AVIAN STUDIES IN THE WILLOW PROJECT AREA, 2017

Charles B. Johnson
Julie P. Parrett
Pamela E. Seiser
John E. Shook

Prepared for
CONOCOPHILLIPS ALASKA, INC.
Anchorage, Alaska

Prepared by
ABR, INC.—ENVIRONMENTAL RESEARCH & SERVICES
Fairbanks, Alaska

AVIAN STUDIES IN THE WILLOW PROJECT AREA, 2017

FINAL REPORT

Prepared for

ConocoPhillips Alaska, Inc.

P.O. Box 100360

Anchorage, AK 99510

Prepared by

Charles B. Johnson

Julie P. Parrett

Pamela E. Seiser

John E. Shook

ABR, Inc.—Environmental Research & Services

P.O. Box 80410

Fairbanks, AK 99708

April 2018

Printed on recycled paper.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

ACKNOWLEDGMENTS

Avian surveys in the Alpine Satellite Development Plan area were conducted by an experienced crew consisting of Tim Obritschkewitsch and co-authors John Shook and Julie Parrett. Tawna Morgan programmed the tablet for aerial survey recording. Pam Odom provided travel and publication support. Will Lentz and Tony LaCortiglia supplied equipment and technical assistance. Bob Burgess reviewed the report. This work was directed by Robyn McGhee, Environmental Studies Coordinator at ConocoPhillips; we appreciate Robyn's and ConocoPhillips' continued support.

INTRODUCTION

The Colville River delta and Northeast Planning Area of the National Petroleum Reserve in Alaska (NE NPR-A) have been focal points of exploration and development for oil and gas since at least the 1990s. During 2017, ABR, Inc., conducted baseline wildlife surveys for selected birds in the Willow Project area of the NE NPR-A in support of ConocoPhillips, Alaska, Inc. (CPAI). Previous studies in the area are described by Johnson et al. (2015).

In this report, we present the results of avian surveys that were conducted in the Willow Project area in 2017. The surveys were designed to collect data on the distribution, abundance, and habitat use of 2 focal taxa (common names followed in parentheses by Iñupiaq names and scientific names) in support of permit applications: Spectacled Eider (Qavaasuk, *Somateria fischeri*) and Yellow-billed Loon (Tuullik, *Gavia adamsii*). These 2 species were selected because of 1) threatened or sensitive status, 2) restricted breeding range, and 3) best management practices adopted for NPR-A (BLM 2013). Spectacled Eider is a federally listed threatened species, and Yellow-billed Loon is currently a BLM sensitive species (BLM 2014) and has a limited breeding range. Data were collected on other eider species concurrently during the Spectacled Eider survey and on other loon species and gulls during surveys for Yellow-billed Loons.

Required state and federal permits were obtained for all survey activities, including a Scientific Permit (Permit No. 17-132) from the State of Alaska and a Federal Fish and Wildlife Permit [Native Threatened Species Recovery–Threatened Wildlife; Migratory Birds, Permit No. TE012155-6 issued under Section 10(a)(1)(A) of the Endangered Species Act (58 FR 27474)] from the U.S. Fish and Wildlife Service Endangered Species Permit Office.

STUDY AREA

The Willow Project area is located in the NE NPR-A about 31 km (19 miles) west of Nuiqsut (Figure 1). The area studied for the Willow Project in 2017 extended approximately 32 km (20 miles) west from the proposed GMT-2 drill site, approximately 19 km (12 miles) north of GMT-2 and 24 km (15 miles) south of GMT-2. The avian study comprised one eider survey area (1,404 km²) and 2 slightly overlapping loon survey areas (together comprising 502 km²) covering potential Yellow-billed Loon nesting and brood-rearing lakes within 3 miles of proposed facilities in the Willow Project area and the adjacent GMT corridor (Figure 1).

Landforms, vegetation, and wildlife habitats in the Willow Project area were described in Wells et al. (2018). Johnson et al. (2015) provided the previous habitat map and descriptions for the NE NPR-A, which included the GMT-2 area before the Willow Project area was mapped.

METHODS

We collected data on eiders in the Willow Project area and on loons in the Willow Project area and in the adjacent GMT corridor. Aerial surveys were used because of the large size of the areas and the short periods of time that each species is at the optimal stage for data collection. In 2017, 1 aerial survey for eiders during pre-nesting was conducted using fixed-wing aircraft and 2 aerial surveys (1 for nesting and 1 for brood-rearing) were conducted from a helicopter for Yellow-billed Loons. Nesting and brood-rearing Pacific Loons (Malġi, *Gavia pacifica*), Red-throated Loons (Qaqsrauq, *G. stellata*), and gulls were recorded during loon surveys. Each of these surveys was scheduled specifically for the period when the species was most easily detected or when the species was at an important stage of its breeding cycle (e.g., nesting or raising broods). See Table 1 for survey details.

Concerns about disturbance to local residents and wildlife from survey flights have dictated that we conduct the fewest survey flights necessary and at the highest altitudes possible. Flight altitudes were set at the maximum level at which the target species could be adequately detected and counted (see survey protocols for each species group below). Daily phone calls with Nuiqsut subsistence representatives were used to identify locations with active hunting parties. Additionally, aerial observers looked for people, boats, and off road vehicles that might indicate presence of subsistence hunters. If hunting parties were present, we diverted the airplane or helicopter to reduce disturbance to hunters.

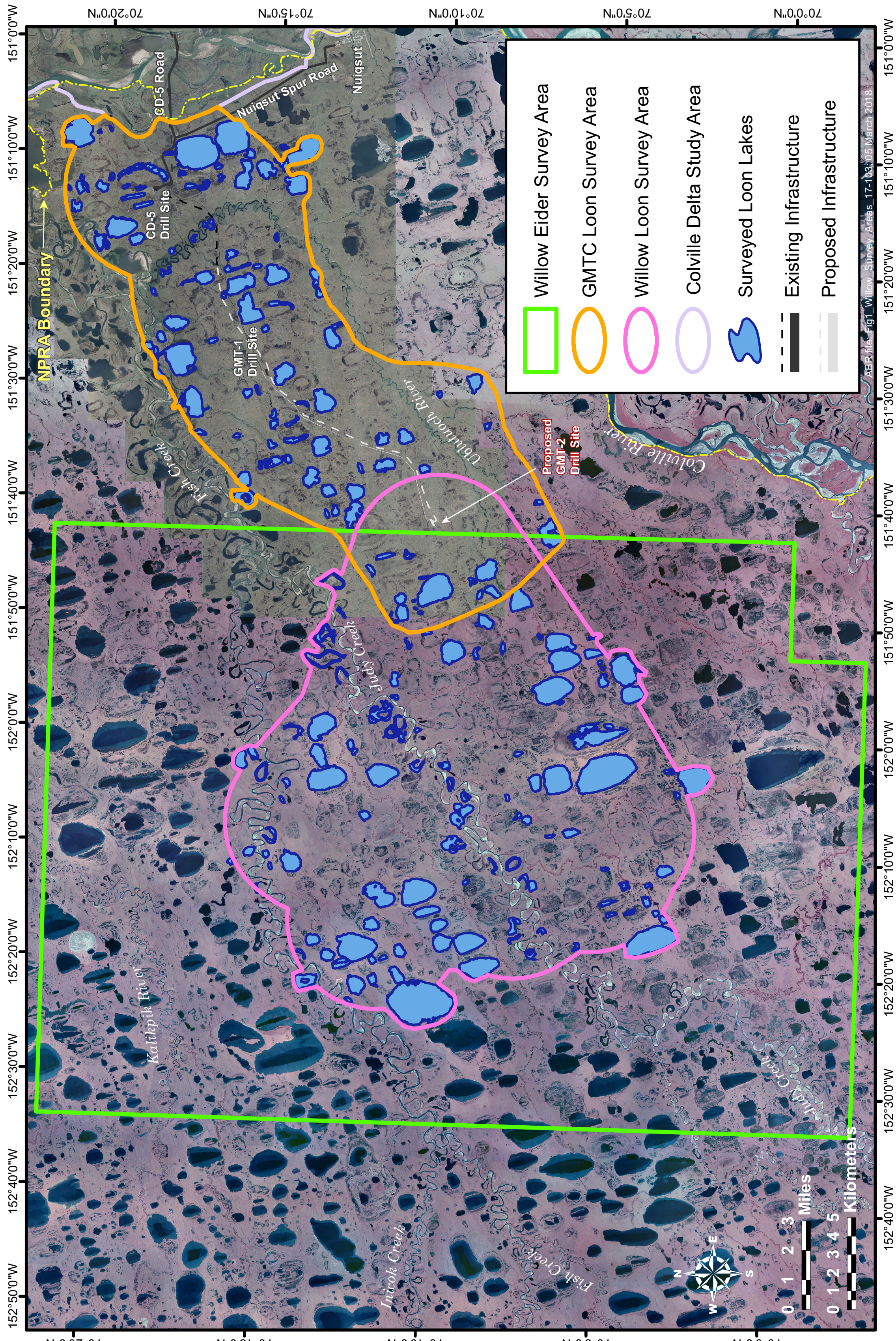


Figure 1. Wildlife survey areas for the Willow avian study, NE NPR-A, 2017.

Table 1. Avian surveys conducted in the Willow Project area and GMT corridor, NE NPR-A, 2017.

	Eider Survey	Yellow-billed Loon Survey[a]	
	Pre-nesting	Nesting	Brood-rearing
Number of Surveys	1	1	1
Survey Dates	13–16 June	19–22 June	21–24 Aug
Aircraft[b]	C185	A-Star	A-Star
Transect Width (km)	0.4	–	–
Transect Spacing (km)	0.8	–	–
Aircraft Altitude (m)	30–35	60–75	60–90
Notes	50% coverage	All lakes ≥ 5 ha in size	All lakes ≥ 5 ha in size

[a] Nests and broods of Pacific Loons, Red-throated Loons, Glaucous Gulls, and Sabine's Gulls were recorded incidentally.
[b] C185 = Cessna 185 fixed-wing airplane; A-Star = Airbus AS 350 B2 helicopter.

During the surveys, locations of eiders, loons, and gulls were recorded on digital orthophoto mosaics of 0.75–1 foot resolution natural color imagery acquired in 2004–2015 by Quantum Spatial (Anchorage, AK). Where recent imagery does not exist, we used BLM's publicly available NPR-A-wide color-infrared ortho-mosaic of 2.5 m resolution. Habitat mapping for the Willow Project area was prepared using a base map of DigitalGlobe satellite imagery of 1.64 foot resolution in natural color and color infrared acquired 5 July 2015. Bird locations plotted on maps were reviewed before they were entered into a geographical information system (GIS) database.

In this report, we present data summaries with means plus or minus standard errors (mean ± SE), unless noted otherwise. Where appropriate, we report median values. Statistical significance is assigned at $P \leq 0.05$ unless otherwise stated. Analyses were conducted in Microsoft® Excel (Office 2010).

EIDER SURVEYS

We evaluated the abundance, distribution, and habitat selection of 2 species of eiders (Spectacled and King eiders) with data collected on 1 aerial survey flown annually during the pre-nesting period (Table 1), when male eiders were still present on the breeding grounds. In 2017, we conducted the pre-nesting survey during 13–16 June using the same methods that were used during previous surveys of the NE NPR-A and the Colville Delta study areas (for details, see Johnson et al. [2015]). The survey was flown in a Cessna 185 airplane at 30–35 m above ground level (agl) and approximately 145 km/h. Two observers each counted eiders in a 200 m wide transect on each side of the airplane (400 m total transect width). A Global Positioning System (GPS) receiver was used to navigate east–west transect lines that were spaced 800 m apart achieving 50% coverage.

LOON SURVEYS

We surveyed the Greater Moose's Tooth Corridor (GMTC) and a portion of the Willow area, for Yellow-billed Loons in 2017 (Figure 1). Loon survey areas encompassed a 3-mi buffer around existing and proposed roads and drill sites associated with the GMT and Willow developments. In the GMTC loon survey area, we surveyed 110 lakes for both nesting and brood-rearing Yellow-billed Loons (Figure 1, Table 1). In the Willow loon survey area, we surveyed 130 lakes for nesting loons and 131 for brood-rearing loons. The GMTC and Willow loon survey areas overlap near the proposed GMT-2 drill site. Fifteen survey lakes, including 3 Yellow-billed Loon territories, are within the area of overlap. We have previously conducted surveys for nesting and brood-rearing Yellow-billed Loons in the NE NPR-A area during 2001–2006, and 2008–2014 (for details, see Johnson et al. [2015]).

Each year the nesting survey was conducted between 19 and 28 June and the brood-rearing survey between 15 and 24 August. Weekly surveys for nests and broods were conducted during

2008–2014 (Johnson et al. 2015). All surveys were flown in helicopter in a lake-to-lake pattern at 60–90 m above ground level. The perimeter of each lake was circled while 1 observer searched lake surfaces and shorelines for loons and nests during the nesting survey and loons and young during the brood-rearing survey. Survey lakes were selected before each survey and included most lakes ≥10 ha in size in 2001–2006 and most lakes ≥5 ha in size in 2008–2014 and 2017. We reduced the minimum survey lake size to 5 ha for nesting surveys to increase survey efficiency. During nesting surveys each year, we also surveyed small lakes (1–10 ha) and aquatic habitats adjacent to survey lakes because Yellow-billed Loons sometimes nest on small lakes next to larger lakes that are used for brood-rearing (North and Ryan 1989, Johnson et al. 2014a). Tapped Lakes with Low-water Connections (lakes whose levels fluctuate with changing river levels) were excluded from surveys during all years because Yellow-billed Loons do not use such lakes for nesting (North 1986, Johnson et al. 2003a).

We recorded incidental observations of Pacific Loons and Red-throated Loons during all nesting and brood-rearing surveys. All locations of loons and their nests were recorded on color photomosaics (1:30,000 scale). Since 2005, Yellow-billed Loon nest locations also were marked on high resolution color images of nest site areas (~1:1,500 scale). All loon locations were digitized into a GIS database. During the brood survey, in a trial of a new data collection technique, observations were collected on a tablet computer with a customized Android application that utilized a moving map with a minimum scale of 1:30,000.

To make annual comparisons among years when different numbers of territories were sampled, we calculated territory occupancy by dividing the number of territories with nests, adults, or broods by the number of territories surveyed. We defined a territory as a single lake, several lakes, or portion of a lake occupied exclusively by 1 breeding pair with a nest or brood in 1 or more years. Territories were identified using data from all years; boundaries between territories were determined by locations where nests and broods occurred, and additionally, by the locations of adults on multi-territory lakes. Territory occupancy was not calculated for the Willow survey area for this report because the majority (75%) of those surveys lakes had not been previously surveyed. Occupancy will be calculated after subsequent surveys are completed.

NEST FATE

Absence of broods is not a reliable indicator of nest failure because broods can disappear in the time between hatch and the brood survey. Therefore, we inspected the contents of nests at territories where a brood was not seen during the August survey to determine nest fate (for details, see Johnson et al. [2015]). Nests were assumed failed if they contained <20 egg fragments, eggshells had signs of predation (i.e., holes, albumen, yolk, or blood), or if eggs were unattended and cold (Parrett et al. 2008). Nests were assumed successful if a brood was present, or if the nest contained ≥20 egg fragments.

GULL SURVEYS

Locations of Glaucous Gull (Nauyavasrugruk, *Larus hyperboreus*) nests were recorded during our aerial surveys for nesting Yellow-billed Loons (see survey methods above). In the GMTC loon survey area, we included incidental observations from ground nest searches—CD-5 goose plots (Rozell and Johnson 2018) and GMT-1 eider nest searches (Seiser and Johnson 2018b). Glaucous Gull broods were recorded opportunistically during brood-rearing surveys for Yellow-billed Loons. Colonies of Sabine's Gulls (Iqirgagiak, *Xema sabini*) also were recorded during the nesting survey for Yellow-billed Loons. The number of nests at each colony was estimated based on the number of potential adult pairs observed. All locations of nests and broods were recorded on color photomosaics (1:30,000 scale).

HABITAT MAPPING AND ANALYSIS

A wildlife habitat was assigned to each observation of birds, nests, or broods by plotting their coordinates on the wildlife habitat maps (Figure 2). For each bird species, habitat use (% of all observations in each identified habitat type) was determined separately for various seasons (e.g., pre-nesting, nesting, and brood-rearing), as appropriate. For each species and season, we used multi-year data to calculate 1) the number of adults, flocks, nests, or broods in each habitat, and

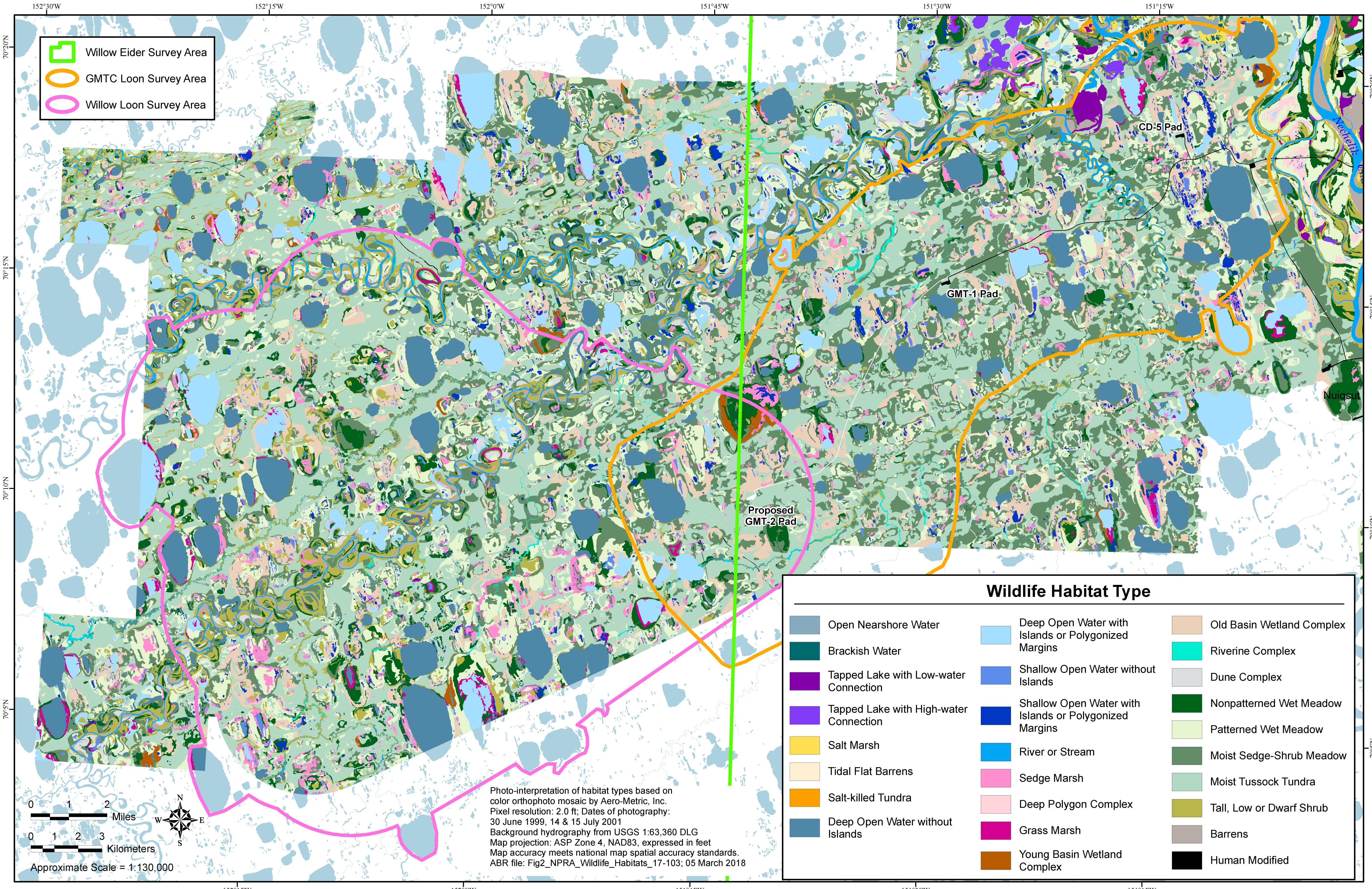


Figure 2. Wildlife habitats in the NE NPR-A area, 2017.

2) the percent of total observations in each habitat (habitat use). Habitat use was calculated from group locations for species when birds were in pairs, flocks, or broods and excluded flying birds. Habitat availability was calculated as the percent of each habitat in the eider and loon survey areas (Table 2). Observations and habitats from the Alpine West, Development, and Exploration subareas areas (see Figure 1, Johnson et al. 2015) were combined with those from the Willow and GMTC. Fish Creek Delta and Fish Creek West subareas were excluded from the analysis because the coastal and deltaic habitat types found there are not available in the Willow Project area. A statistical analysis of habitat selection was used for Spectacled Eiders, King Eiders, and Yellow-billed Loons, to evaluate whether habitats were used in proportion to their availability. Methods were explained in more detail by Johnson et al. (2015).

DATA MANAGEMENT

All data collected during surveys for CPAI were compiled into a centralized database following CPAI's data management protocols (version 10.1, CPAI 2017). All nest, brood, bird, and bird group locations were digitized from survey maps directly into the NAD 83 map datum. Uniform attribute data were recorded for all observations and proofed after data collection and proofed again during data entry. Survey data were submitted to CPAI in GIS-ready format with corresponding metadata.

Table 2. Habitat availability in the Willow eider and Willow loon survey areas, Willow Project area, NE NPR-A, 2017.

	Eider Survey Area		Loon Survey Area	
Habitat	Area (km²)	Availability (%)[a]	Area (km²)	Availability (%)[a]
Deep Open Water without Islands	61.0	8.83	37.4	8.35
Deep Open Water with Islands or Polygonized Margins	38.5	5.57	17.1	3.82
Shallow Open Water without Islands	9.8	1.42	7.0	1.55
Shallow Open Water with Islands or Polygonized Margins	7.2	1.04	3.8	0.85
River or Stream	7.3	1.06	4.0	0.88
Sedge Marsh	17.6	2.54	12.8	2.85
Grass Marsh	4.4	0.64	2.7	0.61
Young Basin Wetland Complex	2.5	0.37	1.8	0.41
Old Basin Wetland Complex	42.8	6.20	28.9	6.44
Riverine Complex	2.0	0.30	1.5	0.33
Dune Complex	6.9	0.99	3.9	0.87
Nonpatterned Wet Meadow	32.4	4.68	24.2	5.39
Patterned Wet Meadow	93.0	13.46	64.1	14.31
Moist Sedge-Shrub Meadow	98.3	14.22	63.1	14.08
Moist Tussock Tundra	206.1	29.83	138.3	30.86
Tall, Low, or Dwarf Shrub[b]	52.6	7.61	32.7	7.29
Barrens[c]	8.4	1.21	4.9	1.09
Human Modified	0.2	0.03	0.1	0.03
Subtotal (total mapped area)	691.0	100	448.2	100
Unknown (unmapped areas)	712.9		54.1	
Total	1,403.8		502.3	

[a] Percent availability calculated proportion of mapped area.
[b] Tall, Low, or Dwarf Shrub includes Moist Tall Shrub, Dry Tall Shrub, Moist Low Shrub, Moist Dwarf Shrub, and Dry Dwarf Shrub.
[c] Barrens includes Dry Halophytic Meadow and Moist Herb Meadow.

RESULTS AND DISCUSSION

SEASONAL CONDITIONS IN THE PROJECT AREA

The Willow Project area is west of the proposed GMT-2 drill site in the Fish and Judy Creek drainages (Figure 1). The GMT corridor extends from the Colville River delta near CD-5 southwest to the proposed GMT-2 drill site (Figure 1). We used the weather station at Colville Village (Helmericks' homesite) for long-term comparisons. Although the Alpine and Nuiqsut weather stations might better reflect the weather conditions for the Willow Project area, neither has as long and complete record of weather data as does Colville Village.

Spring snow depth and timing of break-up in 2017 were fairly typical despite a record warm winter for the Arctic Coastal Plain. The cumulative freezing degree-days (FDD) over the winter of 2016/2017 (6,703 FDD) was the lowest in 19 years of records at Colville Village, and the fourth consecutive winter that had below average cumulative FDD (7,725 ± 153 FDD, [mean ± standard error; n = 19 years]; http://www.weather.gov/aprfc/FreezingDegreeDays).

The snow depth on the Colville River delta was near normal levels in mid-May, when the depth of the arctic snow pack was near its long-term median (Natural Resource Conservation Service 2017). Snow depth at Colville Village on 15 May was equal to the 21-year mean (23 ± 2 cm) for that date, as was the first snow-free date (3 June ± 1 d). Typically, sites south of Colville Village melt out a few days earlier. Alpine and Nuiqsut both reported no measureable snow cover on 26 May. In the Willow Project area, snow cover was estimated to be 40% on 28 May (Michael Baker International 2017a). In spring 2017, daily mean temperatures at Alpine and Nuiqsut averaged 2.1 °C and 2.4 ºC warmer, respectively, than at Colville Village.

Timing of breakup in Fish and Judy creeks was similar to that of the Colville River in 2017, with peak stage occurring at normal dates. In 2017, melt water first reached the head of the Colville River delta (Monument 1) on 22 May and peak stage (4.5 m above mean sea level) occurring on 30 May (Michael Baker International 2017b). Timing of peak discharge and peak stage (30 May) at Monument 1 matched the mean date from 21 years of records (Michael Baker International 2017c). Both peak discharge (8,155 cubic meters per second) and peak stage in 2017 were below long-term mean values. Local melt water was accumulating in drainages of the GMT areas on 23 May, and peak discharge and peak stage at the Tinmiaqsiugvik Bridge occurred on 31 May, while peak stage and peak discharge at river mile 13.8 on Judy Creek occurred on 4 June (Michael Baker International 2017a, c). Peak stage at Judy Creek was the lowest among 6 years of records.

Despite a warm winter, the period when birds arrive was colder than normal. Only 26.5 cumulative thawing degree-days (TDD) were measured at Nuiqsut during 15 May–15 June, well below the 17-year mean of 70 ± 2 cumulative TDD. Typically during this period, the first 2 weeks in June produce the majority of the thawing degree-days. In 2017, a record low 12.7 TDD were recorded in early June in Nuiqsut. The mean temperature in May 2017 (–3.2 °C) was warmer than the long-term mean temperature (–4.6 ± 0.2 °C, n = 18 years), while the mean temperature in June 2017 (4.8 °C) was cooler than the long-term mean temperature (5.9 ± 0.1 °C, n = 17). Mean daily temperatures in June returned to above freezing levels a week earlier at Nuiqsut than at Colville Village.

Timing of midge and mosquito emergence in 2017 was about average. Nest-search crews who began work in the CD-5 area on 8 June reported midge activity on 20 June. A 6-day period of warm weather (mean daily temperatures >10 °C) during 21–27 June brought on mosquito emergence. In most years, mosquitoes emerge in late June or early July.

Timing of nesting by the most common waterfowl species in the NE NPR-A, Greater White-fronted Geese (Niġlivik, *Anser albifrons*), was near average in 2017. The median hatch date in 2017 for Greater White-fronted Geese near CD-5 was 30 June (Rozell and Johnson 2018). Median hatch dates at CD-5 have ranged between 24 June and 3 July in recent years (Johnson et al. 2014b, 2015; Rozell and Johnson 2016).

In contrast to the normal timing for insect emergence and goose nesting, open water on

Yellow-billed Loon breeding lakes became available later in 2017 than in the previous 3 years. Ice coverage on large lakes (>5 ha) on the Colville River delta was estimated visually during aerial surveys for loons during the nesting survey on 21–24 June. Ice cover on breeding lakes on the Colville delta was more extensive in 2017 (82 %, n = 22 lakes) than in the preceding 3-year period (65 ± 8%). In the Willow and GMTC loon survey areas, ice coverage was 70% (n = 35 lakes) during the same period in 2017.

EIDERS

Four species of eiders may occur in the Willow Project area, but only 2 species occur on a regular basis. Of the 2 species of eiders that are most common in the Willow Project area, the Spectacled Eider has received the most attention because it was listed as "threatened" in 1993 (58 FR 27474–27480) under the Endangered Species Act of 1973, as amended. The outer Colville River delta is a concentration area for breeding Spectacled Eiders relative to surrounding areas; nonetheless, Spectacled Eiders nest there annually at low densities and nest at even lower densities in inland areas of the NE NPR-A and the Colville River delta (Burgess et al. 2003a, 2003b; Johnson et al. 2004, 2005, 2018b). The King Eider, which is not protected under the Endangered Species Act, is an annual breeder that is more widespread and generally more numerous than the Spectacled Eider across the Arctic Coastal Plain, although their relative abundance varies geographically. The Steller's Eider was listed as a threatened species in 1997 (62 FR 31748–31757). Steller's Eiders are rare on the Colville River delta, NE NPR-A, and immediate surroundings as these areas are east of their current Alaska breeding range centered around Utqiaġvik (Barrow). The NE NPR-A is within the range of Common Eiders, which nest primarily on barrier islands and coastlines, but are seen rarely on surveys of the NE NPR-A.

SPECTACLED EIDER

Distribution and Abundance

The Willow eider survey area contained a low density of Spectacled Eiders during the pre-nesting period in 2017, which was consistent with results of previous surveys in this portion of the NE NPR-A (Johnson et al. 2015). In 2017, we recorded only 16 Spectacled Eiders (on the ground and flying) and 4 indicated total Spectacled Eiders during the pre-nesting aerial survey, which sampled 50% of the area (Figure 3, Table 3). Extrapolating to the entire survey area produces estimates of 32 observed total and 8 indicated total Spectacled Eiders. Indicated total is a standardized method of counting ducks, which doubles the number of males in singles, pairs, and small groups (no flying birds are included) to compensate for the lower detectability of females (USFWS 1987). In 2017, Spectacled Eiders occurred at one of the 3 lowest densities ever recorded during 16 years of surveys (Table 3). Densities of Spectacled Eider in NE NPR-A have been consistently low (mean = 0.03 ± 0.005 indicated birds/km²) since we began surveys in 1999. The distribution of Spectacled Eiders in 2017 was typical of previous years, when densities were highest on the northern Colville River delta (CD North area) and lowest at inland portions of NPR-A, where the Willow eider survey area is located (Figure 4). Over the 24 years that ABR and others have monitored Spectacled Eiders along the central Beaufort Sea coast, their population trend has been relatively stable (Figure 5). In the NE NPR-A, the annual growth rate is 3% (logarithmic growth rate of 1.03; ln(adults) = 0.033 (year) – 64.6, R^2 = 0.15, P = 0.14, n = 16 years). The growth rate for the adjacent Colville Delta study area was similar at 2% (ln(adults) = 0.018 (year) – 32.27, R^2 = 0.06, P = 0.24, n = 24 years). A slightly negative growth rate (–1%) was estimated from the North Slope eider surveys conducted during the same period for Spectacled Eiders across the entire ACP (logarithmic growth rate = 0.99, n = 25 years; Wilson et al. *in prep.*). However, none of the above growth rates differs significantly from 0% (a logarithmic growth rate of 1.0 equals 0% annual change, or equilibrium).

Habitat Use

Pre-nesting Spectacled Eiders used 14 of 26 available habitats during 16 years of aerial surveys conducted in the NE NPR-A (Table 4). Five habitats were preferred (i.e., use significantly greater than availability, $P \leq 0.05$) including 1 primarily coastal, salt-affected habitat (Brackish Water), 3 aquatic habitats (Shallow Open Water with Islands or Polygonized Margins, Shallow

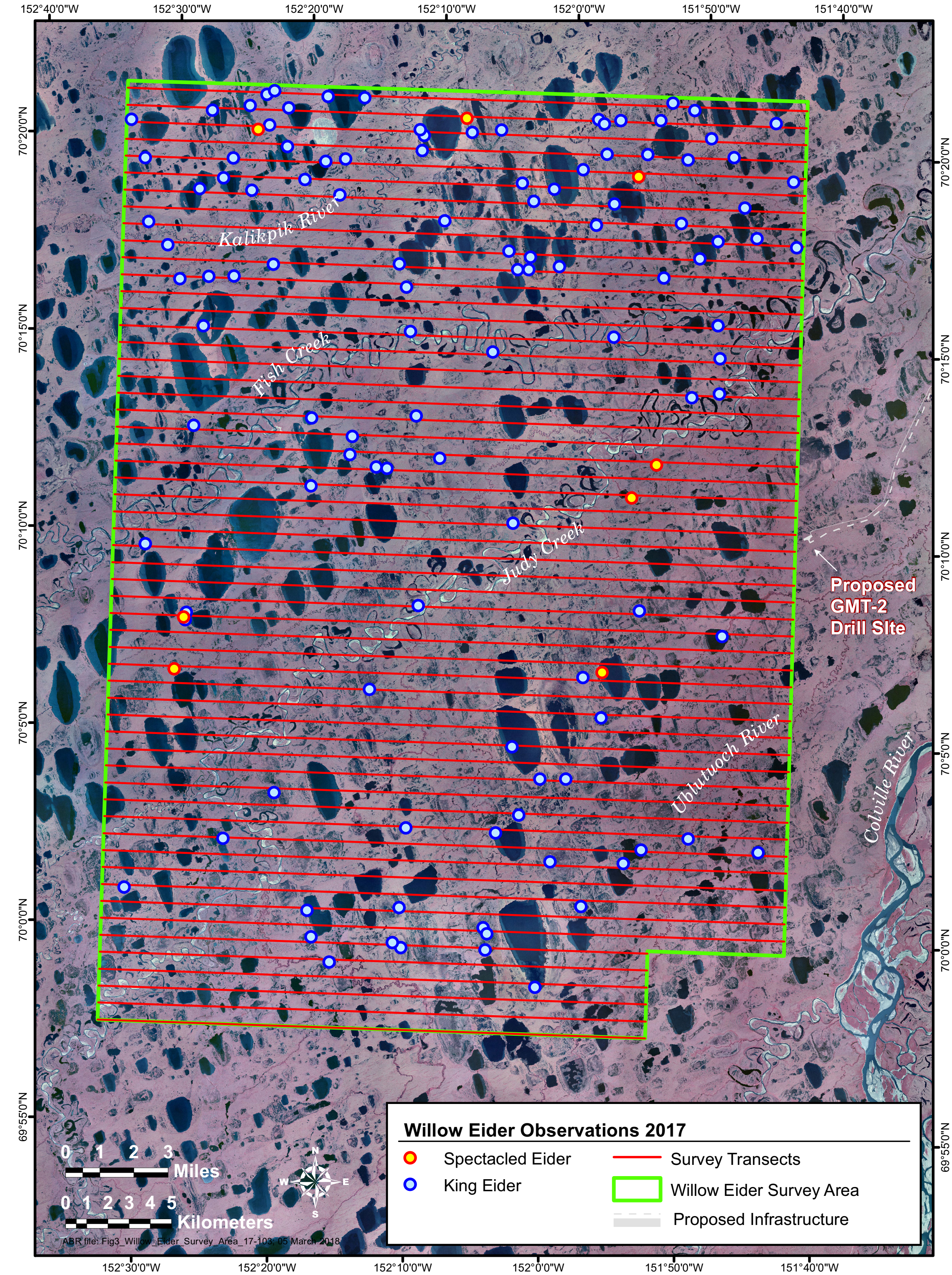


Figure 3. Spectacled Eider and King Eider locations during pre-nesting, Willow eider survey area, NE NPR-A, 2017.

Table 3. Annual number and density (birds/km²) of eiders during pre-nesting aerial surveys in the NE NPR-A in 1999–2006, 2008–2014, and 2017. The Willow eider survey area was surveyed in 2017.

Year	Area Surveyed (km²)	Spectacled Eider				King Eider			
		Total[a]		Density[b]		Total[a]		Density[b]	
		Observed	Indicated	Observed	Indicated	Observed	Indicated	Observed	Indicated
1999	143.4	4	6	0.03	0.04	41	16	0.29	0.11
2000	278.3	6	6	0.02	0.02	55	38	0.20	0.14
2001	511.0	23	22	0.05	0.04	134	98	0.26	0.19
2002	550.1	12	14	0.02	0.03	213	217	0.39	0.39
2003	557.6	10	12	0.02	0.02	191	128	0.34	0.23
2004	430.3	14	10	0.03	0.02	168	130	0.39	0.30
2005	755.1	9	2	0.01	<0.01	253	192	0.34	0.25
2006	755.1	31	26	0.04	0.03	318	332	0.42	0.44
2008	755.1	41	46	0.05	0.06	489	506	0.65	0.67
2009	755.1	29	30	0.04	0.04	387	360	0.51	0.48
2010	755.1	23	24	0.03	0.03	617	457	0.82	0.61
2011	172.0	9	10	0.05	0.06	119	94	0.69	0.55
2012	172.0	4	2	0.02	0.01	81	90	0.47	0.52
2013	172.0	17	14	0.10	0.08	122	98	0.71	0.57
2014	332.7	8	10	0.02	0.03	142	120	0.43	0.36
2017	706.2	16	4	0.02	0.01	248	132	0.35	0.19
Mean	487.6	–	–	0.035	0.033	–	–	0.453	0.375
SE	59.4	–	–	0.005	0.005	–	–	0.043	0.043

[a] Observed total includes flying and non-flying eiders. Indicated total birds was calculated according to standard USFWS protocol (USFWS 1987a). Mean and SE calculated for *n* = 16 years.
[b] Numbers not corrected for sightability. Density (birds/km²) based on 100% coverage of area in 1999 and 2000 and 50% coverage in all other years. Mean and SE calculated for *n* = 16 years.

Open Water without Islands, and Grass Marsh), and 1 complex of mixed terrestrial and aquatic habitat (Old Basin Wetland Complex). Old Basin Wetland Complex also received the greatest percent use with 18.5% of the Spectacled Eider locations. Brackish Water, Shallow Open Water without Islands, and Patterned Wet Meadow were the second most frequently used habitats, each with 13% of the Spectacled Eider locations. Note that Brackish Water occurs along the coast and none occurs in the Willow eider survey area. Brackish Water occurred in the portion of the NE NPR-A north of CD-5 that was included in 12 of the 16 years analyzed for habitat selection. Two habitats were avoided (used significantly less than availability), Moist Sedge-Shrub Meadow and Moist Tussock Tundra, which were also the most abundant habitats (20% and 29% of the area, respectively). All other habitats were used in proportion to their availability.

OTHER EIDERS

Distribution and Abundance

In 2017, we recorded 248 observed (on the ground and flying) and 132 indicated total King Eiders on the pre-nesting aerial survey that sampled 50% of the Willow eider survey area (Figure 3, Table 3). Extrapolating to the entire

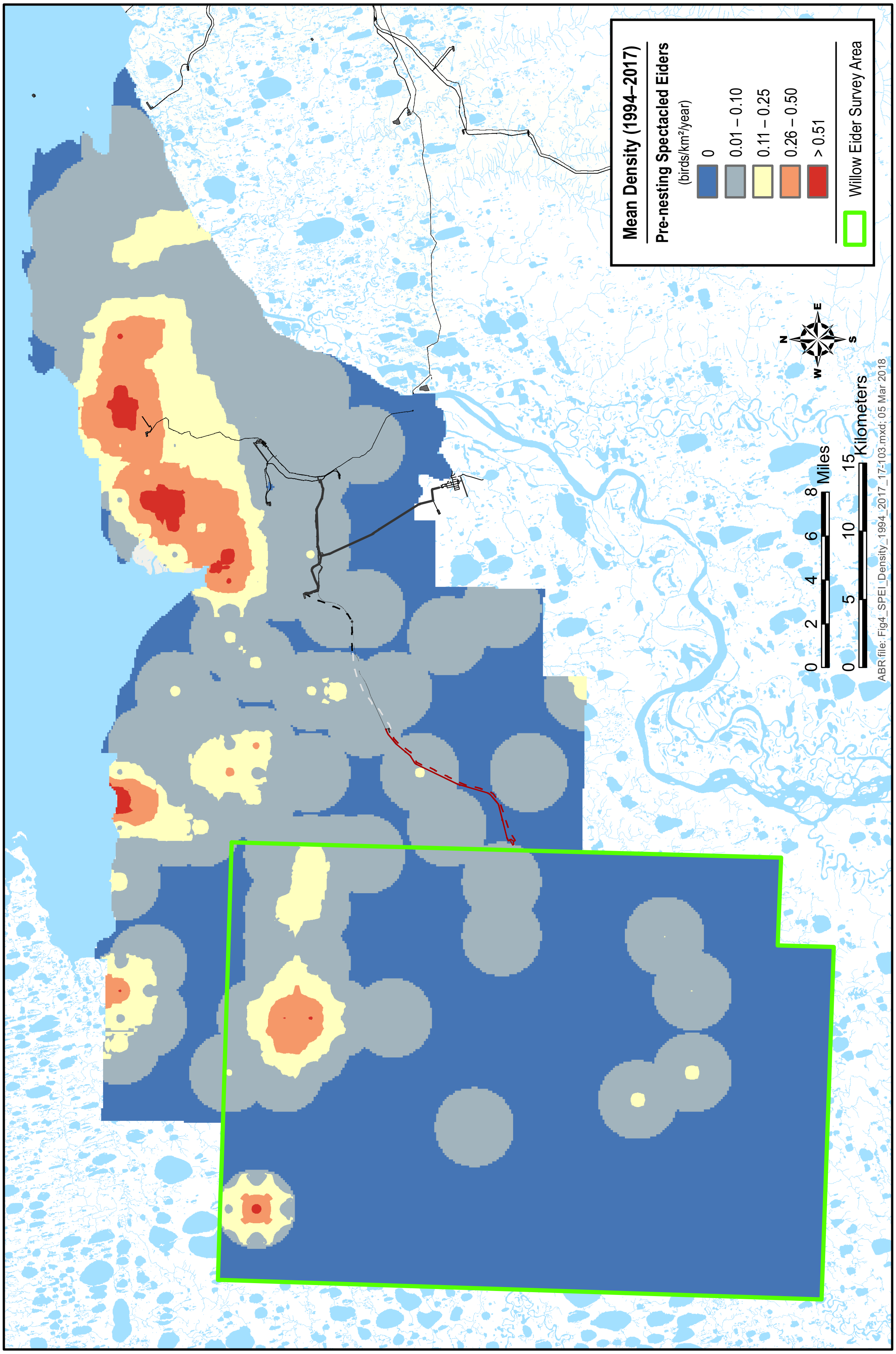


Figure 4. Density distribution for pre-nesting Spectacled Eiders in the Willow eider survey area (2017), NE NPR-A (2001–2006, 2008–2014), and the Colville River delta (1993–1998, 2000–2017).

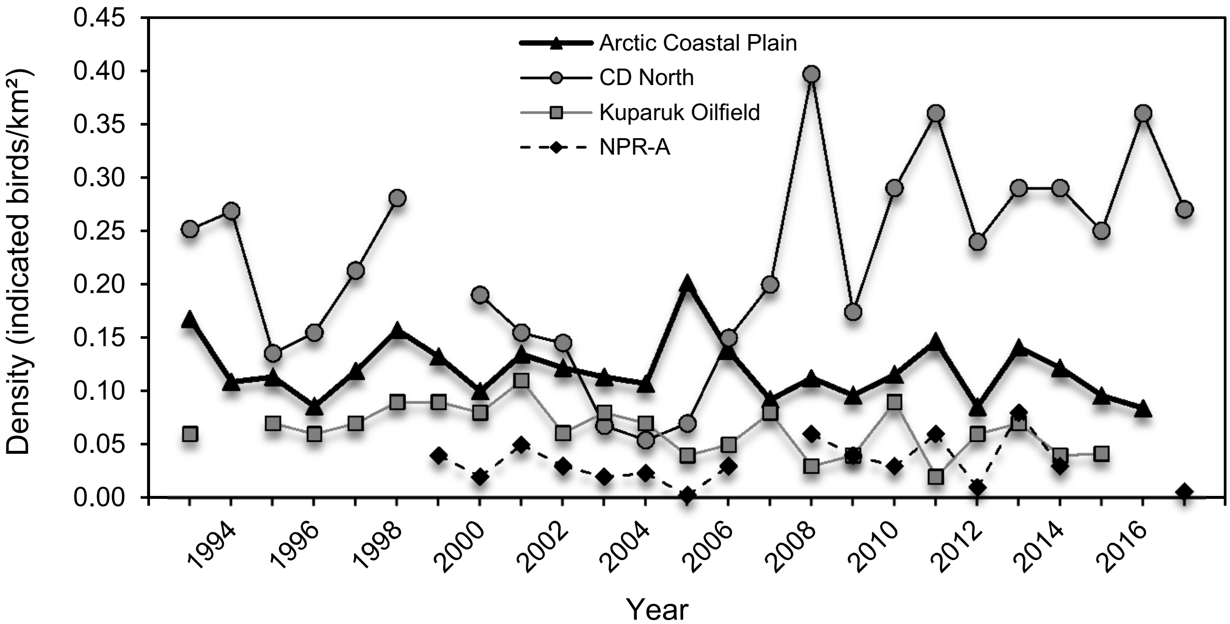


Figure 5. Annual densities of indicated total Spectacled Eiders during pre-nesting aerial surveys in 4 study areas on the Arctic Coastal Plain, Alaska, 1993–2017.

survey area, we estimate 496 observed total and 264 indicated total King Eiders. The 2017 distribution of King Eiders was somewhat uniform throughout the area surveyed, but with more eiders farther north. Since 1999, when pre-nesting surveys were begun in NE NPR-A, the highest densities of pre-nesting King Eiders have been in the north (near Fish Creek and Kalikpik River) with some areas of high density in the southern and eastern portions of the Willow eider survey area (Figure 6). The indicated density of King Eiders in 2017 (0.19 indicated birds/km²) was the third lowest since 1999 and well below the mean (0.375 ± 0.043 indicated birds/km²; Figure 7, Table 3). In contrast, the adjacent Colville Delta study area (reported in Johnson et al. 2018a) had the second highest indicated density in 2017 (with the highest densities on the East Channel) where flocks collect but infrequently nest. We do not know where King Eiders on the Colville River delta nested, but it is possible that some of these eiders moved inland (e.g., to the NE NPR-A and the Kuparuk Oilfield) after the pre-nesting survey was completed.

King Eiders on the ACP have been increasing at a significant rate of 2% annually since 1986 (Wilson et al. *in prep*.). Although we have shorter period over which to measure trend, King Eiders in the NE NPR-A have increased significantly at 6% annually since surveys began in 1999 (ln(adults) = 0.06 (year) – 107.9, $R^2 = 0.31$, $P = 0.03$, $n = 16$ years).

No Steller's or Common eiders were seen in the Willow eider survey area in 2017. Steller's Eiders have been recorded 4 times during pre-nesting in the vicinity, once each in 1993, 1997, 1998, and 2001 (see Figure 4 in Johnson et al. 2018b). No records of breeding have been reported near the Willow Project. Common Eiders are more abundant in the nearshore marine waters and barrier islands that are outside the survey area.

Habitat Use

Steller's and Common eiders do not occur frequently enough to perform habitat use evaluations in the NE NPR-A. King Eiders used 18 of 26 available habitats during pre-nesting surveys for 16 years of aerial surveys (Table 4). King Eiders significantly preferred 11 habitats, 5 of which were also preferred by Spectacled Eiders in NE NPR-A: Brackish Water, Shallow Open Water without Islands, Shallow Open Water with Islands or Polygonized Margins, Grass Marsh, and Old Basin Wetland Complex. King Eiders also preferred: Tapped Lake with Low-water Connection, Salt

Table 4. Habitat selection by Spectacled and King eider groups during pre-nesting in the NE NPR-A in 1999–2006, 2008–2014, and 2017. The Willow eider survey area was surveyed in 2017.

SPECIES Habitat	No. of Adults	No. of Groups	Use (%)[a]	Availability (%)	Monte Carlo Results[b]	Sample Size[c]
SPECTACLED EIDER						
Open Nearshore Water	0	0	0	0.3	ns	low
Brackish Water	14	7	13.0	0.3	prefer	low
Tapped Lake with Low-water Connection	0	0	0	0.2	ns	low
Tapped Lake with High-water Connection	0	0	0	<0.1	ns	low
Salt Marsh	4	2	3.7	0.7	ns	low
Tidal Flat Barrens	0	0	0	0.2	ns	low
Salt-killed Tundra	0	0	0	<0.1	ns	low
Deep Open Water without Islands	4	2	3.7	8.0	ns	low
Deep Open Water with Islands or Polygonized Margins	11	6	11.1	4.7	ns	low
Shallow Open Water without Islands	12	7	13.0	1.2	prefer	low
Shallow Open Water with Islands or Polygonized Margins	14	5	9.3	1.4	prefer	low
River or Stream	1	1	1.9	0.8	ns	low
Sedge Marsh	1	1	1.9	2.1	ns	low
Deep Polygon Complex	0	0	0	<0.1	ns	low
Grass Marsh	3	2	3.7	0.4	prefer	low
Young Basin Wetland Complex	0	0	0	0.3	ns	low
Old Basin Wetland Complex	18	10	18.5	8.2	prefer	low
Riverine Complex	0	0	0	0.4	ns	low
Dune Complex	2	1	1.9	0.9	ns	low
Nonpatterned Wet Meadow	4	2	3.7	3.8	ns	low
Patterned Wet Meadow	16	7	13.0	12.1	ns	low
Moist Sedge-Shrub Meadow	1	1	1.9	19.7	avoid	
Moist Tussock Tundra	0	0	0	28.7	avoid	
Tall, Low, or Dwarf Shrub	0	0	0	4.5	ns	low
Barrens	0	0	0	1.1	ns	low
Human Modified	0	0	0	0	ns	low
Total	105	54	100	100		
KING EIDER						
Open Nearshore Water	4	2	0.3	0.3	ns	low
Brackish Water	15	8	1.3	0.3	prefer	low
Tapped Lake with Low-water Connection	34	10	1.6	0.2	prefer	low
Tapped Lake with High-water Connection	0	0	0	<0.1	ns	low
Salt Marsh	36	16	2.5	0.7	prefer	low
Tidal Flat Barrens	0	0	0.0	0.2	ns	low
Salt-killed Tundra	0	0	0.0	<0.1	ns	low
Deep Open Water without Islands	253	80	12.7	8.0	prefer	
Deep Open Water with Islands or Polygonized Margins	189	70	11.1	4.7	prefer	

Table 4. Continued.

SPECIES Habitat	No. of Adults	No. of Groups	Use (%)[a]	Availability (%)	Monte Carlo Results[b]	Sample Size[c]
Shallow Open Water without Islands	113	60	9.5	1.2	prefer	
Shallow Open Water with Islands or Polygonized Margins	243	95	15.0	1.4	prefer	
River or Stream	32	14	2.2	0.8	prefer	
Sedge Marsh	80	39	6.2	2.1	prefer	
Deep Polygon Complex	0	0	0	<0.1	ns	low
Grass Marsh	31	10	1.6	0.4	prefer	low
Young Basin Wetland Complex	0	0	0	0.3	ns	low
Old Basin Wetland Complex	225	112	17.7	8.2	prefer	
Riverine Complex	9	4	0.6	0.4	ns	low
Dune Complex	0	0	0	0.9	avoid	
Nonpatterned Wet Meadow	48	28	4.4	3.8	ns	
Patterned Wet Meadow	103	55	8.7	12.1	avoid	
Moist Sedge-Shrub Meadow	40	18	2.8	19.7	avoid	
Moist Tussock Tundra	12	7	1.1	28.7	avoid	
Tall, Low, or Dwarf Shrub	6	4	0.6	4.5	avoid	
Barrens	0	0	0	1.1	avoid	
Human Modified	0	0	0	<0.1	ns	low
Total	1,473	632	100	100		

[a] Use = (groups / total groups) × 100.
[b] Significance calculated from 1,000 simulations at α = 05; ns = not significant, prefer = significantly greater use than availability, avoid = significantly less use than availability.
[c] Low = expected value < 5.

Marsh, Deep Open Water without Islands, Deep Open Water with Islands or Polygonized Margins, River or Stream, and Sedge Marsh. Old Basin Wetland Complex was the most used habitat (18%) followed by Shallow Open Water with Islands or Polygonized Margins (15%) and Deep Open Water without Islands (13%). King Eiders significantly avoided the 2 most abundant habitats: Moist Sedge-Shrub Meadow (20% available), and Moist Tussock Tundra (29% available) and also avoided Patterned Wet Meadow; Dune Complex; Tall, Low, or Dwarf Shrub; and Barrens.

YELLOW-BILLED LOON

DISTRIBUTION AND ABUNDANCE

GMTC Loon Survey Area

Five Yellow-billed Loon nests were found in the GMTC loon survey area during the nesting survey in 2017 (Figure 8, Table 5). Three more nests were inferred from the presence of broods during August on lakes where nests were not found during the nesting survey. The total number of nests found (8) was similar to 2014, the only other year when the entire GMTC loon survey area was surveyed. The count of 11 adults seen in 2017, however, was almost half the number seen during 2014 (for densities, see Appendix A). Incidental records of Pacific and Red-throated loon nests and broods are presented in Appendices B and C.

Survey coverage and effort has varied across the NE NPR-A area since surveys were initiated in 2001. In years when surveys were conducted, annual survey coverage varied from 13 to 51 territories. Because of the annual variation in study area size and survey effort, we did not calculate mean numbers of adults and nests. Although standardized nesting and brood-rearing surveys have been conducted annually, weekly surveys for nests and broods were conducted

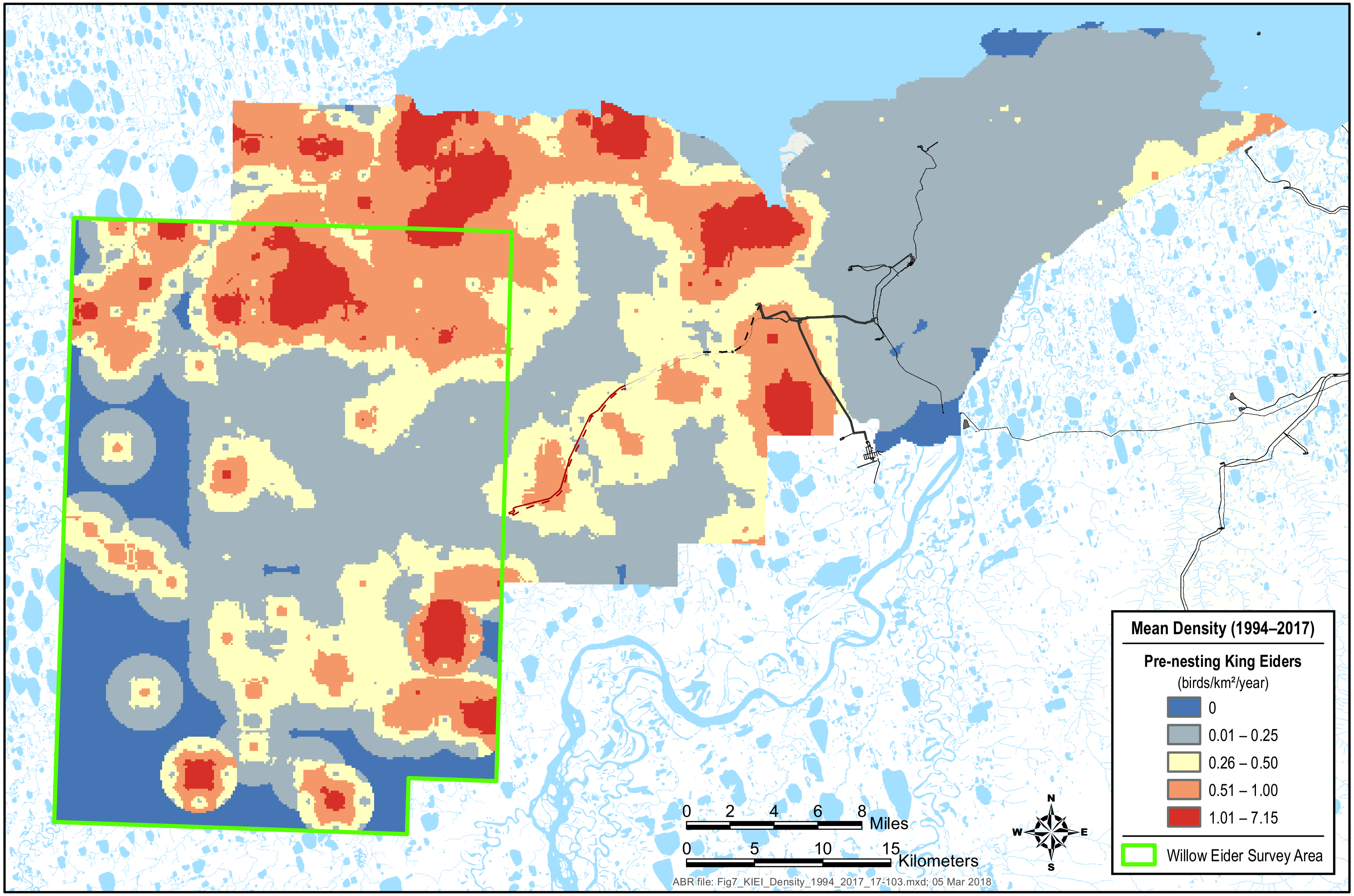


Figure 6. Density distribution for pre-nesting King Eiders in the Willow eider survey area (2017), NE NPR-A (2001–2006, 2008–2014), and the Colville River delta (1993–1998, 2000–2017).

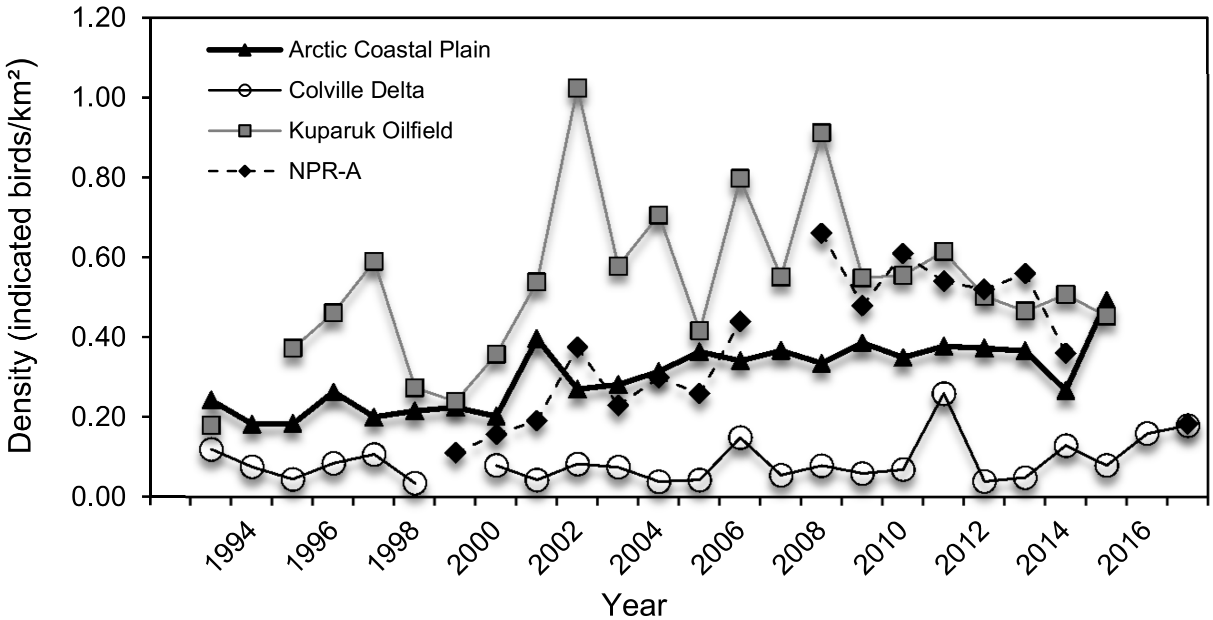


Figure 7. Annual densities of indicated total King Eiders during pre-nesting aerial surveys in 4 study areas on the Arctic Coastal Plain, Alaska, 1993–2017.

during 2008–2014 only. Those additional surveys resulted in higher total nest counts compared to years with a single nesting survey. To adjust for variable coverage and survey effort among years, we used territory occupancy by nests, calculated as the number of nests found only on the nesting survey divided by the number of territories surveyed. Of the 11 territories surveyed during 2017 in the GMTC loon survey area, 45% were occupied by a nest during the nesting survey, which is well below the 13-year mean calculated for the other survey areas in NE NPR-A (mean = 57.1 ± 2.4%).

The nesting survey, however, likely was conducted slightly early relative to nesting phenology in 2017. Generally, surveys are timed for the third week of June, which is a period when most loons have begun incubation (median start date of incubation = 17 June, range 9–23 June, *n* = 45 nests over 5 years). Surveys flown later than that week risk missing nests as nests begin to fail. Although the nesting survey began during a historically appropriate period, nesting phenology appeared to have been delayed in 2017 by a cooler than average June that interrupted spring thaw. Yellow-billed Loons require moats, or open water that forms between shore and lake ice, in order to "taxi" across the water surface to achieve flight. Delayed moat formation can delay or even preclude nesting by preventing access to lakes (North 1986, Johnson et al. 2011, Johnson et al. 2013). Visual estimates of ice cover on large lakes suggest that open water became available later in 2017 compared to previous years (see SEASONAL CONDITIONS IN THE STUDY AREA, above). Furthermore, during the nesting survey, we saw pairs of loons at most of the lakes where nests were not found but broods were seen in August. These sightings suggest that pairs at those lakes probably started incubation after the nesting survey.

During the brood-rearing survey, 21 Yellow-billed Loons, 4 broods, and 4 young were observed in the GMTC loon survey area (Figure 8, Table 6). We inferred 1 additional brood based on eggshell fragments at the nest. As with nests, the total number of broods (5) was similar to the number observed in 2014. The count of 21 adults seen during the brood-rearing survey in 2017 was nearly twice the number seen during June (for densities,

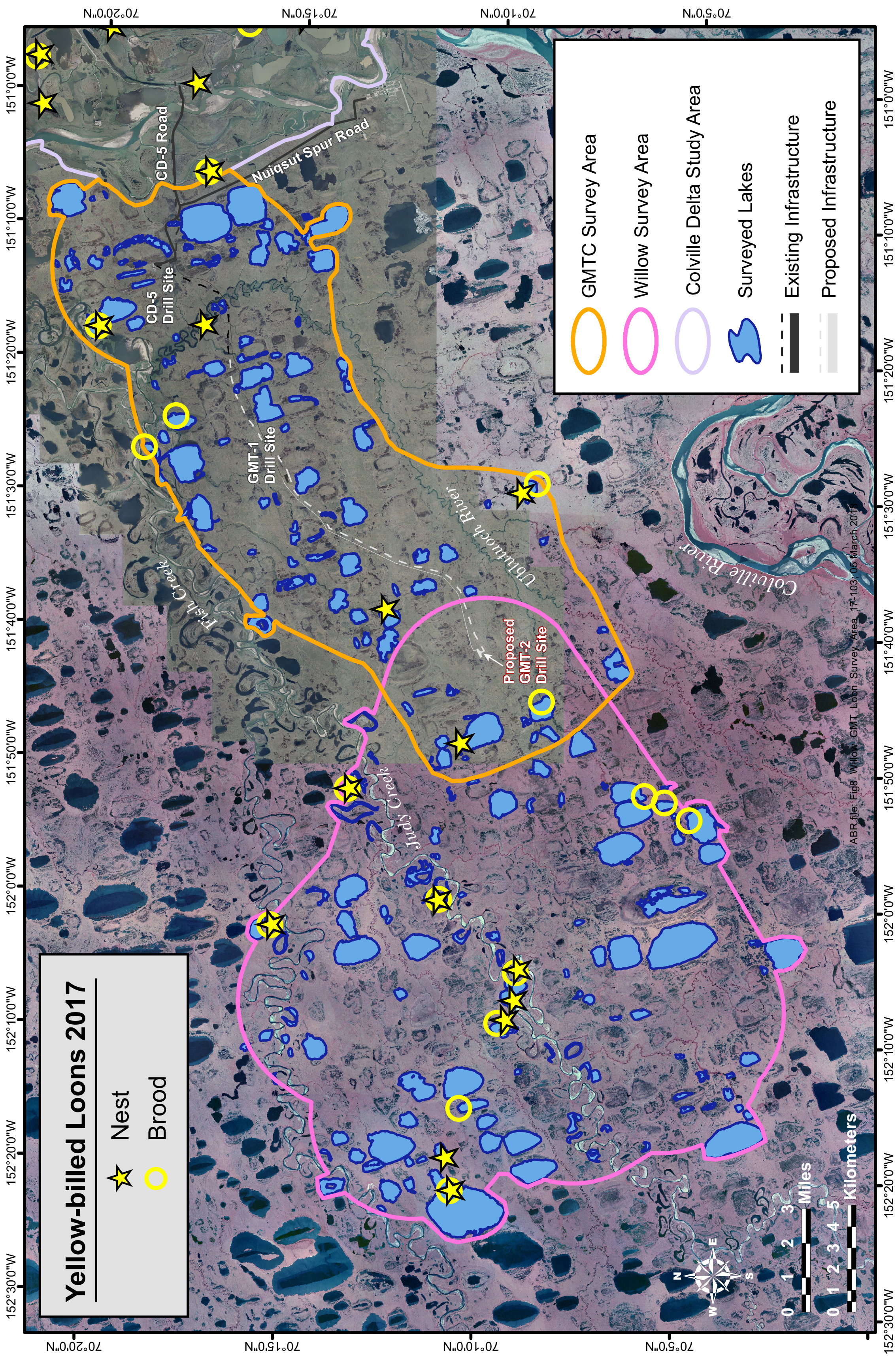


Figure 8. Yellow-billed Loon nest and brood locations, Willow and GMTC loon survey areas, NE NPR-A, 2017.

Table 5. Number of Yellow-billed Loons and nests, and territory occupancy by nests in the GMTC, Willow, and other NE NPR-A survey areas in 2001–2006, 2008–2014, and 2017.

SURVEY AREA	Nesting Survey[a]		All Surveys[b]	No. Territories Surveyed	Nest Occupancy (%)
Year	No. Adults	No Nests	No. Nests		
GMTC[d]					
2014	20	8	9[e]	11	73
2017	11	5	8[f]	11	45
Willow[d]					
2017	38	9	14	16[g]	–[h]
NE NPR-A					
2001	44	19	23[i]	36	53
2002	65	27	27	43	63
2003	53	26	28[g,i]	42	62
2004	60	23	24[i]	41	56
2005	24	8	8	13	62
2006	24	8	8	13	62
2008	82	23	29[f]	51	45
2009	65	27	29[f]	51	53
2010	75	29	36[f]	51	57
2011	32	8	13[f]	21	38
2012	36	15	18[f]	21	71
2013	39	12	14[f]	21	57
2014[j]	47	18	20[f]	28	64
Mean[k]					57.1
SE					2.4

[a] Nesting survey is limited to survey conducted between 19 and 30 June.
[b] Observation effort varied between years. Includes all nests found on loon aerial surveys, ground surveys, camera images or inferred by brood observations. Observation methods other than nesting survey are footnoted.
[c] Calculated as the number of nests found during the nesting survey divided by the number of territories surveyed. Excludes 1 renesting in 2003 in the NE NPR-A area.
[d] GMTC and Willow loon survey areas overlap: 2 adults, 1 nest from the nesting survey, and 1 nest inferred from the presence of a brood were present at the 3 territories that are within both areas.
[e] Includes nest(s) found during revisit (1996–2002), monitoring (2006–2014), and early nesting (2011) surveys.
[f] Includes nest(s) inferred by the presence of a brood observed on a territory lake during ground or aerial surveys.
[g] Ten territories were identified during surveys in previous years, 6 new territories were surveyed during nesting in 2017, and 1 new territory was discovered with a brood that was not surveyed during nesting.
[h] Nest occupancy not calculated because the total number of territories in Willow loon survey area is not known due to lack of historical data.
[i] Includes nest(s) found during ground surveys.
[j] Totals includes observations in part of the GMTC loon survey area.
[k] Mean numbers of adults and nests not calculated because survey area differed among years.

Table 6. Number of Yellow-billed Loons, broods, and territory occupancy by broods in the GMTC, Willow, and other NE NPR-A survey areas in 2001–2006, 2008–2014 and 2017.

SURVEY AREA Year	Brood-rearing Survey[a] No. Adults	Brood-rearing Survey[a] No. Young	Brood-rearing Survey[a] No. Broods	All Surveys[b] No. Broods	No. Territories Surveyed	Brood Occupancy (%)
GMTC[d]						
2014	16	5	5	5	11	45
2017	21	4	4	5[e]	11	45
Willow[d]						
2017	39	9	8	11[e]	17	–[f]
NE NPR-A						
2001	47	5	5	7[g]	32	22
2002	47	7	6	6	39	15
2003	54	18	16	16	37	43
2004	67	12	10	10	40	25
2005	12	3	3	3	13	23
2006	16	2	2	2	12	17
2008	70	15	12	19[e,h]	50	38
2009	86	17	12	15[e]	51	29
2010	70	18	15	16[e]	49	33
2011	31	5	4	4	21	19
2012	42	14	12	12	21	57
2013	21	0	0	1[h]	21	5
2014[i]	29	9	9	11[e]	28	39
Mean[j]						28.1
SE						3.8

[a] Brood-rearing surveys were conducted between 15 and 27 August.
[b] Includes all broods found on brood-rearing survey and any additional broods found during other types of surveys as footnoted.
[c] Calculated as the number of broods from all surveys divided by the number of territories surveyed.
[d] Willow and GMTC loon survey areas overlap: 4 adults, 1 young, and 1 brood seen during the brood-rearing survey were present at the 3 territories that are within both survey areas.
[e] Includes broods from territories where no brood was seen but presence of a brood was determined from eggshell evidence.
[f] Nest occupancy not calculated because the total number of territories in Willow loon survey area is not known due to lack of historical data.
[g] Includes brood(s) found during ground surveys.
[h] Includes brood(s) found during monitoring surveys.
[i] Totals include observations in the GMTC loon survey area..
[j] Mean numbers not calculated because survey area differed among years.

see Appendix A) and similar to the number of adults seen during the nesting and brood-rearing surveys in 2014.

Similar to occupancy by nests, we used territory occupancy by broods to compare reproductive output among years. Occupancy by broods was calculated as the total number of broods found during all surveys divided by the number of territories surveyed. We used the total number of broods, as opposed to only those found on the brood-rearing survey, because nest fate data (see Nest Fate, below) allow us to infer broods at nests where chicks did not survive until the brood-rearing survey. Thus, the total number of broods can be estimated even in the absence of weekly surveys. In the GMTC loon survey area in 2017, 45% of the 11 surveyed territories were occupied by a brood, which is well above the long-term mean calculated for other survey areas in NE NPR-A (mean = 28.1± 3.8%).

Since surveys began in the NE NPR-A, we have identified 11 Yellow-billed Loon territories composed of 16 lakes in the GMTC loon survey area (Appendix D). Eight of those territories were occupied by broods in 2017. Previously, we had not documented breeding at 2 of the territories used in 2017. Both lakes were first surveyed in 2014 and again in 2017.

Willow Loon Survey Area

In the Willow loon survey area, 9 Yellow-billed Loon nests and 38 adults were found during the nesting survey in 2017 (Figure 8, Table 5). An additional 5 nests were inferred from the presence of broods during August on lakes where nests were not found during the nesting survey. Sightings of pairs of loons without nests and a high percentage of ice cover on lakes during the nesting survey suggest that the survey may not have been optimally timed compared to nesting phenology (see GMTC Loon Survey Area, above). During the brood-rearing survey in 2017, 39 Yellow-billed Loons, 8 broods, and 9 young were observed in the Willow loon survey area (Figure 8, Table 6). We inferred 3 additional broods based on eggshell fragments at nests. Incidental records of Pacific and Red-throated loon nests and broods are presented in Appendices B and C.

Twenty-five percent of the 130 lakes surveyed during both the nesting and brood-rearing surveys in the Willow loon survey area had been surveyed in previous years. Lakes along parts of Fish and Judy creeks were first surveyed during 2001. Since then, we have identified 17 Yellow-billed Loon territories composed of 21 lakes in the Willow loon survey area (Appendix D). Fourteen of those 17 territories were occupied by breeding Yellow-billed Loons in 2017.

HABITAT USE

Yellow-billed Loons nested in 14 of 26 available habitats during nesting surveys conducted over 9 years at 55 territories in the NE NPR-A (excluding the Fish Creek Delta subarea; Table 7). Five habitats, supporting 137 of 189 total nests, were preferred for nesting (Deep Open Water with Islands or Polygonized Margins, Shallow Open Water with Islands or Polygonized Margins, Sedge Marsh, Grass Marsh, Nonpatterned Wet Meadow). Within these habitats, nests were built on islands (132 nests), shorelines (39), peninsulas (10), or in emergent vegetation (8). Because the minimum size for habitat mapping is 0.5 ha, islands or patches of emergent vegetation (i.e., Grass Marsh or Sedge Marsh) smaller than 0.5 ha were not classified individually. Rather, these small habitat patches were assigned the habitat of the lake in which they occurred. Deep Open Water with Islands or Polygonized Margins was the habitat used most frequently for nesting (42% of all nests), which reflects the high use of small islands and complex shorelines by nesting loons (Table 7). Although Shallow Open Water with Islands or Polygonized Margins also was a preferred habitat for nesting Yellow-billed Loons, this habitat was used for only 5% of all nests. In all cases, the shallow water habitat used for nests was either connected or adjacent to (<190 m from) a deep lake. Nesting Yellow-billed Loons avoided nesting in 4 habitats, which together occupied 59% of the available habitat.

Yellow-billed Loons were highly selective in their use of brood-rearing habitat. All 82 Yellow-billed Loon broods in the NE NPR-A area (excluding Fish Creek Delta subarea) were found in 4 lake habitats, only 1 of which was preferred: Deep Open Water with Islands or Polygonized Margins (Table 7). Although that habitat occupies only ~5% of the NE NPR-A area, it contained 80% all broods. Seventeen percent of broods were in Deep Open Water without Islands, but use of that habitat was not significantly higher than its availability (8%). Shallow water with Islands and Polygonized Margins was the only shallow-water habitat used during brood-rearing and was used by 1 brood. That brood, however, was from a territory comprising 2 lakes. The shallow lake has an extensive Sedge Marsh margin that is used for nesting in some years. The other lake is classified as Deep Open Water with Islands and Polygonized Margins and has been used for brood-rearing in most years. The selection analyses for nesting and brood-rearing highlight the importance of large, deep waterbodies to breeding Yellow-billed Loons.

NEST FATE

In total, 20 nests (including 13 seen on the nesting survey and 7 that were inferred from the presence of broods) were recorded in the GMTC and Willow loon survey areas. During the

Table 7. Habitat selection by nesting and brood-rearing Yellow-billed Loons, NE NPR-A, 2001–2004, 2008–2010, 2014, and 2017. The GMTC and Willow loon survey areas were surveyed in 2017.

SEASON Habitat	No. of Nests or Broods	Use (%)[a]	Availability (%)	Monte Carlo Results[b]	Sample Size[c]
NESTING					
Open Nearshore Water	0	0	0.5	ns	low
Brackish Water	0	0	0.2	ns	low
Tapped Lake with Low-water Connection	0	0	0.3	ns	low
Tapped Lake with High-water Connection	2	1.1	<0.1	ns	low
Salt Marsh	0	0	0.5	ns	low
Tidal Flat Barrens	0	0	1.2	ns	low
Salt-killed Tundra	0	0	<0.1	ns	low
Deep Open Water without Islands	9	4.8	7.7	ns	
Deep Open Water with Islands or Polygonized Margins	79	41.8	5.5	prefer	
Shallow Open Water without Islands	1	0.5	1.0	ns	low
Shallow Open Water with Islands or Polygonized Margins	10	5.3	1.4	prefer	low
River or Stream	0	0	1.2	ns	low
Sedge Marsh	23	12.2	1.7	prefer	low
Deep Polygon Complex	1	0.5	<0.1	ns	low
Grass Marsh	6	3.2	0.4	prefer	low
Young Basin Wetland Complex	0	0	0.3	ns	low
Old Basin Wetland Complex	2	1.1	7.4	avoid	
Riverine Complex	0	0	0.3	ns	low
Dune Complex	5	2.6	1.4	ns	low
Nonpatterned Wet Meadow	19	10.1	3.5	prefer	
Patterned Wet Meadow	16	8.5	12.0	ns	
Moist Sedge-Shrub Meadow	14	7.4	20.4	avoid	
Moist Tussock Tundra	2	1.1	26.6	avoid	
Tall, Low, or Dwarf Shrub	0	0	5.0	avoid	
Barrens	0	0	1.4	ns	low
Human Modified	0	0	<0.1	ns	low
Total	189	100	100		
BROOD-REARING					
Open Nearshore Water	0	0	0.5	ns	low
Brackish Water	0	0	0.2	ns	low
Tapped Lake with Low-water Connection	0	0	0.3	ns	low
Tapped Lake with High-water Connection	1	1.2	<0.1	ns	low
Salt Marsh	0	0	0.5	ns	low
Tidal Flat Barrens	0	0	1.2	ns	low
Salt-killed Tundra	0	0	<0.1	ns	low
Deep Open Water without Islands	14	17.1	7.7	ns	
Deep Open Water with Islands or Polygonized Margins	66	80.5	5.5	prefer	low
Shallow Open Water without Islands	0	0	1.0	ns	low

Table 7. Continued.

SEASON Habitat	No. of Nests or Broods	Use (%)[a]	Availability (%)	Monte Carlo Results[b]	Sample Size[c]
Shallow Open Water with Islands or Polygonized Margins	1	1.2	1.4	ns	low
River or Stream	0	0	1.2	ns	low
Sedge Marsh	0	0	1.7	ns	low
Deep Polygon Complex	0	0	<0.1	ns	low
Grass Marsh	0	0	0.4	ns	low
Young Basin Wetland Complex	0	0	0.3	ns	low
Old Basin Wetland Complex	0	0	7.4	avoid	
Riverine Complex	0	0	0.3	ns	low
Dune Complex	0	0	1.4	ns	low
Nonpatterned Wet Meadow	0	0	3.5	ns	low
Patterned Wet Meadow	0	0	12.0	avoid	
Moist Sedge-Shrub Meadow	0	0	20.4	avoid	
Moist Tussock Tundra	0	0	26.6	avoid	
Tall, Low, or Dwarf Shrub	0	0	5.0	ns	low
Barrens	0	0	1.4	ns	low
Human Modified	0	0	<0.1	ns	low
Total	82	100	100		

Note: Includes the Development, Exploration, Fish and Judy Creek, Alpine West, GMTC, and Willow loon survey areas. See Johnson et al. (2015) for survey areas not described in Figure 1.

[a] % use = (nests / total nests) × 100 or (broods / total broods) × 100.

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

[c] Low = expected number <5.

brood-rearing survey, 11 of 20 Yellow-billed Loon nests had a brood. Because the absence of a brood does not always indicate nest failure, all 9 nests without broods were visited on the ground to determine nest fate. Four of the 9 nests contained >20 egg fragments (range 30–75 fragments), indicating that at least 1 egg hatched in those nests. The remaining 5 nests contained no egg remains. Overall, we determined that a total of 15 of 20 nests hatched.

We began visiting inactive nests to verify nest fate in 2008. During 2008–2014, we also conducted weekly nest and brood monitoring surveys, which provide better estimates of the total number of nests and broods. Weekly surveys detect more nests especially in years when late nesting phenology results in numerous nests being initiated after the nesting survey, as occurred in 2017. Nests that are missed during the single nesting survey can only be detected during the brood-rearing survey if they produce a brood, which would bias estimates of nesting success high because more successful nests would be included in the calculation. Because of lower survey effort in 2017, nesting success based on the total number of nests detected is not directly comparable to previous years when weekly surveys were conducted. Restricting the annual data to nests found only on nesting surveys and years in which nest fate data were collected allows a standardized comparison of apparent nesting success among years. Based on nests determined from single nest surveys and hatching determined from nest fate data and the presence of broods, 8 of the 13 nests found during the nesting survey hatched in 2017 for an apparent nesting success of 61%. This estimate was well above the 8-year mean (49.4 ± 8.1%) and was among the 3 highest estimates of nest success observed since 2008.

GULLS

DISTRIBUTION AND ABUNDANCE

GMTC Loon Survey Area

During 2017, we recorded 38 Glaucous Gull nests on the aerial survey for nesting loons in the GMTC loon survey area (Figure 9, Table 8) and 4 additional nests were found on ground-based nest searches (Rozell and Johnson 2018). Only active gull nests are recorded on aerial surveys. Two colonies in the GMTC loon survey area accounted for 43% of nests found in 2017; all other nests were individual locations. The GMT-1 West colony, located ~3.8 km southwest of the GMT-1 drill site, contained 10 nests in 2017, and has doubled in size since our first visit in 1999 (Anderson and Johnson 1999). The CD-5 East colony, 1.3 km northeast of the CD-5 drill site, contained 8 nests in 2017. Just south of the survey area is the CD-5 South colony with 12 nests. The nest counts at the all 3 colonies have increased since 2004 (Table 8).

The number of Glaucous Gull nests in the GMTC loon survey area in 2017 (38 nests) was higher than the number counted in 2014 (32 nests), when similar survey methods were employed (Johnson et al. 2015). Nest counts in 2002–2004 (range: 42–51 nests) were collected during aerial surveys for Tundra Swans and loons and during ground-based nest searches, which covered more area than the 2017 aerial loon surveys.

We did not calculate gull nesting density in 2014 and 2017, because the loon aerial surveys did not include all potential gull nesting lakes in the survey area, for example Shallow Open Water lakes that <5 ha in area. All wildlife habitats types were covered in the 2002–2004 surveys. The mean density for Glaucous Gull nests in GMTC loon survey area (3-year mean = 0.14 nests/km^2, 331.1 km^2 survey area) was higher than 3-year mean density of nests in the NE NPR-A area (0.08 nests/ km^2, 1,091.6 km^2 survey area) and the adjacent Colville Delta study area (0.09 nests/km^2, 363.5 km^2 survey area) (Burgess et al. 2003a, 2003b; Johnson et al 2003b, 2005).

Four Glaucous Gulls broods were recorded on 3 waterbodies during the survey for brood-rearing loons (Figure 9). Brood-rearing gulls included a total of 12 adults and 9 young. The count of young Glaucous Gulls in 2017 was low compared with the 25 young recorded in 2014 (Johnson et al. 2015). Relatively low counts of young were also documented on the Colville Delta study area in 2017 (Johnson et al. 2018a). The timing of the loon brood surveys occurs close to when young gulls fledge, thus a portion of the young may be flight capable and move out of their nesting lakes.

No Sabine's Gull nests were recorded during loon nesting aerial survey in the GMTC loon survey area in 2017, and only 1 Sabine's nest was recorded in 2014 (Johnson et al. 2015). Sabine's Gulls and nests are likely undercounted during loon aerial surveys.

Willow Loon Survey Area

Twelve Glaucous Gull nests were counted at 11 locations on the aerial survey for nesting loons in the Willow loon survey area in 2017 (Figure 9, Table 8), including 1 Glaucous Gull nest located in the area of overlap between the Willow and GMTC loon survey areas. Prior to 2017, only portions of the Willow area were surveyed for loons and gulls. Using only lakes that were surveyed during 4 years, we detected a slight increase in the number of Glaucous Gull nests (8) in 2017 compared with 2002–2004 (4–7 nests). In 2017, 5 young and 4 adults in 3 broods were recorded during the aerial survey for loons.

Three groups of nesting Sabine's Gulls were recorded in the Willow loon survey area during the nesting aerial survey. The largest concentration of Sabine's Gulls (50 adults) was found in a lake in the southern portion of the Willow loon survey area (Figure 9). Two colonies contained ≥ 10 nests each. On aerial surveys, we detect colonies more readily than single nests, which results in an underestimate of the total nests present. For example, on the Yukon-Kuskokwim Delta, ground-searchers found single nests were as common as colonies of nests (Norment et al 2015).

Habitat Use

Glaucous Gulls nests and colonies were found in 6 different habitats in the GMTC and Willow loon survey areas in 2017 (Table 9). The 3 most commonly used habitats also contained colonies: Shallow Open Water with Islands or Polygonized Margins (60% of all nests), Grass Marsh (11% of all nests), and Deep Open Water with Islands or Polygonized Margins (9% of nests). Two Glaucous

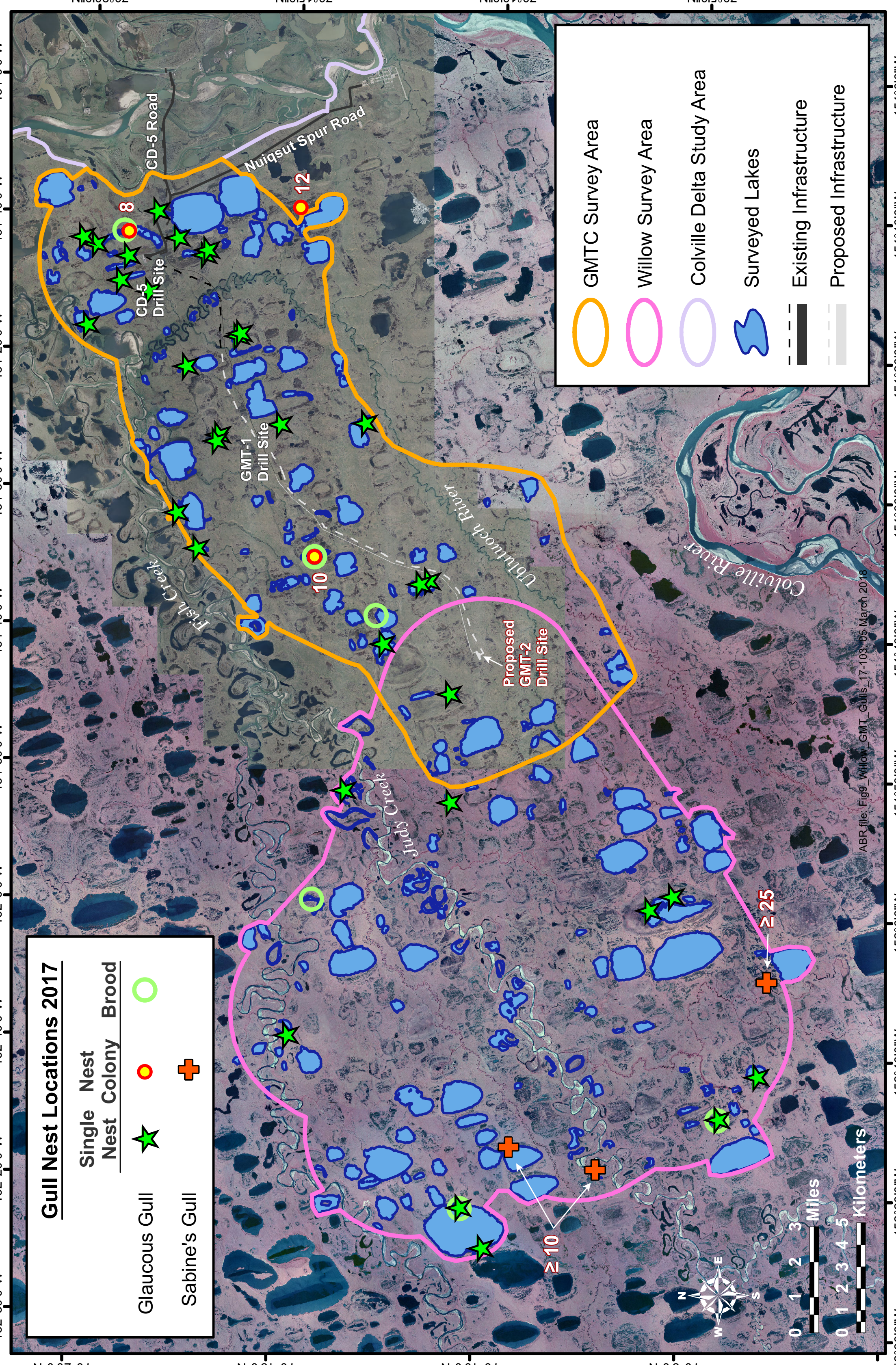


Figure 9. Glaucous Gull and Sabine's Gull nest and brood locations, Willow and GMTC loon survey areas, NE NPR-A, 2017. Numbers at colony sites indicate estimated number of nests in colonies.

Table 8. Number of Glaucous Gull nests recorded during aerial surveys for nesting loons in the GMTC and Willow loon survey areas, NE NPR-A.

Survey Area Method Year	Nests	GMT-1 West Colony Nests	CD-5 East Colony Nests	CD-5 South Colony Nests	Brood Groups	Total Young
GMTC[a]						
Loon Survey						
2014	33	9	3	9	11	25
2017	38	10	8	12	4	9
Combined Loon, Swan, and Ground-based Surveys						
2002	42	6	3	4	-	-
2003	51	7	4	7	-	-
2004	42	6	3	6	-	-
Willow[a]						
Loon Survey						
2017	12	-	-	-	3	5

[a] GMTC and Willow loon survey areas overlapped in 2017:1 nest, 1 brood, and 2 young are included in both the Willow and GMTC totals.

Table 9. Habitat use by nesting Glaucous Gulls recorded during aerial surveys for nesting loons in the GMTC and Willow loon survey areas, NE NPR-A, 2014 and 2017.

	2014		2017	
Habitat	Nests	Use (%)	Nests	Use (%)
Tapped Lake with High-water Connection	–	0	2	3.8
Deep Open Water with Islands or Polygonized Margins	6	17.1	5	9.4
Shallow Open Water with Islands or Polygonized Margins	21	60.0	32	60.4
Sedge Marsh	2	5.7	4	7.5
Grass Marsh	1	2.9	6	11.3
Young Basin Wetland Complex	1	2.9	0	0
Old Basin Wetland Complex	3	8.5	2	3.8
Moist Sedge-Shrub Meadow	1	2.9	0	0
Unmapped area	–	–	2	3.8
Total	35	100	53	3.8

Gull colonies (18 nests) were located in Shallow Open Water with Islands or Polygonized Margins. The remaining nests were found on islands or shorelines in 3 other habitats and in unmapped areas. In 2014, Glaucous Gulls nested in 2 additional habitats—Young Basin Wetland Complex and Moist Sedge-Shrub Meadow (Table 9). Sabine Gulls nested in Sedge Marsh and Grass Marsh.

LITERATURE CITED

Anderson, B. A., and C. B. Johnson. 1999. Baseline avian surveys in four lease blocks within the National Petroleum Reserve–Alaska, 1999. Report for ARCO Alaska, Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK. 18 pp.

BLM (Bureau of Land Management). 2004. Alpine Satellite Development Plan Final Environmental Impact Statement. U.S. Department of the Interior, Bureau of Land Management, with assistance from Minerals Management Service, Anchorage, AK.

BLM. 2013. National Petroleum Reserve-Alaska. Final Integrated Activity Plan/Environmental Impact Statement Record of Decision. U.S. Department of the Interior, Bureau of Land Management, Anchorage, AK.

BLM. 2014. Supplemental Environmental Impact Statement for the Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth One Development Project. August 2014. U.S. Department of the Interior, Bureau of Land Management, Anchorage, AK.

Burgess, R. M., C. B. Johnson, B. E. Lawhead, A. M. Wildman, P. E. Seiser, A. A. Stickney, and J. R. Rose. 2003a. Wildlife studies in the CD South study area, 2002. Third annual report for ConocoPhillips Alaska, Inc., Anchorage, by ABR, Inc., Fairbanks, AK. 126 pp.

Burgess, R. M., C. B. Johnson, A. M. Wildman, P. E. Seiser, J. R. Rose, A.K. Prichard, T. J. Mabee, A. A. Stickney, and B. E. Lawhead. 2003b. Wildlife studies in the Northeast Planning Area of the National Petroleum Reserve–Alaska, 2002. Report for ConocoPhillips Alaska, Inc., Anchorage, by ABR, Inc., Fairbanks, AK. 126 pp.

CPAI (ConocoPhillips Alaska, Inc.). 2017. Data management protocols North Slope Field Surveys, Version 10.1.

Johnson, C. B., R. M. Burgess, B. E. Lawhead, J. P. Parrett, J. R. Rose, A. A. Stickney, and A. M. Wildman. 2003a. Wildlife studies in the CD North study area, 2002. Third annual report for ConocoPhillips Alaska, Inc., Anchorage, by ABR, Inc., Fairbanks, AK. 104 pp.

Johnson, C. B., R. M. Burgess, B. E. Lawhead, J. Neville, J. P. Parrett, A. K. Prichard, J. R. Rose, A. A. Stickney, and A. M. Wildman. 2003b. Alpine Avian Monitoring Program, 2001. Fourth annual and synthesis report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 194 pp.

Johnson, C. B., R. M. Burgess, A. M. Wildman, A. A. Stickney, P. E. Seiser, B. E. Lawhead, T. J. Mabee, J. R. Rose, and J. E. Shook. 2004. Wildlife studies for the Alpine Satellite Development Project, 2003. Annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 155 pp.

Johnson, C. B., R. M. Burgess, A. M. Wildman, A. A. Stickney, P.E. Seiser, B. E. Lawhead, T. J Mabee, A. K. Prichard, and J. R. Rose. 2005. Wildlife studies for the Alpine Satellite Development Project, 2004. Second annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 129 pp.

Johnson, C. B., A. M. Wildman, J. P. Parrett, J. R. Rose, T. Obritschkewitsch, and P.E. Seiser. 2011. Avian studies for the Alpine Satellite Development Project, 2010. Eighth annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 69 pp.

Johnson, C. B., A. M. Wildman, J. P. Parrett, J. R. Rose, T. Obritschkewitsch, and P.E. Seiser. 2012. Avian studies for the Alpine Satellite Development Project, 2011. Ninth annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 91 pp.

Johnson, C. B., A. M. Wildman, J. P. Parrett, J. R. Rose, T. Obritschkewitsch, and P.E. Seiser. 2013. Avian studies for the Alpine Satellite Development Project, 2012. Tenth annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 92 pp.

Johnson, C. B., A. M. Wildman, A. K. Prichard, and C. L. Rea. 2014a. Yellow-billed Loon territory occupancy near a new oil development. Report for ConocoPhillips Alaska, Inc., Anchorage, by ABR, Inc., Fairbanks, AK. 27 pp.

Johnson, C. B., J. P. Parrett, T. Obritschkewitsch, J. R. Rose, K. B. Rozell, P. E. Seiser, and A. M. Wildman. 2014b. Avian studies for the Alpine Satellite Development Project, 2013. Eleventh annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 115 pp.

Johnson, C. B., J. P. Parrett, T. Obritschkewitsch, J. R. Rose, K. B. Rozell, and P. E. Seiser. 2015. Avian studies for the Alpine Satellite Development Project, 2014. Twelfth annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK. 124 pp.

Johnson, C. B., J. P. Parrett, and P. E. Seiser. 2018a. Avian studies for the Alpine Satellite Development Project, 2017. Fifteenth annual report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK.

Johnson, C. B., J. E. Shook, and R. M. Burgess. 2018b. Biological assessment for the polar bear, Spectacled Eider, and Steller's Eider in the GMT-2 project area. Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by ABR, Inc., Fairbanks, AK.

Michael Baker International. 2017a. Willow spring breakup and summer monitoring and hydrological assessment. Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by Michael Baker, Jr., Inc., Anchorage, AK.

Michael Baker International. 2017b. Colville River delta spring breakup monitoring and hydrological assessment. Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by Michael Baker, Jr., Inc., Anchorage, AK.

Michael Baker International. 2017c. GMT1 spring breakup and summer monitoring and hydrological assessment. Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by Michael Baker, Jr., Inc., Anchorage, AK.

Natural Resources Conservation Service. 2017. Alaska Snow Survey Report May 1, 2017. USDA, Palmer Alaska.

Norment, C. J., R. A. Stehn, J. B. Fischer, and T. Moser. 2015. Sabine's Gull (*Xema sabini*) nesting aggregations in western Alaska. Northwestern Naturalist 96: 101–106.

North, M. R. 1986. Breeding biology of Yellow-billed Loons on the Colville River delta, arctic Alaska. M.S. thesis, North Dakota State University, Fargo. 109 pp

North, M. R., and M. R. Ryan. 1989. Characteristics of lakes and nest sites used by Yellow-billed Loons in arctic Alaska. Journal of Field Ornithology 60: 296–304.

Parrett, J., A. Wildman, and C. Johnson. 2008. Using evidence found at the nest to judge nest fate for Yellow-billed Loons (*Gavia adamsii*). Page 35 *in* Proceedings of the 2008 Alaska Bird Conference, 3–7 March 2008, Fairbanks, AK. [abstract only]

Rozell, K. B., and C. B. Johnson. 2016. Nesting Greater White-fronted Goose study at CD-5, 2015. Report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK.

Rozell, K. B., and C. B. Johnson. 2018. Nesting Greater White-fronted Goose study at CD-5, 2017. Report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK.

Seiser, P. E., and C. B. Johnson. 2018b. Eider nest searches in the GMT-1 area, 2017. Report for ConocoPhillips Alaska, Inc., and Anadarko Petroleum Corporation, Anchorage, AK, by ABR, Inc., Fairbanks, AK.

USFWS (U.S. Fish and Wildlife Service). 1987. Standard operating procedures for aerial waterfowl breeding ground population and habitat surveys in North America. Unpublished report by the Migratory Bird and Habitat Research Laboratory, Patuxent Wildlife Research Center, Laurel, MD. 96 pp.

USFWS. 2012. Threatened and endangered species Yellow-billed Loon (*Gavia adamssii*). https://www.fws.gov/alaska/fisheries/endangered/pdf/yellowbilled_loon_factsheet_v2.pdf. Accessed 10 December 2017

Wells, A. F., T. Christopherson, W. A. Davis, D. Dissing, G. V. Frost, S. L. Ives, M. J. Macander, R. W. McNown, and C. S. Swingley. 2018. An ecological land survey and integrated terrain unit mapping for the Willow Master Development Plan Area, National Petroleum Reserve-Alaska, 2017. Draft Report for ConocoPhillips Alaska, Inc., Anchorage, AK, by ABR, Inc., Anchorage, AK.

Wilson, H. M., W. W. Larned, and M. A. Swaim. *In prep.* Waterfowl breeding population survey, Arctic Coastal Plain, Alaska, 2012–2016. Unpublished report by U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.

Appendix A. Annual density (number/km²) of Yellow-billed Loons, nests, and broods in the GMTC, Willow, and other NE NPR-A survey areas in 2001–2006, 2008–2014, and 2017.

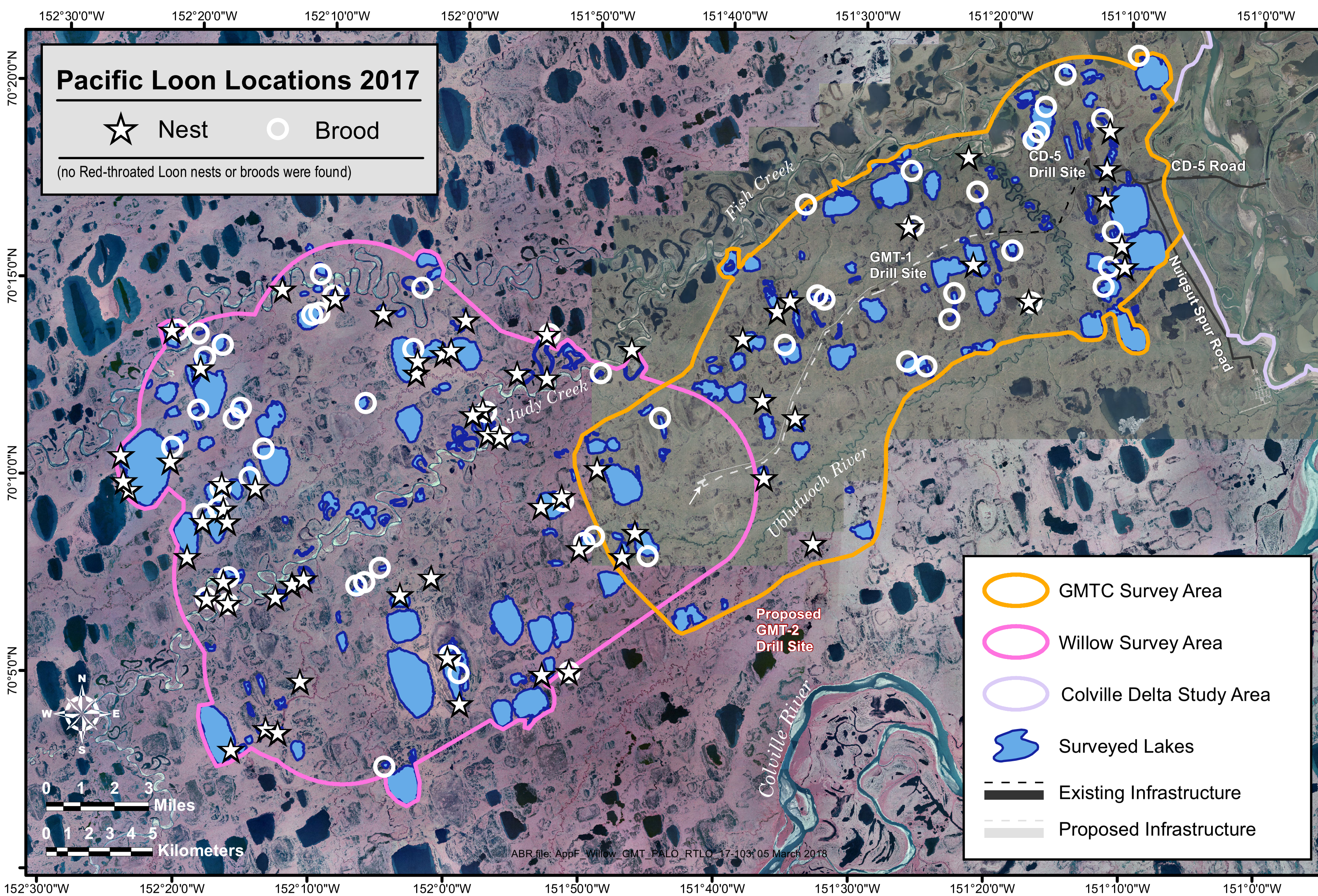
SURVEY AREA Year	Nesting Survey Adults	Nests[a]	Brood-rearing Survey Adults	Broods[b]
GMTC[c,d]				
2014	0.06	0.02 (0.03)	0.04	0.01 (0.01)
2017	0.03	0.01 (0.02)	0.05	0.01 (0.01)
Willow[d,e]				
2017	0.07	0.01 (0.03)	0.08	0.01 (0.02)
NE NPR-A[f,g]				
2001	0.07	0.03	0.08	0.01
2002	0.07	0.03	0.05	0.01
2003	0.06	0.03	0.06	0.02
2004	0.07	0.03	0.08	0.01
2005	0.11	0.04	0.06	0.01
2006	0.11	0.04	0.07	0.01
2008	0.17	0.05 (0.06)	0.14	0.02 (0.04)
2009	0.13	0.05 (0.06)	0.16	0.03 (0.03)
2010	0.15	0.06 (0.06)	0.14	0.03 (0.03)
2011	0.12	0.03 (0.05)	0.12	0.02 (0.02)
2012	0.14	0.06 (0.07)	0.17	0.05 (0.05)
2013	0.16	0.05 (0.06)	0.08	0 (<0.01)
2014[h]	0.09	0.03 (0.04)	0.06	0.02 (0.02)

[a] Density of nests found on the nesting survey and, in parentheses, cumulative density including additional nests inferred from broods (all years) or found during revisit (1996–2002) and monitoring (2006–2014) surveys.
[b] Density of broods found on the brood-rearing survey and, in parentheses, cumulative density including additional broods found during monitoring surveys (2005–2014) or inferred from egg remains (2017) that did not survive to the time of the brood-rearing survey.
[c] GMTC loon survey area = 359.4 km^2.
[d] GMTC and Willow loon survey areas overlap.
[e] Willow loon survey area was 502.3 km^2.
[f] Survey area included 5 subareas: Development (617.8 km²) surveyed in 2001–2004, Exploration (260.4 km²) in 2002–2004, Alpine West (79.7 km²) in 2002–2006 and 2008–2013, Fish Creek Delta (130.5 km²) in 2005–2006 and 2008–2013, and the Fish and Judy Creek Corridor (255.9 km²) in 2008–2010. In 2011–2013, the eastern one-quarter of the Fish and Judy Creek Corridor subarea (41.0 km²) was surveyed. In 2014, area surveyed was 525.2.
[g] Mean densities not calculated for NE NPR-A because the study area differed among years.
[h] Totals include observations in the GMTC loon survey area.

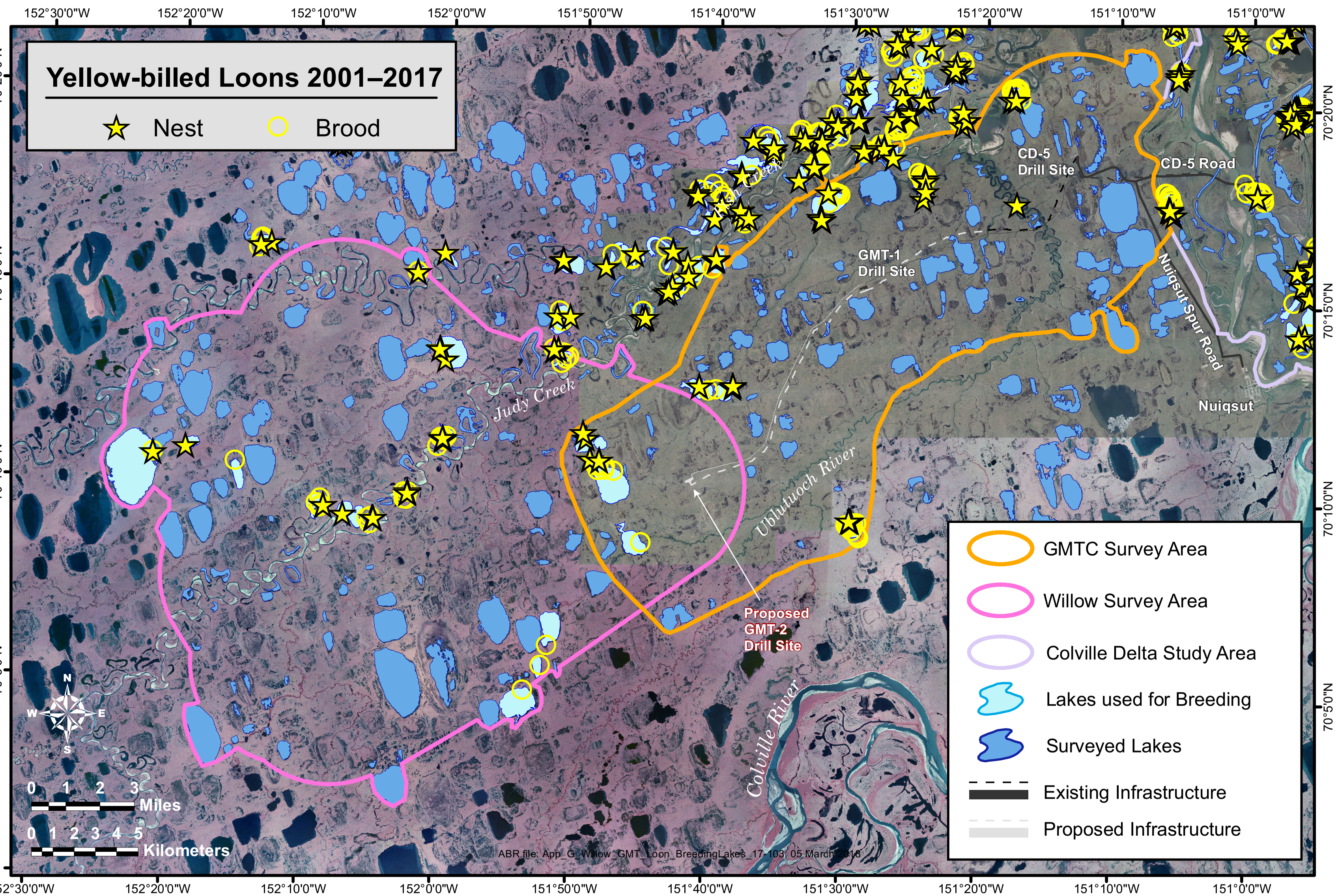
Appendix B. Number of Pacific and Red-throated loons and their nests, broods, and young during aerial surveys, GMTC and Willow loon survey areas, NE NPR-A, 2017.

SURVEY AREA[a] Survey Type	Pacific Loon[b]			Red-throated Loon[b]		
	Adults	Nests/ Broods	Young	Adults	Nests/ Broods	Young
GMTC						
Nesting	210	19	–	10	0	–
Brood-rearing	242	25	30	2	0	0
WILLOW						
Nesting	251	50	–	1	0	–
Brood-rearing	295	39	48	1	0	0

[a] GMTC loon survey area = 206.7 km², Willow loon survey area = 155.9 km²; see Figure 7.
[b] Densities of Pacific and Red-throated loons were not calculated because surveys did not include smaller lakes (<5 ha) where those species commonly nest.



Appendix C. Pacific Loon nests and broods during aerial surveys, Willow and GMTC loon survey areas, NE NPR-A, 2017.



Appendix D. Lakes used by nesting and brood-rearing Yellow-billed Loons, Willow and GMTC loon survey areas, NE NPR-A, 2001–2006, 2008–2014 and 2017.