dens (Johnson et al., in prep.). Most of the area remaining to be searched for dens in the NPRA Study Area consists of sand dunes in the extensive complex of riparian habitats along Fish and Judy Creeks. This type of habitat is preferred by red foxes for denning on the Colville delta, so we expect to find a few more red fox dens, especially in view of the widespread sightings of the species in 2001 (Figure 19, lower). The small area of tundra remaining to be searched north of Fish Creek (Figure 19, upper) is more likely to contain arctic fox dens.

The presence of 23 arctic fox dens in the 615-km² NPRA Study Area produces an unadjusted density (i.e., including the portions not searched) of 1 den/27 km². When confined solely to the 2001 search area (524 km², or 85% of the study area), the density increases to 1 den/23 km². These figures are intermediate between the 1 den/37 km² in the Colville delta survey area (551 km²) and 1 den/17 km² in the Alpine Transportation Corridor survey area (343 km²) studied by Johnson et al. (2001, in prep.) east of the NPRA, which together included 35 arctic fox dens found over a period of 9 years. The density of arctic fox dens we found in NPRA 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 and Alpine Transportation Corridor study areas of Johnson et al. (2001, in prep.). The density of arctic fox dens in the NPRA Study Area is lower than was reported for the 805-km² developed area of the Prudhoe Bay Oilfield (1 den/12–15 km²; Eberhardt et al. 1983, Burgess et al. 1993, Rodrigues et al. 1994, Ballard et al. 2000), but was at the high-density end of the range reported for undeveloped areas nearby the Prudhoe field (1 den/28–72 km²; Burgess et al. 1993, Rodrigues et al. 1994, Ballard et al. 2000).

The single red fox den found and the incomplete search of the most suitable denning habitat make it pointless to calculate a density for this species in 2001. The density of red fox dens in the Colville delta survey area in 2001 was 1 den/61 km² (treating 2 adjacent dens used by one breeding pair of foxes as a single site) (Johnson et al., in prep.). Comparative data on den density are unavailable for this species from other arctic tundra areas, but it appears that the density of red fox dens on the Colville delta is particularly high for the Arctic Coastal Plain. Although we expect to find more red fox dens in the NPRA Study Area, we do not expect the density to be as high as on the Colville delta.

Based on brief visits at the 23 arctic fox dens during 1–2 and 12 July 2001 and longer observations at 7 of those dens during 12–16 July, we concluded that pups were present at a minimum of 3 natal dens and strongly suspected that pups were present at 2 other active dens (Table 11). Adults but no pups were seen at 3 other dens. Thus, the number of active dens (occupied at some point by pups) was estimated to be 5 (22%) of the 23 arctic fox dens; the remaining 18 dens (78%) showed signs of occasional use by adults only or were completely inactive. This den occupancy rate by litters (natal and active categories combined) was below the 8-year mean and at the low end of the range reported for the area between the western Colville delta and the Kuparuk Oilfield (mean = 38%; SD = 15%; range = 24–67%) (Johnson et al. 2001). 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. Burgess et al. (1993) estimated that 45–58% of the dens in their study area in the Prudhoe Bay Oilfield produced litters in 1992, although only 21% still were occupied by families at the time of ground visits in late July–early August. In 1993, the occupancy rate by arctic foxes at 53 natural den sites in the Prudhoe Bay Oilfield and surrounding area was 71%, and 49% of the sites were classified as natal dens (Ballard et al. 2000).

On 12, 14, and 16 July 2001, we expended ~24 hr observing 8 dens (7 arctic fox dens and 1 red fox den) that were suspected to be active on the initial check at the beginning of July. The red fox den was an inactive site, near which an adult had been seen sleeping in mid-June. We counted 9 pups at 3 arctic fox dens for a mean litter size of 3 pups (SD = 1.7, $n$ = 3) but did not observe pups at the 2 other dens that were strongly suspected of being natal sites. This litter size matches the mean for years when rodent prey are not numerous (see below). Estimates of pup production are minimal figures because pups often remain underground for extended periods, making it difficult to reliably obtain complete counts. In general, our observations at dens were most successful in obtaining pup counts during early morning and evening, when foxes tend to be most active. Counts are most reliable when adults deliver food to the den site (Eberhardt 1977, Fine 1980). 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). Garrott (1980) noted that movements of arctic foxes from natal dens to secondary dens typically occurred after early to mid-July when the young were 5–7 weeks old, and that interchange of young between dens occurred after the initial move. We could not confirm any such moves by arctic foxes in 2001, although several sites where adults were present on the first visit were deemed inactive when observed on subsequent visits.

The range of variation in litter size for arctic foxes in the Colville delta region is illustrated by the 1995 and 1998 means of 3.0 and 3.1 pups, respectively (Johnson et al. 1996, 1999), and the means of 5.4 and 6.1 pups from the high-production years of 1999 and 1996, respectively (Johnson et al. 1997, 2000b). These figures were virtually identical to those reported by Garrott (1980) for low and high years of 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 litter count. The occupancy rate and litter sizes at arctic fox dens in 2001 led us to infer that the density of small mammals in the NPRA Study Area was relatively low, although we have no population sampling data to support this inference.

## OTHER MAMMAL SURVEYS

### BACKGROUND

#### Muskox

Muskoxen are native to Alaska but were extirpated by the late 1800s (Smith 1989). Historical records (Bee and Hall 1956) indicate a high level of use of the NPRA Study Area by muskoxen before extirpation. 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, muskox sign had been found in the western Kuparuk Oilfield (P. Kleinleder, pers. comm.) and lone bulls were seen near the Colville River (Reynolds et al. 1986). Golden (1990) reported that a small, mixed-sex group of muskoxen first overwintered in the area southeast of Nuiqsut in 1988–1989. A few muskoxen (mostly lone bulls) were seen on the Colville delta in summer during 1992–1993 and 1995–1998 (Smith et al. 1993, 1994; Johnson et al. 1996, 1997, 1998, 1999), and a group of 10–11 adults (mostly bulls) used the northeastern portion of the delta consistently in 2001 (Lawhead and Prichard 2002).

Most of the muskox population that resides in the Colville–Itkillik region just east of the study area appears to winter in the Itkillik Hills, then disperses seasonally into smaller groups during summer, some of which move northward along the smaller drainages to the vicinity of the Colville delta, while others move to the Kuparuk River floodplain (Johnson et al. 1998, Danks 2000, Lawhead and Prichard 2002). Lenart (2001) counted 277 muskoxen between the Colville River and ANWR (Game Management Unit [GMU] 26B) in April 2000, 53% of the total number of 523 animals observed in northeastern Alaska (GMU 26B and 26C combined). Slightly fewer than half of the animals in GMU 26B were found west of the Sagavanirktok River (GMU 26B West), where late-winter surveys by ADFG counted 92 muskoxen in 1997, 79 in 1998, 96 in 1999, 90 in 2000, and estimated 107 in 2001 (Lenart 2001). Thus, at least 100 muskoxen reside in the area between the Sagavanirktok and Colville rivers and occur consistently in winter across the Itkillik Hills and the upper Kuparuk River. Lawhead and Prichard (2002) estimated that at least 151 different muskoxen occurred in the general region stretching from the NPRA Study Area to the Sagavanirktok River, including animals as far east as Franklin Bluffs and as far west as the west side of the Colville River and NPRA. Muskox numbers in the northeastern portion of NPRA are not well-documented, but appear to be lower than in the area east of the Colville River. Suitable habitat exists in northeastern NPRA and it is expected that the population in the area will continue to increase (BLM 1998, Danks 2000).

Muskoxen home ranges are smaller and activity and movement rates are much lower during winter than summer. Long-distance movements from winter to summer ranges are common in mid- to late June following river break-up and leafing out of willows along drainages (Reynolds 1992b). Group size typically decreases from winter to summer as the breeding season (rut) approaches; most groups in ANWR ranged from 10 to 30 animals (Reynolds et al. 1986, Reynolds 1992a). The breeding season occurs in August and September, and calves are born between late April and late June, peaking around mid-May (Reynolds et al. 1986). Cows produce single calves at intervals of one to 3 years. Habitat use by muskoxen varies seasonally. In winter, muskoxen select upland habitats near ridges and bluffs with shallow, soft snow cover that permits easy access to food plants (Klein et al. 1993). In spring, muskoxen use moist tussock tundra and moist sedge–shrub tundra, apparently seeking high-quality flowering sedges (Jingfors 1980, Reynolds et al. 1986). By late spring and summer, muskoxen prefer river terraces, gravel bars, and shrub stands along rivers and tundra streams

(Jingfors 1980, Robus 1981), where they eat willow leaves, forbs (especially legumes), and sedges (Robus 1984, O'Brien 1988). Thus, riparian shrub habitats and moist sedge–shrub meadows are the most important habitats for muskoxen.

### Grizzly Bear

The grizzly bear (also called brown bear) is more likely to be encountered in the NPRA Study Area than is the polar bear (Bee and Hall 1956, BLM 1998); den records for the latter species (S. Schliebe, USFWS, unpubl. data) do not include any dens in the study area. Grizzly bears occur throughout northern Alaska from the Brooks Range to the Arctic Ocean. Population densities of grizzlies are considerably lower on the coastal plain than in the mountains and foothills (Shideler and Hechtel 2000). The number of bears using the northeastern NPRA is not well-documented, being confined mainly to a few incidental sightings (e.g., Noel 1999, 2000). The population to the east in the Prudhoe Bay and Kuparuk oilfields appears to have increased in the last 2 decades, however, and is likely to remain high because of the high survival of cubs born to females in the oilfields (Shideler and Hechtel 2000). ADFG biologists estimate that 60–70 grizzlies inhabit the "oilfield region" between the Colville and Canning rivers, extending inland 100 km to the White Hills, for a mean density of ~4 bears/100 km², about twice the density estimated for other areas of the coastal plain (Shideler and Hechtel 2000). Adult female bears have large home ranges (2,300–4,700 km²) and are highly mobile, sometimes moving 50 km a day (Shideler and Hechtel 2000). Adult males cover even larger areas, especially during the breeding season in June when they typically move through the home ranges of several females.

Grizzly bears in northern Alaska occupy dens between late September and May. One to 3 cubs (mean of 2) are born per litter in December or January (Reynolds 1979, Garner and Reynolds 1986, Shideler and Hechtel 1995). Males and females remain separate for most of the year, coming together only briefly to court and mate between May and July (Garner et al. 1986). All bears occupy winter dens, with females and cubs entering dens earlier and emerging later than males and single females (Garner and Reynolds 1986, Shideler and Hechtel 2000). On the coastal plain, where permafrost limits the amount of denning habitat, grizzlies dig dens in pingos, banks of rivers and lakes, dunes, and steep gullies in uplands (Harding 1976, Shideler and Hechtel 2000). Most of the bears studied by ADFG denned within 50 km of the oilfields, although a few denned up to 90 km inland (Shideler and Hechtel 1995, 2000). Most grizzly dens in the Colville–Kuparuk region are clustered in the uplands southeast of the Colville River Delta, in the headwaters of the Miluveach and Kachemach rivers, although dens occur in low densities across the coastal plain tundra in suitable sites. Little information is available on the occurrence of dens in the NPRA Study Area.

Grizzlies use river drainages on the coastal plain as primary travel routes, foraging areas, and denning areas (Johnson et al. 1996, Shideler and Hechtel 2000). In spring and summer, grizzly bears mainly eat plants, but also take ground squirrels, fox pups, caribou, and muskoxen (Quimby 1974, Garner and Reynolds 1986, Garner et al. 1986, Shideler and Hechtel 2000). Riparian habitats contain concentrations of preferred foods such as legumes (flowering plants in the pea family) and ground squirrels, and radio-tracking has confirmed they are preferred habitats (Shideler and Hechtel 2000). Artificial food sources also are powerful attractants, so human facilities located near rivers are especially likely to attract grizzly bears.

### Wolverine

Wolverines are uncommon to rare on the coastal plain; they are more abundant in the foothills and mountains of the Brooks Range (Bee and Hall 1956, BLM 1998). In the mid-1980s, a rough population estimate of ~820 wolverines was calculated for the western North Slope (GMU 26A), assuming a density of 1 wolverine/140 km² (BLM 1998), but no other population estimates are available. Wolverines are harvested by subsistence hunters and trappers from Nuiqsut and other North Slope villages primarily during the winter months, when snowmachines provide wide-ranging access. In 1992, the estimated harvest by Nuiqsut residents was 14 wolverines (Fuller and George 1997) and 8 wolverines were reportedly taken in 1994–1995 (Brower and Opie 1997). Female wolverines give birth and rear young in winter dens excavated in snowdrifts and areas of deep snow cover. Wolverines have been observed rarely during caribou and waterfowl surveys in summer and fall on the Kuparuk River (ABR, unpubl. data) and on and near the Colville delta. Single adult wolverines were seen along the Tamayagiaq Channel of the Colville delta on 27 June 1993 (Smith et al. 1994) and near the mouth of the Kachemach River on 11 June 1998 (Johnson et al. 1999). Two wolverine sightings were reported in the vicinity of the NPRA Study Area in 1977–1978 (BLM 1998).

## DISTRIBUTION AND ABUNDANCE

### Muskox

One small group of muskoxen was seen in the NPRA Study Area in 2001. The group, comprising 5 or 6 adults at various times, was seen on 5 occasions between 9 June and 27 June, with successive locations proceeding eastward through the southern portion of the study area (Figure 19, lower; Table 12). No calves were present in this group, but a small group of 3 adults and 2 calves was seen east of the study area in the Colville River floodplain on 20 August 2001. Two other groups were seen near the Colville River ~20 km and ~45 km south of the study area on 23 May, containing 9 and 12 animals, respectively; the latter group included 2 young calves (Lawhead and Prichard 2002).

### Grizzly Bear

Grizzly bears were seen on 7 occasions in 2001 (Table 12). Four of the sightings occurred in the NPRA Study Area, one was just outside the northeast corner, and the other 2 were south and west of the area (Figure 19, lower). Two of these sightings were females with cubs. The pattern of sightings indicated a tendency to use the riparian habitats along Fish and Judy creeks, areas containing high concentrations of preferred foods such as ground squirrels and legumes.

Table 12. Mammals observed incidentally during aerial surveys of caribou and waterbirds in and near the NPRA Study Area, 20 May–24 October 2001.

| Species | Date | No. of Adults | No. of Young | Comments |
|---|---|---|---|---|
| Muskox | 9 June | 5 | 0 | Near Rendezvous A exploratory well site |
| | 11 June | 5 | 0 | Near Rendezvous A exploratory well site |
| | 17 June | 6 | 0 | Near Rendezvous A exploratory well site |
| | 23 June | 6 | 0 | N bank of Ublutuoch River |
| | 27 June | 5 | 0 | N bank of Ublutuoch River |
| | 20 August | 3 | 2 | Colville River, SE of Nuiqsut (not on Fig. 19) |
| Grizzly bear | 23 June | 1 | 0 | Judy Creek, SW portion of study area |
| | 30 June | 1 | 0 | NW portion of study area, N of Fish Creek |
| | 14 July | 1 | 0 | NE corner of study area |
| | 23 July | 1 | 0 | Fish Creek, W of study area |
| | 14 August | 1 | 1 | Colville River, S of study area (not on Fig.19) |
| | 21 August | 1 | 2 | Fish Creek; yearling or 2-yr-old cubs |
| | 24 August | 1 | 0 | Judy Creek near Moose's Tooth C exploratory well site |
| Grizzly den | 1 July | – | – | N bank of Ublutuoch River |
| | 2 July | – | – | At fox den site 219 |
| | 12 July | – | – | W bank of drained-lake basin, N of Fish Creek |
| Red fox | 20 May | 1 | 0 | Ublutuoch River |
| | 15 June | 1 | 0 | W of study area (not on Fig. 19) |
| | 21 August | 1 | 0 | Fish Creek |
| | 12 October | 1 | 0 | SE corner of study area |
| Wolverine | 29 September | 1 | 0 | SW portion of study area |

Three grizzly bear dens were found during the fox den survey in July 2001 (Figure 19, lower). All were estimated to have been used within the preceding 2–3 years at most; the size and shallowness of grizzly dens generally results in collapse within a few seasons after use. One of the dens was excavated in a river bank, one in a low ridge adjacent to an arctic fox den, and the third was in the bank of a drained-lake basin (Table 12). Several of the bears radio-collared by ADFG in the oilfield region have denned near the Colville River or on the Colville delta in past years, but no dens have been located in the NPRA Study Area. With further search effort for fox dens, more bear dens likely will be found.

Wolverine

One adult wolverine was seen south of Fish Creek in the southwestern portion of the study area on 29 September 2001 during a caribou survey (Figure 19, lower; Table 12).

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Appendix A. Common and scientific names of birds and mammals observed in the NPRA Study Area, Alaska, 1999–2001.

| COMMON NAME | SCIENTIFIC NAME | COMMON NAME | SCIENTIFIC NAME |
|---|---|---|---|
| BIRDS | | | |
| Red-throated Loon | *Gavia stellata* | Upland Sandpiper | *Bartramia longicauda* |
| Pacific Loon | *Gavia pacifica* | Whimbrel | *Numenius phaeopus* |
| Yellow-billed Loon | *Gavia adamsii* | Bar-tailed Godwit | *Limosa lapponica* |
| Red-necked Grebe | *Podiceps grisegena* | Ruddy Turnstone[b] | *Arenaria interpres* |
| Greater White-fronted Goose | *Anser albifrons* | Semipalmated Sandpiper | *Calidris pusilla* |
| Canada Goose | *Branta canadensis* | Baird's Sandpiper | *Calidris bairdii* |
| Brant | *Branta bernicla* | Pectoral Sandpiper | *Calidris melanotos* |
| Tundra Swan | *Cygnus columbianus* | Dunlin | *Calidris alpina* |
| Northern Shoveler | *Anas clypeata* | Stilt Sandpiper | *Calidris himantopus* |
| Northern Pintail | *Anas acuta* | Long-billed Dowitcher | *Limnodromus scolopaceus* |
| Green-winged Teal | *Anas crecca* | Common Snipe | *Gallinago gallinago* |
| Greater Scaup[a] | *Aythya marila* | Red-necked Phalarope | *Phalaropus lobatus* |
| Steller's Eider | *Polysticta stelleri* | Red Phalarope | *Phalaropus fulicaria* |
| Spectacled Eider | *Somateria fischeri* | Pomarine Jaeger | *Stercorarius pomarinus* |
| King Eider | *Somateria spectabilis* | Parasitic Jaeger | *Stercorarius parasiticus* |
| Surf Scoter[b] | *Melanitta perspicillata* | Long-tailed Jaeger | *Stercorarius longicaudus* |
| White-winged Scoter | *Melanitta fusca* | Glaucous Gull | *Larus hyperboreus* |
| Long-tailed Duck | *Clangula hyemalis* | Sabine's Gull | *Xema sabini* |
| Red-breasted Merganser | *Mergus serrator* | Arctic Tern | *Sterna paradisaea* |
| Bald Eagle | *Haliaeetus leucocephalus* | Snowy Owl[b] | *Nyctea scandiaca*. |
| Northern Harrier | *Circus cyaneus* | Short-eared Owl | *Asio flammeus* |
| Rough-legged Hawk[b] | *Buteo lagopus*. | Common Raven | *Corvus corax* |
| Golden Eagle | *Aquila chrysaetos* | Horned Lark[b] | *Eremophila alpestris*. |
| Merlin | *Falco columbarius* | Yellow Wagtail | *Motacilla flava* |
| Peregrine Falcon | *Falco peregrinus* | Wilson's Warbler | *Wilsonia pusilla* |
| Willow Ptarmigan | *Lagopus lagopus* | American Tree Sparrow | *Spizella arborea* |
| Rock Ptarmigan | *Lagopus mutus* | Savannah Sparrow | *Passerculus sandwichensis* |
| Sandhill Crane[b] | *Grus canadensis* | Lapland Longspur | *Calcarius lapponicus* |
| Black-bellied Plover | *Pluvialis squatarola* | Snow Bunting[b] | *Plectrophenax nivalis*. |
| American Golden-Plover | *Pluvialis dominica* | Common Redpoll | *Carduelis flammea* |
| Semipalmated Plover[b] | *Charadrius semipalmatus* | | |
| MAMMALS | | | |
| Arctic Ground Squirrel | *Spermophilus parryii* | Grizzly Bear | *Ursus arctos* |
| Brown Lemming[b] | *Lemmus sibiricus* | Ermine[b] | *Mustela erminea* |
| Collared Lemming | *Dicrostonyx rubricatus* | Wolverine | *Gulo gulo* |
| Gray Wolf[b] | *Canis lupus* | Caribou | *Rangifer tarandus* |
| Arctic Fox | *Alopex lagopus* | Muskox | *Ovibos moschatus* |
| Red Fox | *Vulpes vulpes* | | |

[a] Unidentified scaup observed, probably Greater Scaup.
[b] Indicates species not observed during this investigation, but known to occur in the NPRA.

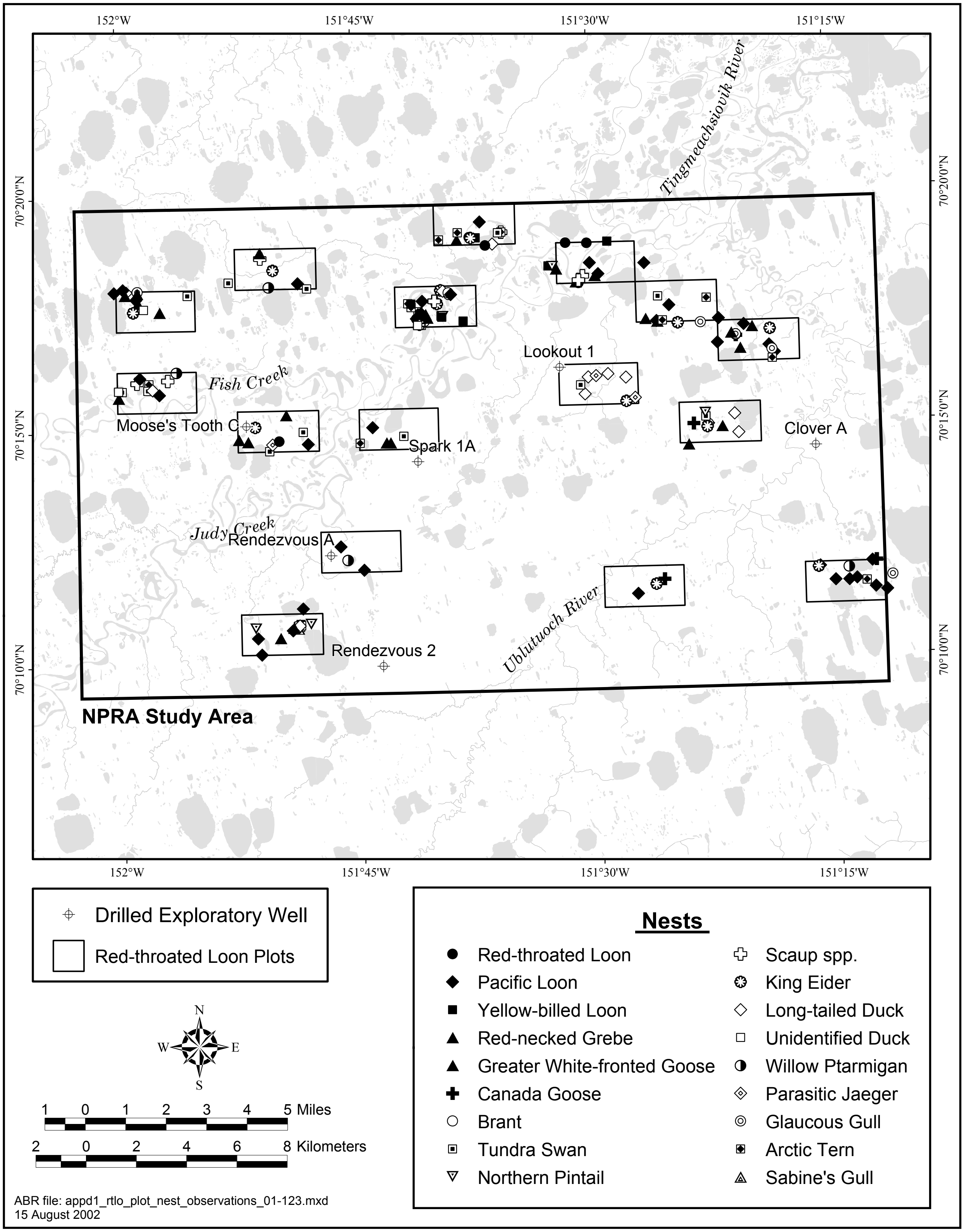
Appendix B. Coordinates (North American Datum 83 in decimal degrees) of endpoints for the midlines of the 24 breeding-bird plots in the NPRA Study Area, Alaska, 2001.

| | Start | | End | |
|---|---|---|---|---|
| Plot No. | Latitude | Longitude | Latitude | Longitude |
| 1 | 70.27807 | -151.98065 | 70.28508 | -151.99740 |
| 2 | 70.27635 | -151.98452 | 70.27437 | -151.95508 |
| 3 | 70.27805 | -151.94412 | 70.27915 | -151.91730 |
| 4 | 70.28369 | -151.94296 | 70.28182 | -151.91683 |
| 25 | 70.23495 | -151.76157 | 70.24262 | -151.77585 |
| 26 | 70.25840 | -151.74066 | 70.25140 | -151.76213 |
| 27 | 70.25087 | -151.73165 | 70.24183 | -151.73487 |
| 28 | 70.24185 | -151.74382 | 70.23347 | -151.75871 |
| 33 | 70.20074 | -151.74321 | 70.20966 | -151.73777 |
| 34 | 70.20154 | -151.73203 | 70.19409 | -151.71738 |
| 35 | 70.20267 | -151.72727 | 70.19595 | -151.70987 |
| 36 | 70.20160 | -151.71855 | 70.21052 | -151.72302 |
| 45 | 70.28148 | -151.91757 | 70.29062 | -151.61970 |
| 46 | 70.29528 | -151.59748 | 70.29245 | -151.57213 |
| 47 | 70.29302 | -151.55849 | 70.29842 | -151.57989 |
| 48 | 70.29486 | -151.55057 | 70.30372 | -151.55568 |
| 53 | 70.28950 | -151.24070 | 70.29638 | -151.25748 |
| 54 | 70.29119 | -151.23918 | 70.28442 | -151.21965 |
| 55 | 70.29785 | -151.21815 | 70.30703 | -151.21108 |
| 56 | 70.29295 | -151.20960 | 70.30186 | -151.20676 |
| 65 | 70.17402 | -151.32649 | 70.17376 | -151.35454 |
| 66 | 70.17242 | -151.32566 | 70.17152 | -151.35177 |
| 67 | 70.16514 | -151.32670 | 70.15636 | -151.32131 |
| 68 | 70.15950 | -151.35153 | 70.16823 | -151.35814 |

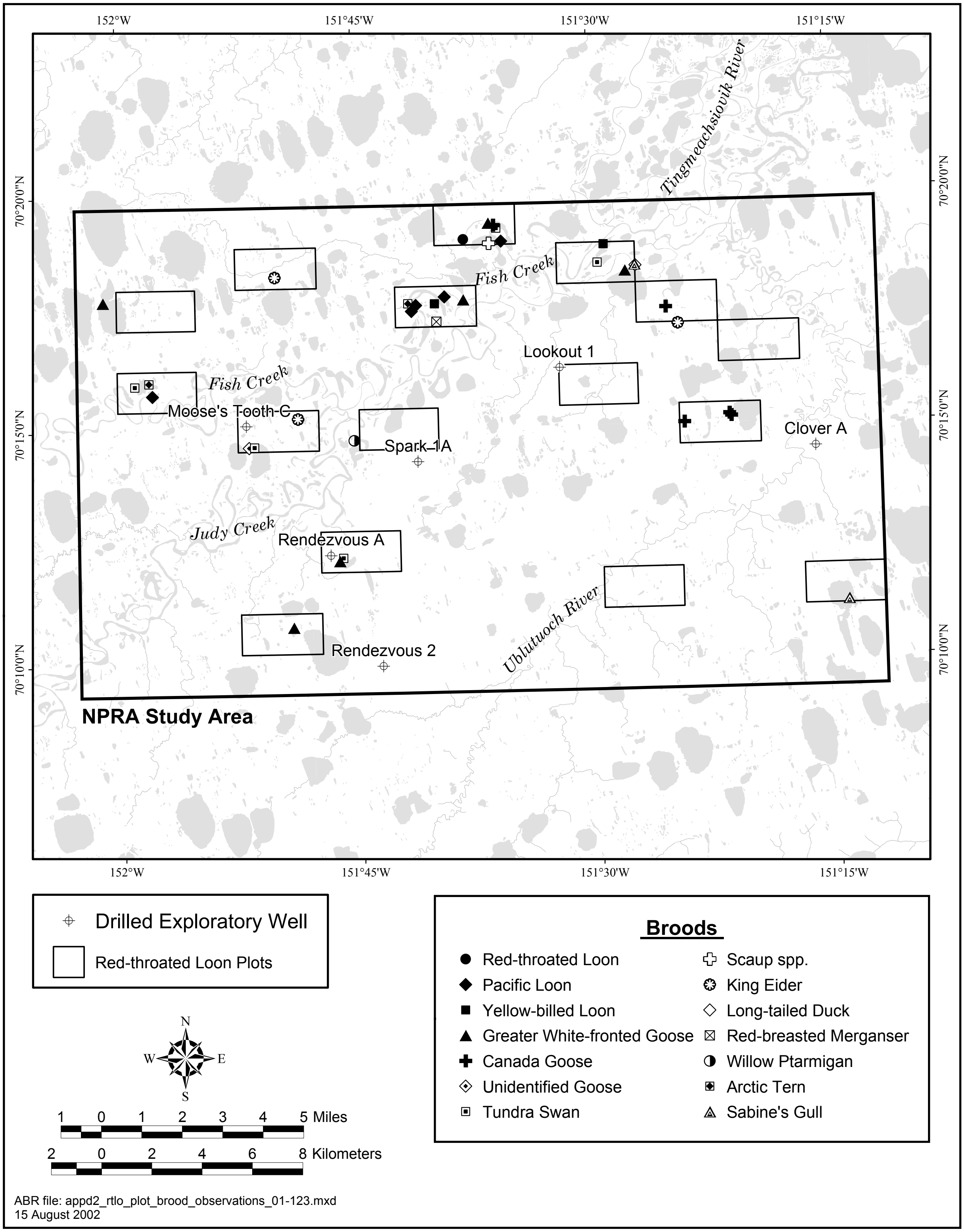
Appendix C. Number of nests, broods, and young found on 16 Red-throated Loon plots in the NPRA Study Area, 2001.

| | Nesting | | Brood-rearing[a] | | |
|---|---|---|---|---|---|
| Species | No. Plots[b] | No. Nests | No. Plots[b] | No. Broods | No. Young |
| Red-throated Loon | 3 | 6 | 1 | 1 | 1 |
| Pacific Loon | 15 | 31 | 3 | 5 | 5 |
| Yellow-billed Loon | 4 | 6 | 2 | 2 | 2 |
| Red-necked Grebe | 1 | 1 | – | – | – |
| Greater White-fronted Goose | 11 | 24 | 6 | 6 | 21 |
| Canada Goose | 4 | 4 | 3 | 5 | 18 |
| Brant | 1 | 2 | – | – | – |
| Tundra Swan | 9 | 11 | 5 | 5 | 10 |
| Northern Pintail | 3 | 4 | – | – | – |
| Scaup spp. | 5 | 7 | 1 | 1 | 4 |
| King Eider[c] | 11 | 13 | 3 | 3 | 10 |
| Long-tailed Duck | 7 | 12 | 1 | 1 | 6 |
| Red-breasted Merganser | – | – | 1 | 1 | 7 |
| Unidentified duck | 3 | 4 | – | – | – |
| Willow Ptarmigan | 4 | 4 | 1 | 1 | 1 |
| Parasitic Jaeger | 2 | 3 | – | – | – |
| Glaucous Gull | 4 | 7 | – | – | – |
| Sabine's Gull | 1 | 1 | 2 | 2 | 4 |
| Arctic Tern | 8 | 19 | 2 | 2 | 2 |

[a] Broods were seen during the mid-July nesting survey and the August brood-rearing survey. Only 4 of 16 plots were surveyed during the August brood-rearing survey.
[b] Numbers in this column indicate the number of plots on which a species was observed.
[c] Includes 3 probable King Eider nests identified from feather and down samples.




Appendix D1. Locations of nests found during ground searches on 16 Red-throated Loon plots in the NPRA Study Area, 2001.




Appendix D2. Locations of broods found during ground searches on 16 Red-throated Loon plots in the NPRA Study Area, 2001.