DATA REPORT

AVIAN STUDIES IN THE KUPARUK OILFIELD, ALASKA, 2012

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PREPARED FOR

CONOCOPHILLIPS ALASKA
ANCHORAGE, ALASKA

AND

THE KUPARUK RIVER UNIT

PREPARED BY

ABR, INC.–ENVIRONMENTAL RESEARCH & SERVICES
FAIRBANKS, ALASKA

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INTRODUCTION

ABR, Inc., has conducted avian studies in the Kuparuk Oilfield for ConocoPhillips Alaska (formerly PHILLIPS Alaska, Inc.) and its predecessor, ARCO Alaska, Inc., since 1988. The emphasis of this study in recent years has been long-term monitoring of the distribution, abundance, and productivity of selected waterfowl populations. Our studies in 2012 focused on 3 species: Spectacled Eider (*Somateria fischeri*), Tundra Swan (*Cygnus columbianus*), and Brant (*Branta bernicla*). These species were selected for study in the oilfields for several reasons. The Spectacled Eider was listed by the U.S. Fish and Wildlife Service (USFWS) as a threatened species in 1993 and its population status on the North Slope is being monitored in support of the recovery efforts for this species. Annual surveys for Spectacled Eiders began in the Kuparuk Oilfield in 1993. The Tundra Swan has been identified as an indicator species for the health of waterbird populations and their wetlands systems in the oilfields by federal and state agencies. Tundra Swan surveys in the Kuparuk Oilfield began with a preliminary reconnaissance in 1988 and have continued with annual systematic surveys ever since. The largest Brant colonies in Alaska (particularly those on the Yukon-Kuskokwim Delta) have been declining for at least 2 decades, although there are indications that smaller colonies elsewhere in Alaska have been increasing. This species is considered to be sensitive to disturbance, particularly during the molting and brood-rearing periods (Murphy and Anderson 1993). Brant surveys were initiated in the Kuparuk Oilfield in 1988 and have continued annually since then, with some modifications in seasonal and geographic scope.

This report summarizes the results of 2012 surveys for these 3 species. Unlike annual reports prior to 2005, this data report briefly summarizes objectives and annual survey results for each species, including supporting tables and figures, but with limited analysis or historical context. Brief methods are provided in Appendix 1 for the surveys conducted in 2012. The reader is referred to the 2003 and 2004 annual reports (Anderson et al. 2004, 2005) for detailed methodologies, analysis, and discussion of results.

CONDITIONS IN THE STUDY AREA

Birds returning to the Kuparuk Oilfield in mid–late May encountered widespread snow that melted rapidly, leaving the tundra largely snow-free by early June, except for areas around roads, pipelines, and pads. Temperatures during both the arrival period (late May) and the nest initiation/early incubation period (early June) were slightly cooler than average, while the mean monthly temperature for June was slightly warmer than the 23-year average (Table 1; http://www.ncdc.noaa.gov/oa/climate/ghcn-daily/). Peak stage at Monument 1 on the Colville River occurred on 27 May, 5 days earlier than peak discharge on 1 June, which was 1 day later than the 24-year average. Neither peak was notable in terms of either surface elevation or volume (Michael Baker Jr., Inc. 2012). Breakup on the Kuparuk River occurred around 27 May, 1 day earlier than the historical average of 28 May. Snow cover was 100% through 22 May but then melted rapidly with traces of snow remaining until 5 June. By comparison, there was 100% snow cover 5 inches deep on 31 May 2010. Although snow was mostly gone by the end of May 2012, temperatures were near freezing in the first week of June and large lakes retained ice through mid-June. Shallow lakes retained high levels of meltwater through the first week of June. Over the period of waterfowl arrival and peak nest initiation (15 May–15 June), 28 cumulative thawing degree-days were recorded, cooler than the 24-year average of 60 cumulative thawing degree-days (range = 19–128 thawing degree-days; Table 1; Figure 1). By comparison with 24-year averages, late May 2012 was the fourth coolest and early June 2012 the sixth coolest on record (Figure 1).

Table 1. Annual mean temperatures (°C) for May and June compared to the 24-year mean, and cumulative thawing degree-days for 15 May–15 June at the Kuparuk aiport, 1989–2012.

Year	Mean Temperature (°C)		Cumulative Thawing Degree-days[a]
	May	June	
1989	–7.7	4.3	26
1990	–2.8	5.7	56
1991	–2.5	4.5	22
1992	–5.7	4.6	75
1993	–4.4	4.2	42
1994	–6.3	3.0	54
1995	–2.6	4.7	59
1996	–2.7	6.9	128
1997	–4.8	4.5	60
1998	–2.1	7.0	120
1999	–5.0	3.1	32
2000	–9.3	6.6	37
2001	–10.8	4.1	54
2002	–2.2	4.4	91
2003	–4.6	3.2	34
2004	–5.5	7.2	38
2005	–4.7	3.1	19
2006	–3.1	8.1	117
2007	–7.5	4.2	46
2008	–2.6	7.1	107
2009	–2.9	3.9	88
2010	–5.7	3.5	55
2011	–5.0	na	40
2012	–5.5	5.4	28
24-year average	–4.8	4.9[b]	60

[a] Thawing degree-days are calculated as the cumulative mean daily temperatures in degrees Celsius for each day with mean temperature above freezing (0 °C) in the period 15 May–15 June.
[b] June average based on a 23-year average due to the unavailability of a June 2011 mean.

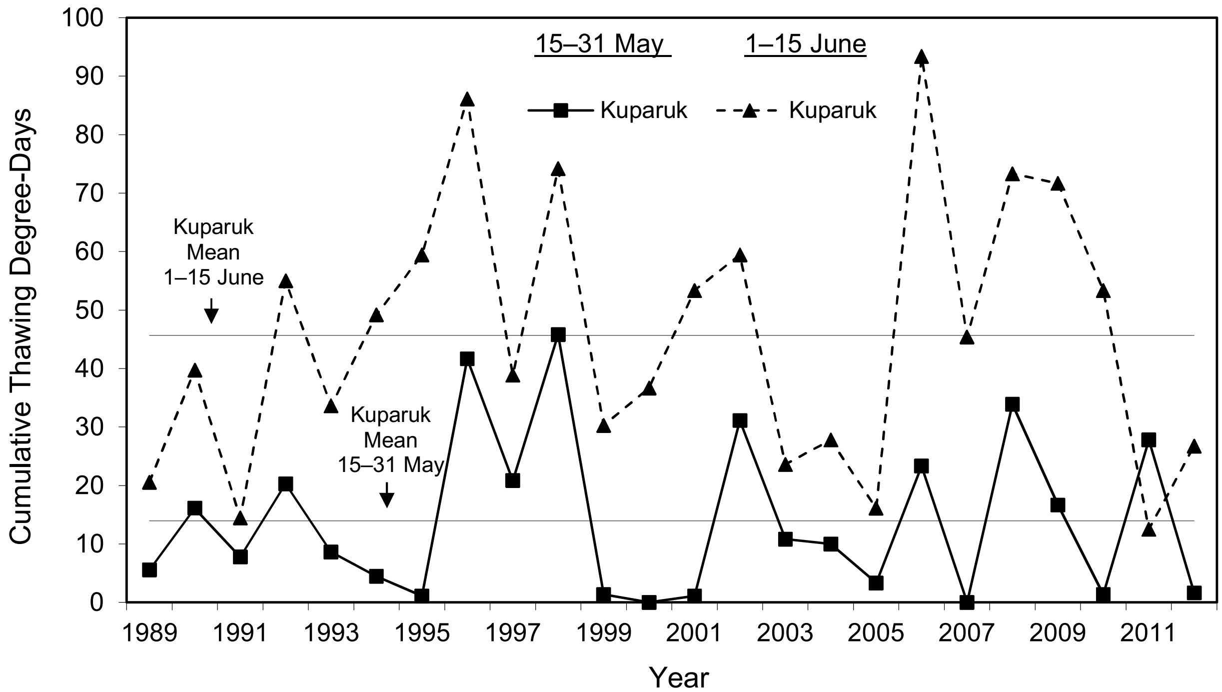

Figure 1. Number of cumulative thawing degree-days in the Kuparuk Oilfield 15–31 May and 1–15 June and mean cumulative thawing degree-days 15–31 May and 1–15 June, 1989–2012.

SPECTACLED EIDER

The Spectacled Eider is one of 4 species of eiders that breed in arctic Alaska (Bellrose 1976). Spectacled, King (*S. spectabilis*), and Common (*S. mollissima*) eiders all nest in the oilfields on Alaska's North Slope (Johnson and Herter 1989). Spectacled Eiders have undergone severe declines in abundance, particularly on the Yukon-Kuskokwim Delta in western Alaska (Kertell 1991, Stehn et al. 1993). Because of their decline in abundance, Spectacled Eiders were listed by the USFWS as a “threatened species” under the Endangered Species Act on 9 June 1993 (58 FR 27474-27480). The USFWS has developed a Recovery Plan for the Spectacled Eider (USFWS 1996) that outlines the research needs for promoting the recovery of the species. Research needs for Spectacled Eiders are being addressed by an annual aerial survey for eiders conducted on the North Slope by the USFWS, by USFWS-sponsored research on nesting ecology and reproduction conducted on the Yukon-Kuskokwim Delta, and by industry-sponsored research on the North Slope (including this study and studies on the Colville River delta).

The 2012 season was the 20th year of road and nest searches and the 19th year of aerial surveys (no aerial survey was flown in 1994) for Spectacled Eiders in the Kuparuk Oilfield. The goals of the Spectacled Eider study include 1) monitoring population trends in the oilfields; 2) identifying important nesting habitats and determining how eiders are distributed relative to these habitats and oilfield infrastructure (roads, processing facilities, and drilling pads); and 3) monitoring the breeding biology and nesting success of eiders to determine if productivity is being affected negatively by oilfield activities or by natural processes. The study area is illustrated in Figure 2. The 2012 study had 4 objectives to meet these goals:

- Conduct road surveys to monitor the distribution and abundance of Spectacled Eiders near facilities in the Kuparuk Oilfield during pre-nesting.
- Conduct an aerial survey to determine the broader distribution and abundance of pre-nesting Spectacled Eiders in the Kuparuk Oilfield, and compare the results

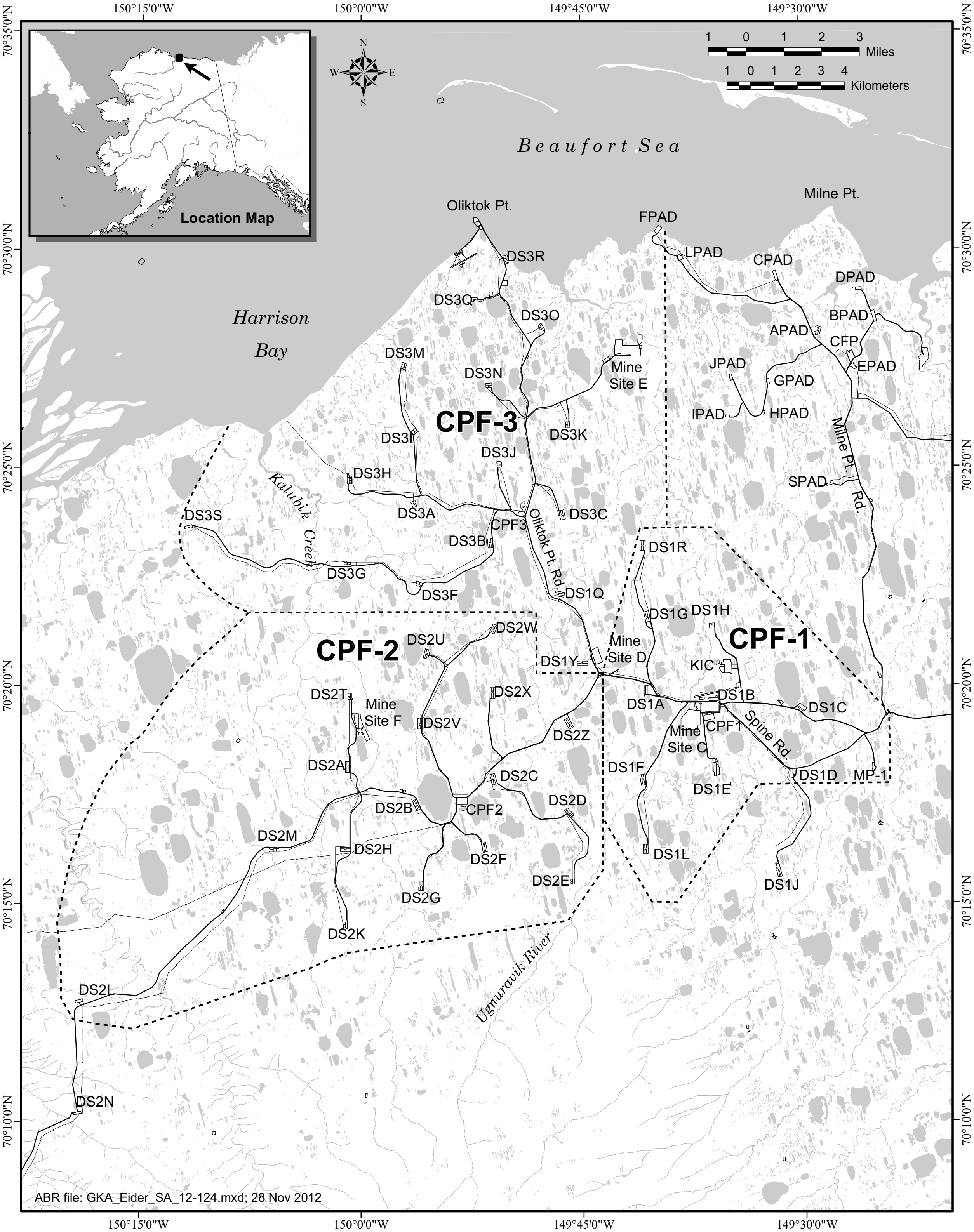

Figure 2. Study area for the Spectacled Eider road surveys in the Kuparuk Oilfield, Alaska, 2012.

of the survey with previous ABR aerial surveys (1993, 1995–2011), and with U.S. Fish and Wildlife Service surveys across the Arctic Coastal Plain.

- Evaluate the relationship between locations of pre-nesting pairs and subsequent nest locations.
- Monitor a number of eider nests with time-lapse cameras to evaluate causes of nesting failures (3 time-lapse cameras were deployed in 2012; these data are briefly mentioned here and have been archived for future analysis).

2012 RESULTS

In the Kuparuk Oilfield, a road survey was conducted daily from 5–17 June with a selection of sites with Spectacled Eiders surveyed again on 18 June. In 2012, a complete survey of eider habitats near the Kuparuk Oilfield road system was completed every 2 days. A peak count of 27 Spectacled Eiders was recorded during the complete road survey of the oilfield on 5–6 June 2012 (Appendix 2). This count was 50% higher and over a week earlier than the peak count of 18 eiders on 14–15 June 2011, but was less than a third of the peak number recorded in 1995 (65 eiders).

To determine the extent to which early spring temperatures affected the number of Spectacled Eiders observed, each year was categorized as “warm” (>75 cumulative thawing degree-days), “moderate” (51–75 cumulative thawing degree-days), or “cool” (≤50 cumulative thawing degree-days) for the period 15 May–15 June. To allow a comparison of surveys among years, a daily population of pre-nesting eiders was estimated as a running 2-day total, such that the estimated population of pre-nesting eiders in surveyed habitats adjacent to the Kuparuk Oilfield road system on day x equals the observations from day x plus the observations from day x–1. Only eiders within the 500-m-wide road survey area were included in comparisons among years and Julian dates (JD) were used to standardize between leap and non-leap years. A summary of eiders (both Spectacled and King eiders) found within and outside of the 500-m road survey area in 2012 is presented in Appendix 2. Estimated daily mean numbers of pre-nesting Spectacled Eiders were compared among categories (warm, moderate, or cool; Figure 3).

Dates of earliest arrival often were uncertain, but in all types of years small numbers of pre-nesting Spectacled Eiders are typically are present between JD 156 and 158, in early June (Figure 3). In all years, the number of Spectacled Eiders observed eventually decreases as males (the more visible of each pair) depart the nesting areas and females start incubation (or also abandon breeding attempts and depart nesting areas) by mid-June. Results indicate that the number of eiders increases earlier in warm years than it does in moderate years, but in both warm and moderate years fairly large numbers arrive quickly, over several days in early June (JD 157–160 in warm years and JD 158–162 in moderate years). In both warm and moderate years, the number of pre-nesting Spectacled Eiders peaks for several days and then drops off rapidly. The peak in numbers appears to be shorter in warm years than it is in moderate years (JD 160–164 versus JD 162–168, respectively), but the number of Spectacled Eiders using pre-nesting habitats is higher in moderate years than it is in warm years (Figure 3). These observations probably reflect overall earlier nest initiation in warm years by comparison with less synchronous and somewhat later nest initiation is moderate years. In cool years, the number of eiders increases slowly (JD 157–161) and then remains more-or-less stable over a protracted period (JD 161–169), only reaching about 50% of total numbers observed during peak pre-nesting in moderate years (Figure 3).

As noted above, only 28 cumulative thawing degree-days were recorded during mid-May/mid-June, so 2012 was categorized as “cool”. However, fairly large numbers of Spectacled Eiders were present during the first 2 days of surveys, and the arrival period in 2012 appeared to be more similar to that of either a “warm” or “moderate” year than to a “cool” year (Figure 3). There were more Spectacled Eiders observed during each of the first 3 days of the survey (JD 157–159) in 2012 than in any other year except 1993, when 30 Spectacled Eiders were seen on JD 158. It should be noted that only 4 years started surveys as early as JD 157, whereas there were 6–8

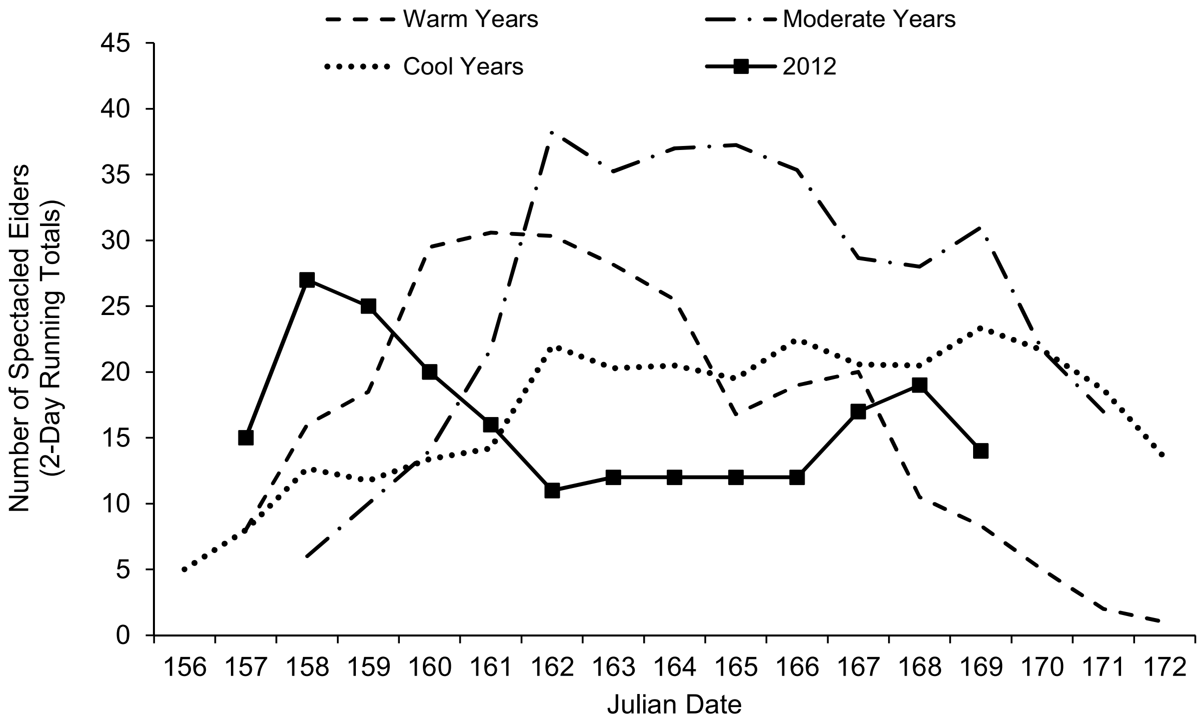

Figure 3. Estimated daily mean number of Spectacled Eiders present during road surveys of the Kuparuk Oilfield in 2012, and estimated daily mean number of Spectacled Eiders present by type of year (warm, moderate, or cool), 1993–2012. Daily numbers of eiders are estimated as 2-day running totals, as described in text.

years with surveys on JD 158 and 159, respectively. Numbers in 2012 quickly peaked at 27 eiders on JD 158, dropped to 11–12 eiders on JD 161–166, then climbed to a second smaller peak on JD 168 (Figure 3). Low numbers of eiders on JD 161–166 in 2012 corresponded to a period when winds were easterly at 19–30 mph, which may have delayed eiders coming into the field.

As in previous years, most Spectacled Eiders in 2012 occurred in the CPF-2 area of the Kuparuk Oilfield, with observations in that area clustered around the Drill Site (DS)-2V, east of DS-2C, southwest of DS-2T, near DS-2F, and north of the access road to DS-2G (Figure 4). In the CPF-3 area, Spectacled Eiders were seen in the vicinity of Mine Site E and at several locations along the Oliktok Point Road. There were sightings in the wetlands and basin wetland complexes around CPF-3 and in the basin wetland complex north of DS-1Y (Figure 4). As in previous years, Spectacled Eiders also were observed in the CPF-1 area, in the large basin complex west of DS-1E.

Spectacled Eiders were located a mean distance of 195.6 m from oilfield infrastructure (roads, pads, and facilities) in 2012; the mean distances in previous years were 131.6–271.8 m (Table 2).

Spectacled Eiders used a variety of habitat types during pre-nesting (Table 3), but >65% of all observations in 2012 (n = 62) were in 4 major habitats: Shallow Open Water with Islands or Polygonized Margins (13%), Sedge Marsh (21%), Nonpatterned Wet Meadow (19%), and Patterned Wet Meadow (11%). Fifteen percent of observations of Spectacled Eiders were in Human-modified Waterbodies, including natural ponds altered by roads, drainage impoundments, and human-created waterbodies.

The aerial survey in 2012 was conducted 8–16 June and provided information on the distribution and habitat use of Spectacled Eiders across the broader Kuparuk Oilfield (Figure 5). During that survey, 17 groups of Spectacled Eiders (totaling 38 adults) were counted on the ground and 7

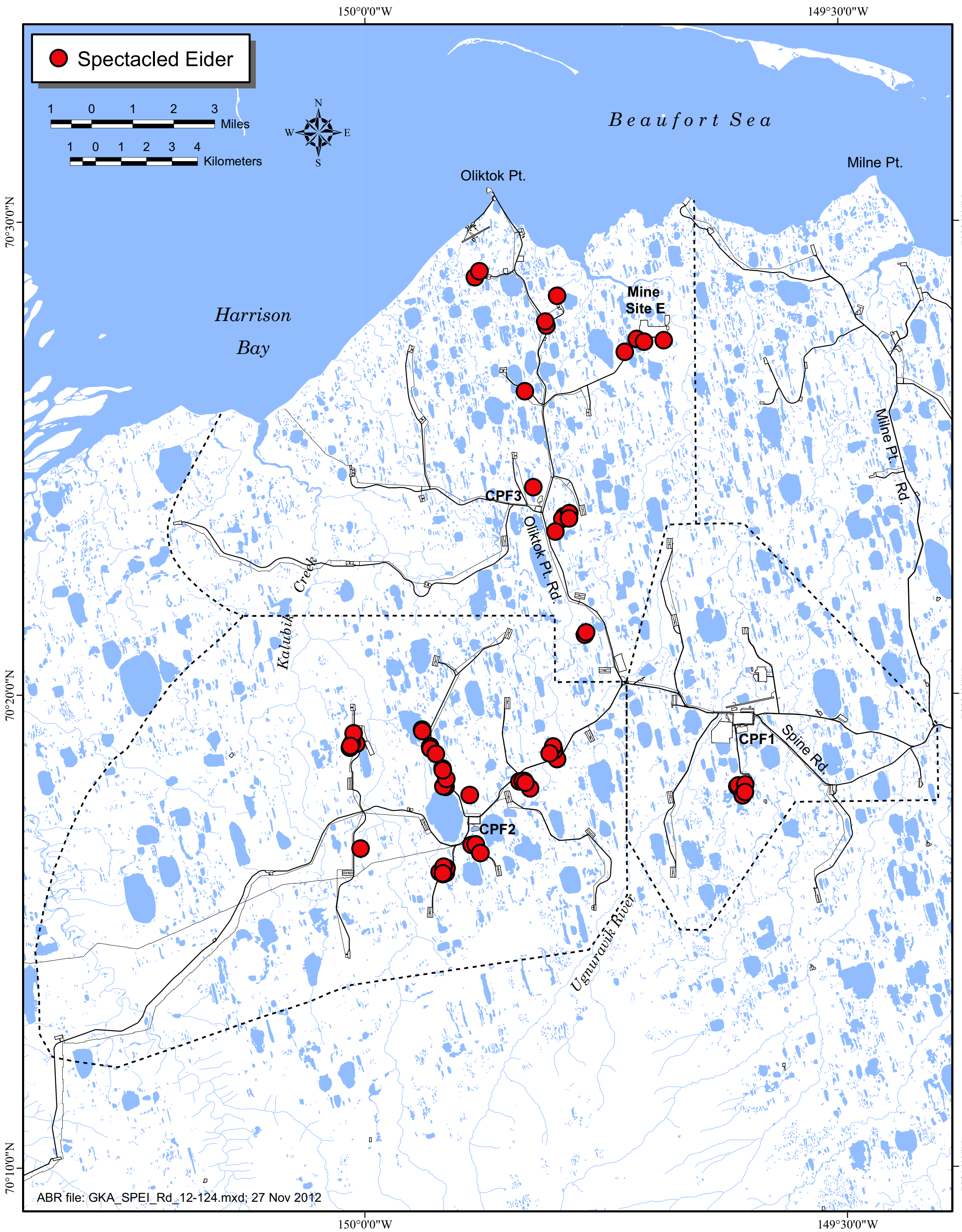

Figure 4. Distribution of Spectacled Eider observations during pre-nesting road surveys in the Kuparuk Oilfield, Alaska, 5–18 June 2012. Dashed areas delineate the CPF-1, CPF-2, and CPF-3 subareas used for comparisons of abundance and distribution.

Table 2. Mean distances (m) of Spectacled Eiders to oilfield facilities during pre-nesting road surveys in the Kuparuk Oilfield, Alaska, 1993–2012. Only observations within the 500-m road survey area are included.

	Distance (m) to Nearest Oilfield Facility			
Year	Mean	SD	Range	n[a]
1993	231.3	125.9	9–506	115
1994	244.8	126.0	23–478	70
1995	223.0	139.2	7–500	94
1996	245.4	139.2	16–504	46
1997	271.8	124.8	50–499	80
1998	259.3	118.2	17–538	67
1999	195.2	130.3	13–495	66
2000	252.6	134.6	21–494	71
2001	264.5	125.6	13–483	53
2002	229.6	146.2	9–494	76
2003	254.8	152.9	9–495	68
2004	186.7	133.7	3–415	29
2005	261.3	146.4	8–457	22
2006	225.6	142.5	6–498	34
2007	194.6	142.7	4–459	38
2008	160.2	147.5	3–483	47
2009	131.6	102.5	2–431	36
2010	155.8	127.3	3–435	37
2011	169.4	144.9	5–494	24
2012	195.6	136.0	2–486	57

[a] n = number of observations.

additional birds were observed flying (Table 4; Figure 6). Spectacled Eider densities within the survey area (non-flying birds only) were 0.06 total birds/km² and 0.03 breeding pairs/km², comparable to several other years and a recovery from the densities recorded in 2011, which were the lowest values yet recorded during the study (Table 5).

The densities of Spectacled Eiders are lower in the Kuparuk Oilfield than they are in the Arctic Coastal Plain (ACP) as a whole (Figure 7). Additionally, the eider densities in the Kuparuk Oilfield vary independently of densities measured across the Arctic Coastal Plain and in the neighboring Colville River delta. For example, Spectacled Eider densities were higher in 2008 than in 2007 across the Arctic Coastal Plain (Larned et al. 2009), whereas the reverse was true in the Kuparuk Oilfield. In 2009, densities increased slightly in the Kuparuk Oilfield, but decreased across the Arctic Coastal Plain (Larned et al. 2010) and in 2011, densities fell to record levels in the Kuparuk Oilfield, but were high across the Arctic Coastal Plain (Larned et al. 2012). Reasons for these differences in density of eiders between our surveys and those of the USFWS include variations in the timing of the USFWS survey relative to the Kuparuk Oilfield surveys. Also, the USFWS surveys include areas between the Colville River delta and Barrow that have higher densities of Spectacled Eiders than are found in Kuparuk. However, in the neighboring Colville River delta where the surveys are conducted during the same period as the Kuparuk surveys and by the same crew of surveyors, some of the highest densities were recorded in the years when the Kuparuk Oilfield had the lowest densities (2008 and 2011) and low densities were recorded in the Colville River delta in years when higher densities were recorded in the Kuparuk Oilfield (Johnson et al., in preparation).

Table 3. Habitat use (% of observations) of pre-nesting Spectacled Eiders in the Kuparuk Oilfield, Alaska, 2012. Only observations within the 500-m road survey area are included.

Habitat[a]	Percent
Fresh Waters	
Deep Open Water with Islands or Polygonized Margins	1.6
Shallow Open Water without Islands	4.8
Shallow Open Water with Islands or Polygonized Margins	12.9
Marshes	
Sedge Marsh	21.0
Grass Marsh	1.6
Basin Wetland Complexes	
Young Basin Wetland Complex	1.6
Old Basin Wetland Complex	6.5
Meadows	
Nonpatterned Wet Meadow	19.4
Patterned Wet Meadow	11.3
Moist Sedge-Shrub Meadow	1.6
Tundra	
Moist Tussock Tundra	3.2
Human Modified	
Human Modified Waterbodies	14.5
Number of Observations	62

[a] Habitat types follow hierarchical habitat classification described in Roth et al. (2007, 2008).

Based on 19 years of aerial surveys, the population of Spectacled Eiders in the Kuparuk Oilfield appeared to be decreasing slightly, although numbers are highly variable among years. Low numbers in 2008 were followed by a 2-year rebound, before numbers dropped again in 2011 with another modest rebound in 2012 (Table 5; Figure 7). The long-term population trend of Spectacled Eiders on the Arctic Coastal Plain also suggests a slight decrease in recent years (Larned et al. 2012).

In late June 2012, 12 Spectacled Eider nests (10 known Spectacled Eider nests and 2 that were identified by examination of feathers) were found during searches of 17 locations in the oilfield (Table 6; Figure 8; Appendix 3). While searching for Spectacled Eiders, we also found 17 King Eider nests and 5 eider nests that could not be identified to species. In 2012, Spectacled Eider nests were located in the CPF-2 area near DS-2F, DS-2H, DS-2V, DS-2Z and CPF-2; in the CPF-1 area near DS-1E and DS-1Y; and in the CPF-3 area near DS-3O and south of Pit E (Table 7; Figure 8).

In all years, some locations support more than one nesting pair of Spectacled Eiders and many are used in multiple years (Table 7). Annual reuse of these areas indicates that traditional “colony sites” are used by Spectacled Eiders in the Kuparuk Oilfield, although some pairs nest singly. In 2012, 3 locations supported multiple nesting pairs of Spectacled Eiders: DS-1E, DS-1Y, and DS-2F. Several traditional colony sites did not have Spectacled Eiders in 2012, most notably DS-2C and DS-2T.

In all years, Spectacled Eider nests were located close to water. In 2012, the mean distance of known Spectacled Eider nests to the nearest water was 14.7 m, much higher than the long-term

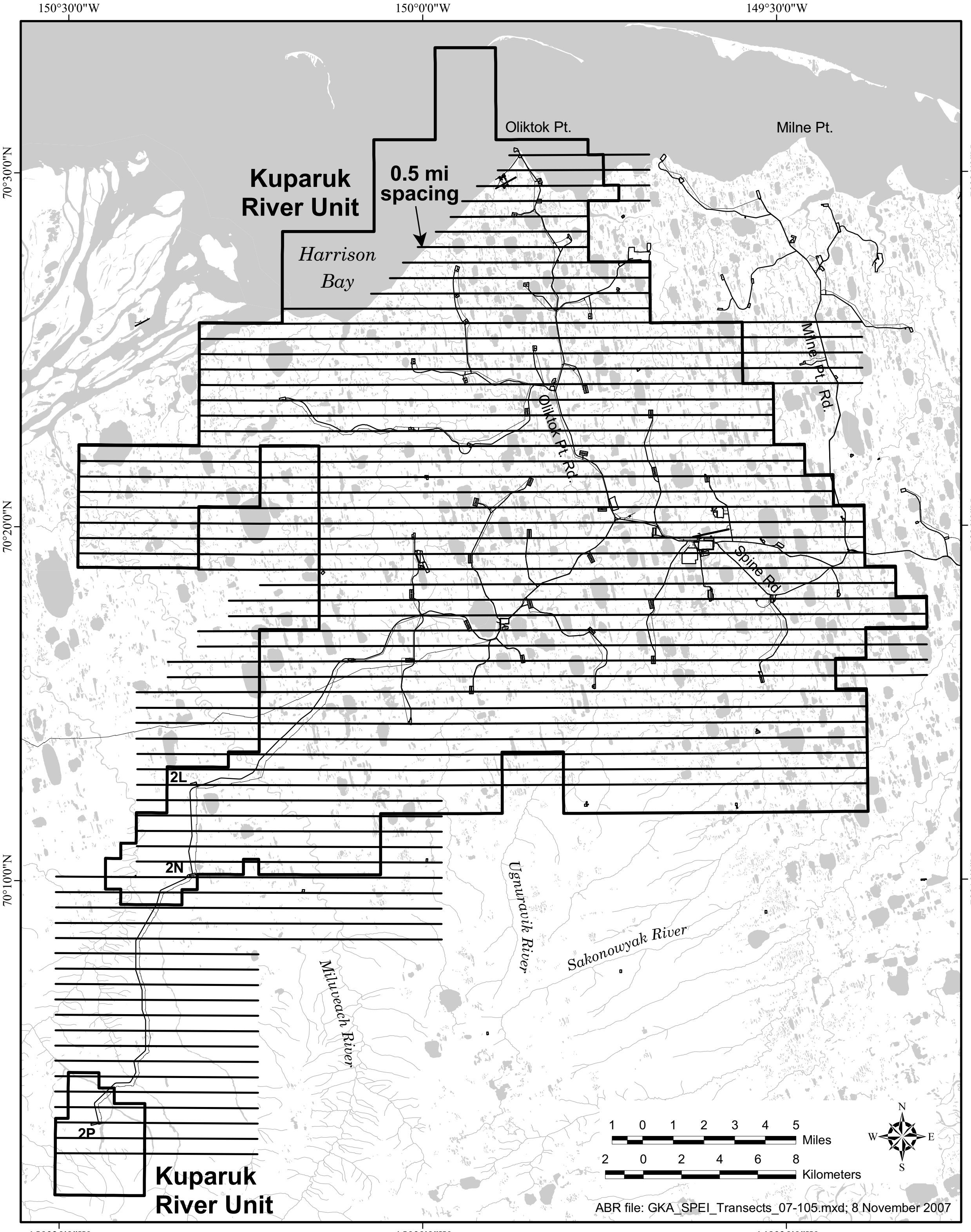

Figure 5. Aerial survey area for Spectacled Eiders in the Kuparuk Oilfield, Alaska, 2012. Transects were spaced 0.5 miles apart for 50% coverage of the survey area.

Table 4. Numbers and densities (per km²) of Spectacled Eiders recorded during a pre-nesting aerial survey of the Kuparuk Oilfield, Alaska, 8–16 June 2012.

	Non-flying	Flying	All Birds
Numbers Observed			
Males	20	9	29
Females	18	8	26
Total Birds	38	17	55
Observed Pairs	18	8	26
Number of Sightings	17	7	24
FWS Indicated Total Birds[a]	40		
Density (birds/km²)b			
Total Birdsc	0.06	0.03	0.09
Breeding Pairsd	0.03	0.01	0.04
FWS Indicated Total Birds	0.06		

[a] FWS Indicated Total Birds is calculated according to the standard protocol (USFWS 1987a); flying birds are not counted.

Total indicated birds = (lone males × 2) + (flocked males × 2) + (pairs × 2) + (group total × 1).

1) “lone males” are single, isolated males without a visible associated female;

2) “flocked males” are two or more males in close association (limited to 2–4 males per flock; no females in the flock);

3) a “pair” is a male and female in close association; and

4) a “group” is three or more of a mixed-sex grouping of the same species in close association, which cannot be separated into singles or pairs (one female with two males was considered to be a pair and a lone male, and one female with three males was considered to be a pair and two lone males).

[b] Density calculated based on a total area surveyed of 640.4 km².

[c] Unadjusted density of total birds = total birds/km² surveyed.

[d] Number of breeding pairs = total males counted not in flocks (flock > 4 males).

mean (3.1 m, n = 20 years) because of 1 nest located 75 m from any water. The mean distance of known nests to the nearest waterbody in 2012 was 15.0 m, similar to the 20-year mean of 15.1 m (Table 8). For these two measurements, ‘water’ is defined as any type of water, including ephemeral ponds or flooded tundra, whereas a ‘waterbody’ is a permanent pond or lake ≥0.5 acres surface area. As in previous years, most Spectacled Eider nests in 2012 were relatively far from the closest oilfield infrastructure (mean = 393 m for all nests; SD = 274; range 8–861 m). The one exception was a successful Spectacled Eider nest found near DS-3O just 8 m from infrastructure. This nest, at the same site used in 2010 and 2011, is the closest Spectacled Eider nest to infrastructure that we have recorded during Kuparuk ground searches in the last 20 years.

In 2012, nesting success for Spectacled Eiders was 33.3% (4 of 12 nests), much lower than the 20-year mean of 42.8% (Table 6). King Eiders in 2012 also experienced lower nesting success than the 20-year mean of 31.1%. Two Spectacled Eider nests failed due to avian predation, 1 failed due to fox predation, and the causes of the remaining 5 nest failures could not be determined from inspection of the nest bowls after hatch. One King Eider nest was destroyed by a fox, and the causes of the remaining 16 nest failures could not be determined.

In 2012, 3 Reconyx PM-75 time-lapse cameras that recorded images every 30 sec were installed approximately 30 m from 3 Spectacled Eider nests (1 at DS-2F, 1 at CPF-2, and 1 at DS-3O). All 3 nests were determined to be successful based on time-lapse photographs and nest evidence (presence of successful egg membranes and shell fragments) examined during the fate visit. Spectacled Eider broods were visible in photographs from all 3 cameras. Nest 43.02

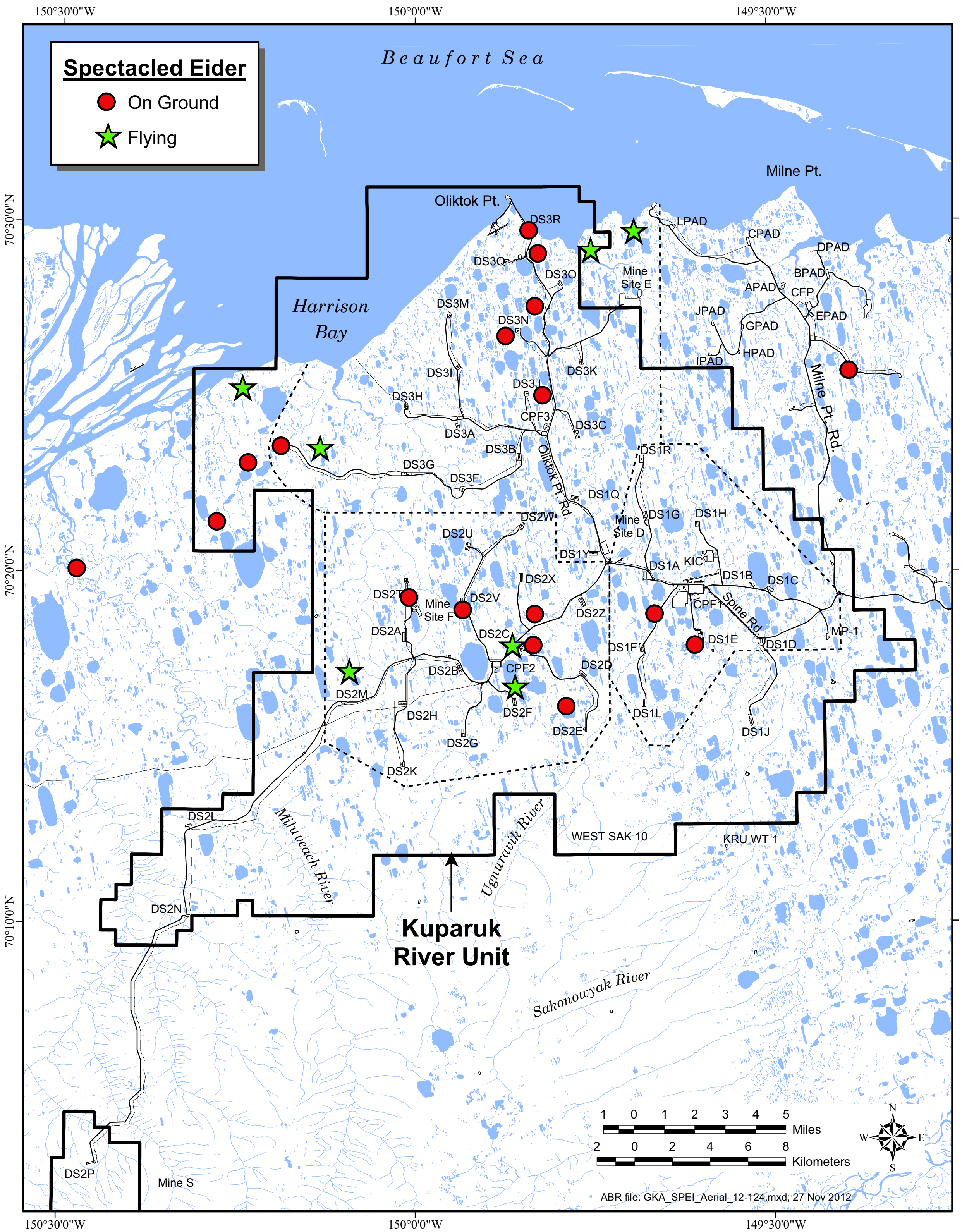

Figure 6. Distribution of Spectacled Eiders observed on the aerial survey of the Kuparuk Oilfield, Alaska, 8–16 June 2012.

Table 5. Numbers and densities (per km²) of Spectacled Eiders recorded during pre-nesting aerial surveys of the Kuparuk Oilfield, Alaska, 1993 and 1995–2012.

	Numbers of Eiders Observed					Density (birds/km²)[a]			
Year	Non-flying Birds	Flying Birds	Total Birds	FWS Indicated Total Birds[b]	Number of Sightings	Breeding Pairs[c]	Total Birds[d]	FWS Indicated Total Birds	Survey Dates (June)
1993 – First Survey	79	46	125	91	66	0.14	0.24	0.17	12 & 15
– Second Survey	24	17	41	34	26	0.06	0.08	0.06	18–20
1995	32	2	34	39	17	0.04	0.06	0.07	14–16
1996	22	18	40	32	24	0.05	0.07	0.06	10–14
1997	33	18	51	40	24	0.06	0.09	0.07	12–14, 16
1998	43	15	58	50	32	0.06	0.10	0.09	11–12, 14
1999	26	50	76	50	23	0.08	0.14	0.09	12–13
2000	36	24	60	40	27	0.07	0.11	0.08	13–14
2001	54	7	61	58	28	0.07	0.12	0.11	14–16
2002	22	5	27	32	22	0.03	0.04	0.06	13–15
2003	27	4	31	44	23	0.04	0.05	0.08	15–16
2004	24	3	27	38	21	0.04	0.05	0.07	17–18
2005	14	4	18	20	12	0.02	0.03	0.04	13–15
2006	21	3	24	24	14	0.03	0.05	0.05	12–13
2007	46	2	48	27	27	0.04	0.07	0.08	12–14
2008	14	7	21	20	14	0.02	0.02	0.03	13–15
2009	26	2	28	28	14	0.03	0.04	0.04	10–13
2010	47	11	58	56	31	0.04	0.09	0.09	9–14
2011	14	3	17	16	10	0.01	0.02	0.02	10-14
2012	38	17	55	40	24	0.04	0.09	0.06	8–16

[a] Density calculated based on total area surveyed of 525.1 km² (1993), 550.5 km² (1995–1998), 525.4 km² (1999–2006), and 640.4 km² (2007–2012); the 1998 densities were calculated for the smaller study area used in 1995–1997 because no eiders were recorded in the expanded Tarn area surveyed at 50% coverage in 1998.

[b] FWS Indicated Total Birds is calculated according to the standard protocol (USFWS 1987a) as described in Table 4; flying birds are not counted.

[c] Number of breeding pairs = total males counted (flying and non-flying combined).

[d] Unadjusted density of total birds = total birds/km² surveyed (flying and non-flying combined).

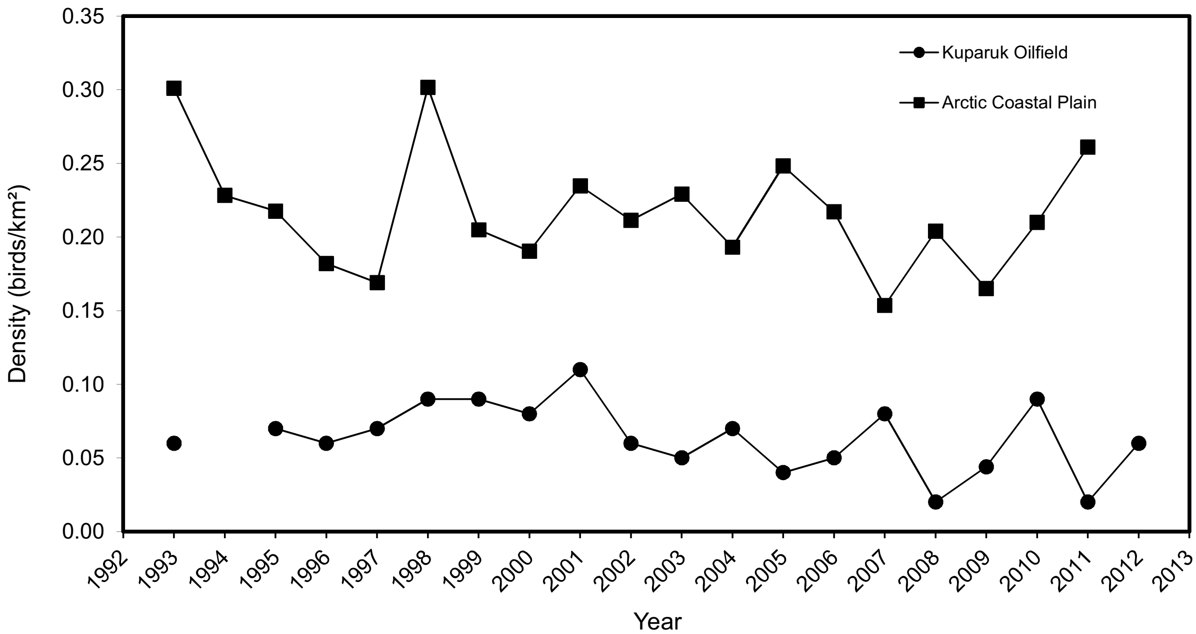

Figure 7. Spectacled Eider densities (indicated total birds/km²) estimated from aerial surveys of the Kuparuk Oilfield (this study) and from aerial surveys of the Arctic Coastal Plain (USFWS pre-nesting eider surveys), June 1993–2012. A visibility correction factor is not used for these data.

hatched on 11 July and had a brood of ≥2 chicks, and nests 7.01 and 43.01 hatched on 12 July with broods of 4 and ≥2 chicks, respectively. All broods appeared to have departed the immediate vicinity of the nest within 24 h. At all 3 Spectacled Eider nests, avian predators (Glaucous Gull, Parasitic Jaeger, Common Raven) occasionally were observed nearby, while only one fox was observed at one nest in 2012. Nest 43.02 was visited multiple times by a Glaucous Gull which stood on the eider nest island next to the incubating hen but was unable to force her off the nest. A Rough-legged Hawk was also seen using a mound approximately 10 m from the nest on 2 occasions but had no direct interactions with the nest or nesting bird. The incubating eider did conceal in response to the hawk's presence. Glaucous Gulls, Pomarine Jaegers, and one Common Raven were observed flying near nest 7.01 but only landed at the nest site after the hen left with her brood on 12 July. A red fox was recorded within 5 m of the nest on one occasion but was never recorded again, not during incubation nor during the 24-h period following the departure of the brood from the nest. Very little avian predator activity was observed in the vicinity of nest 43.01; 1 Glaucous Gull was recorded in 5 photographs at distances >50 m. Judging from the daily presence of flocks of Arctic Terns and Sabine's Gulls, there likely was a colony nearby which may have deterred avian predators from visiting the area. Other eiders were seen in the vicinity of both nests 3.01 and 43.01. At nest 7.01, which was located 8 m from infrastructure, a King Eider brood was seen on 12 July feeding within 10 m of the Spectacled Eider nest. At nest 43.01, 1 non-nesting Spectacled Eider female was observed on 2 occasions swimming in the vicinity of the occupied nest and loafing on the nest island next to the incubating hen. Further explanation is not possible, but it is likely that this bird was a failed breeder. Data presented in this report do not represent all information available from these time-lapse cameras; the photographs from these cameras have been archived for future analysis.

Table 6. Annual nest search effort and number and fates of nests of Spectacled and King eiders in the Kuparuk Oilfield, Alaska, 1993–2012.

Species	Year	Total Nests[a]	Successful Nests: Number	Successful Nests: Percent	Nest Search Effort (No. Areas Searched)[b]
Spectacled Eider					
	1993	17	6	35.3	33
	1994	14	5	35.7	24
	1995	14	4	28.6	17
	1996	16	7	43.8	17
	1997	11	3	27.3	13
	1998	12	5	41.7	10
	1999	5	3	60.0	11
	2000	11	7	63.6	13
	2001	8	1	12.5	10
	2002	18[c]	9	50.0	11
	2003	17[d]	8	47.1	13
	2004	4	0	0.0	10
	2005	13[e]	12	92.3	9
	2006	8	5	62.5	12
	2007	8	2	25.0	9
	2008	6	0	0.0	10
	2009	9	5	55.6	10
	2010	4	2	50.0	9
	2011	8	4	50.0	11
	2012	12	4	33.3	17
	Mean	10.8	4.6	42.8	—
King Eider					
	1993	16	12	75.0	33
	1994	19	6	31.6	24
	1995	8	1	12.5	17
	1996	17	7	43.8[f]	17
	1997	14	1	7.1	13
	1998	20	5	25.0	10
	1999	13	2	15.4	11
	2000	19	8	42.1	13
	2001	17	3	20.0[g]	10
	2002	26	11	42.3	11
	2003	16	4	25.0	13
	2004	17	4	23.5	10
	2005	13	7	53.8	9
	2006	21	7	33.3	12
	2007	21	2	9.5	9
	2008	33	14	45.2[h]	10
	2009	17	3	17.6	10
	2010	6	1	16.7	9

Table 6. Continued.

Species	Year	Total Nests[a]	Successful Nests Number	Successful Nests Percent	Nest Search Effort (No. Areas Searched)[b]
King Eider (cont.)	2011	14	7	53.8 [i]	11
	2012	17	2	11.8	17
	Mean	17.2	5.4	31.1	—

[a] Includes nests for known and probable (based on feather identification) species, but does not include unidentified eider nests (all failed except 4 nests of unknown fate in 2012): 1993 = 4 nests; 1994 = 2 nests; 1997 = 2 nests, 2006 and 2007 = 4 nests, 2009 = 2 nests, 2010=1 nest, 2011=2 nests, and 2012=5 nests.

[b] Number of distinct areas in the Kuparuk Oilfield searched for Spectacled Eider nests. No areas were searched specifically for King Eiders. UAF researchers searched 3 areas in 2004 and 1 area in 2005 without ABR assistance.

[c] Five nests found by Laura Phillips, UAF, during her nest searches for King Eiders, were included in this total.

[d] Three nests found by Laura Phillips, UAF, during her nest searches for King Eiders, were included in this total.

[e] One nest found by Rebecca McGuire, UAF, during her nest searches for King Eiders, was included in this total.

[f] One nest was still active when last checked; therefore, nesting success was based on 16 nests total.

[g] Two nests had unknown fates; therefore, nesting success was calculated for 15 nests total.

[h] Two nests had unknown fates; therefore, nesting success was calculated for 31 nests total.

i One nest had unknown fate; therefore, nesting success was calculated for 13 nests total.

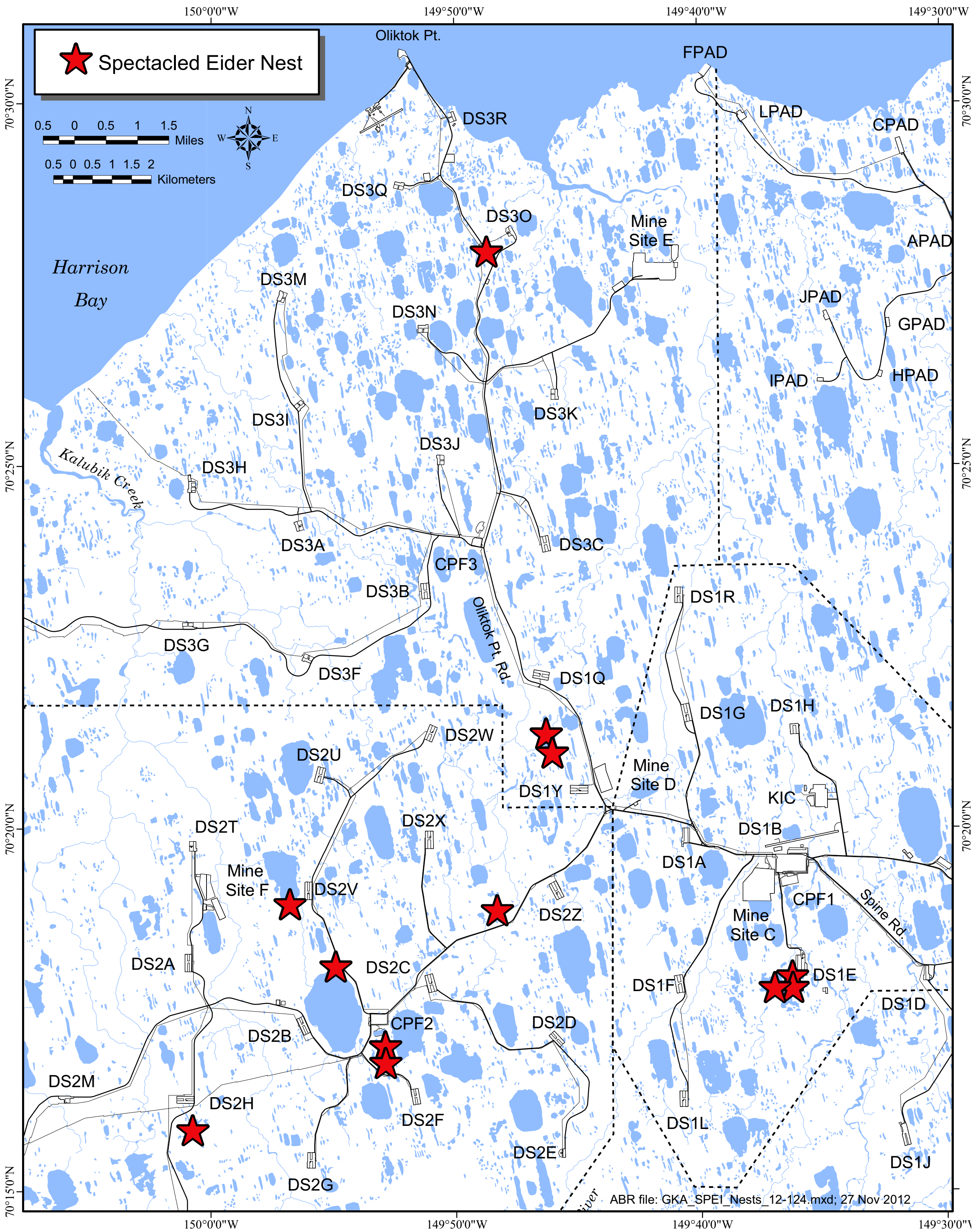

Figure 8. Locations of Spectacled Eider nests in the Kuparuk Oilfield, Alaska, 2012.

Table 7. Numbers of Spectacled Eider nests by locations used in one or more years in the Kuparuk Oilfield, Alaska, 1993–2012.

	Total Spectacled Eider Nests[a]																			
Nesting Location	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Colonies[b]																				
S of DS-1E	0	1	0	0	0	2	1	0	0	5	2	0	2	2	2	1	3	0	1	3
N of DS-1Y	2	2	1	1	1	0	0	1	1	0	1	—	—	—	—	—	—	—	—	2
E of DS-2C	5	4	4	4	3	2	1	1	4	2	2	1	0	1	1	1	1	0	1	—
N of DS-2F	1	1	1	0	0	2	0	1	1	1	0	0	1	0	0[d]	0	—	0	1	2
N of DS-2K	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	—	—	—	—
W of DS-2V	0	0	1	2	1	0	1	2	0	1	0	1	3	0	3	2	1	0	0	1
S of DS-2T	0	0	0	1	0	0	1	2	1	0	3	0	4	1	0	1	1	3	2	—
S of DS-2X	2	2	2	2	2	2	1	1	1	0	2	0	0	1	1	0	1	0	0	—
W of DS-2X	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	—	—
CPF-3 Brant Colony	2	2	0	3	1	4	0	1	0	2	1	0	1	1	0	1	1	—	—	—
S of Pit E	0	0	2	1	2	0	0	0	0	0	2	1	0	1	1	1	1	0	1	—
Annual Locations[c]																				
N of DS-2G	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
S of DS-2H	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	—	—	—	1
DS-3N	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	—	—	0	—
DS-3O	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	1
DS-3Q	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	—	0	—	—
N of CPF-3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	—	—	—	—

[a] Includes nests of probable Spectacled Eiders which were identified to species based on feather samples.
[b] Colonies were locations that supported more than one nesting pair in at least one year.
[c] Annual locations supported one pair in at least one year.
[d] One nest that may have been a Spectacled Eider was located here, but species could not be confirmed with feather samples.

Table 8. Distances (m) of Spectacled Eider nests to the nearest water, waterbody, and oilfield infrastructure (road or pad) in the Kuparuk Oilfield, Alaska, 1993–2012.

Feature	Known Nests				All Nests[a]			
Year	Mean	SD	Range	*n*	Mean	SD	Range	*n*
Water								
1993	3.0	3.2	0.2–10	8	2.0	2.4	0.2–10	17
1994	0.7	1.2	0.1–4	8	0.8	1.0	0.1–4	14
1995	2.4	2.0	0.5–7	9	2.1	2.0	0.5–7	15
1996	0.6	0.8	0.1–3	12	1.0	1.6	0.1–6	16
1997	5.4	9.7	0.1–20	4	2.9	5.8	0.1–20	7
1998	0.8	0.7	0.1–2	6	2.3	4.2	0.1–15	12
1999	5.7	10.8	0.5–25	5	5.7	10.8	0.5–25	5
2000	0.7	0.5	0.1–1.5	8	1.0	0.9	0.1–3	11
2001	0.8	0.7	0.2–2.0	5	1.0	1.0	0.1–3	8
2002	0.5	0.5	<0.1–2	15	0.4	0.4	<0.1–2	18
2003[b]	2.5	5.0	0.1–20	15	2.6	4.9	0.1–20	16
2004	0.5	0.5	0.1–1	3	2.9	4.8	0.1–10	4
2005	3.0	8.1	0.1–30	13	3.0	8.1	0.1–30	13
2006	0.2	0.2	0.1–0.5	6	0.3	0.2	0.1–0.5	8
2007	0.6	0.8	0.1–1.5	3	4.2	10.4	0.1–30	8
2008	0.4	0.1	0.3–0.5	3	0.4	0.3	0.1–1	6
2009	1.5	1.8	0.1–5	7	1.6	1.6	0.1–5	9
2010	0.9	0.9	<0.1–2	4	0.9	0.9	<0.1–2	4
2011	18.1	40.9	0.1–110	7	15.9	38.4	0.1–110	8
2012	14.7	26.1	0.1–75	10	13.9	23.8	0.1–75	12
Waterbody								
1993	3.7	3.5	0.2–10	8	2.5	2.7	0.2–10	17
1994	1.3	1.9	0.1–5	8	2.5	5.2	0.1–20	14
1995	8.4	6.2	0.5–15	9	9.6	8.2	0.5–30	15
1996	0.6	0.8	0.1–3	12	2.0	3.8	0.1–15	16
1997	5.4	9.7	0.1–20	4	4.4	6.4	0.1–20	7
1998	1.4	1.9	0.1–5	6	3.9	5.5	0.1–15	12
1999	16.3	21.3	0.5–50	5	16.3	21.3	0.5–50	5
2000	17.1	27.3	0.1–75	8	13.8	23.6	0.1–75	11
2001	13.6	20.6	1.0–50	5	11.5	16.8	1.0–50	8
2002	4.6	11.0	<0.1–40	15	3.9	10.1	<0.1–40	18
2003[b]	24.8	36.9	0.2–100	15	23.6	35.9	0.2–100	16
2004	2.1	0.5	0.3–4	3	3.7	4.5	0.3–10	4
2005	27.2	31.4	0.5–100	13	27.2	31.4	0.5–100	13
2006	6.9	10.6	0.3–25	6	10.2	15.2	0.3–40	8
2007	0.7	0.7	0.1–1.5	3	12.8	17.2	0.1–40	8
2008	31.8	27.3	0.4–50	3	16.2	24.3	0.1–50	6
2009	9.4	9.8	0.1–25	7	10.5	10.3	0.1–25	9
2010	33.9	42.3	<0.1–88	4	33.9	42.3	<0.1–88	4
2011	23.9	60.4	<0.1–161	7	31.9	60.3	<0.1–161	8
2012	15.0	36.1	<0.1–125	10	15.5	36.1	<0.1–125	12

Table 8. Continued.

Feature Year	Known Nests Mean	SD	Range	*n*	All Nests[a] Mean	SD	Range	*n*
Oilfield Infrastructure								
1993	540	149	353–742	8	500	180	123–742	17
1994	514	206	162–801	8	498	209	162–855	14
1995	427	102	239–591	9	430	156	208–823	15
1996	420	194	114–872	12	425	178	114–872	16
1997	521	144	345–662	4	479	221	82–900	7
1998	372	85	345–662	6	454	160	212–718	12
1999	398	167	194–598	5	398	167	194–598	5
2000	325	160	138–666	8	349	154	138–666	10[c]
2001	549	390	315–1240	5	491	306	315–1240	8
2002	384	200	52–723	15	407	194	52–723	18
2003	463	217	177–896	16	456	212	177–896	17
2004	478	298	129–804	3	499	247	219–804	4
2005	389	157	68–665	13	389	157	68–665	13
2006	406	108	264–531	6	409	94	264–537	8
2007	334	89	233–402	3	407	106	233–546	8
2008	252	114	142–369	3	364	146	142–501	6
2009	317	144	108–469	7	355	149	108–551	9
2010	330	250	29–594	4	330	250	29–594	4
2011	392	177	207–704	7	346	208	29–704	8
2012	338	252	8–845	10	393	274	8–861	12

[a] All nests includes known and probable (based on feathers) nests.
[b] One Spectacled Eider nest did not have distance to the nearest waterbody or water.
[c] One probable Spectacled Eider nest excluded from the analysis because its precise location was unknown.

TUNDRA SWAN

Tundra Swans are an important component of the waterbird community in northern Alaska. The health of the Tundra Swan population in the oilfields is considered by state and federal agencies to be an indicator of the overall health of waterbird populations and their wetland ecosystems. Accordingly, swans have received considerable attention from both the oil industry and regulatory agencies, especially when planning and permitting new developments. ConocoPhillips Alaska traditionally has included Tundra Swans in their environmental planning for the oilfields. For example, nest and brood locations for Tundra Swans are identified on environmental sensitivity maps for oil-spill response in the Kuparuk oilfield, and avoidance of traditional swan nest sites is a consideration when planning new infrastructure. After preliminary reconnaissance surveys in 1988, ABR has monitored swans annually since 1989 in a number of areas, including the Kuparuk study area, by conducting systematic aerial surveys during nesting and brood-rearing (Stickney et al. 2012).

The Tundra Swan study had 2 objectives in 2012, the 24th year of regional systematic swan surveys:

- Locate and map the distribution of nests and enumerate adults during nesting.
- Locate and map the distribution of broods, enumerate adults and young, and assess productivity of swans during brood-rearing.

2012 RESULTS

Aerial surveys were flown to collect information on Tundra Swan abundance and distribution during the nesting and brood-rearing periods in 2012. The nesting survey was conducted 22–26 June 2012 and the brood-rearing survey 16–18 August 2012.

To streamline analysis and ensure comparability, we divided the 2012 data into 2 study areas with historically different levels of survey effort. The 'Kuparuk' study area (2,380 km²) comprised all regions that were consistently covered in all 24 years of systematic surveys, including a section that was formerly part of the Oil and Gas Lease 54 (Figure 9). The 'South Kuparuk' study area (358 km²) comprised areas with inconsistent coverage prior to the last several years. The South Kuparuk data are presented in Appendix 4 and results for the Kuparuk study area are reported below.

During the nesting aerial survey, 715 Tundra Swans were recorded at 422 locations in the Kuparuk study area (Table 9: Appendix 5). Swans and nests recorded in the South Kuparuk study area are presented in Appendix 4 and a more detailed description of survey results for 2012 is presented in Appendix 5. The number of in 2012 was the highest ever recorded, 12% higher than the previous record number (638) in 2010, and 58% higher than the long-term mean of 449.8 swans. Although some of the difference in numbers may be attributed to inter-observer variation (different observers between years of surveys, a similar increase also was observed on the Colville River delta (Johnson et al., in prep.). Swan density in the Kuparurk study area in 2012 (0.30 swans/km²) was 57% higher than the long-term mean (0.19 swans/km²; 1989–2012; Appendix 6). The number of adult swans in the Kuparuk study area has increased significantly since 1989 ($r^2 = 0.6$, $P < 0.01$).

In 2012, 101 Tundra Swan nests (0.04 nests/km²) were found in the Kuparuk study area (Figure 10), a 5% decrease from 2011 (Table 9), but 14% higher than the 24-year mean of 88.3 nests. The number of nests in 2012 was the seventh highest and 17% lower than the maximum of 122 nests recorded in 1996. Since 1989, the number of swan nests has increased significantly in the oilfield ($r^2 = 0.24$, $P = 0.02$), although numbers have fluctuated annually. The annual number of swan nests is highly correlated ($r^2 = 0.26$, $P < 0.01$) with spring temperatures during the arrival and nest initiation period, with fewer nests being active during years with low cumulative thawing degree-days and more nests being active during years with high cumulative thawing degree-days during 15 May–15 June (Figure 11).

During the brood-rearing survey, 1,080 swans (919 adults and 161 young) were observed at 481 locations in the Kuparuk study area (Table 10; Appendix 7). The total number of swans recorded during brood-rearing in 2012 was the highest ever recorded, 47% higher than the 23-year mean of 736 swans, and 12% higher than the previous record in 2008 (964). Again, some component of the increase may be due to inter-observer variability. The number of adults increased 29% between June and August 2012, due to a substantial increase in the number of adults without young (+38%) accompanied by a 6% decrease in the number of adults with young. The decrease in the number of adults with young between June and August 2012 undoubtedly reflects brood losses and a gradually increasing count of failed breeders. Adult swans without young include swans with nests that failed, swans whose broods were lost before the August survey, and swans that never attempted breeding.

In 2012, 72 broods (161 young) of Tundra Swans were counted in the Kuparuk study area (Table 10; Figure 12). The number of broods in 2012 was near the 23-year average (70 broods), but was 19% lower than the number recorded in 2011 (101 broods) which was the highest recorded in the oilfield since monitoring began in 1989. The mean brood size of 2.2 young in 2012 (range 1–4 young) was slightly lower than the 23-year mean. Young swans represented 15% of the total swans in 2012, compared to the long-term average of 23%. Approximate nesting success of 71% in 2012 was fair compared with the long-term average of 80%. Annual nesting success and clutch size of Tundra Swans have been correlated to weather conditions in the nesting area, with cool springs typically associated with lower nesting success than warmer springs. Overall Tundra Swans had a good nesting and brood-rearing season in the Kuparuk study area in 2012.

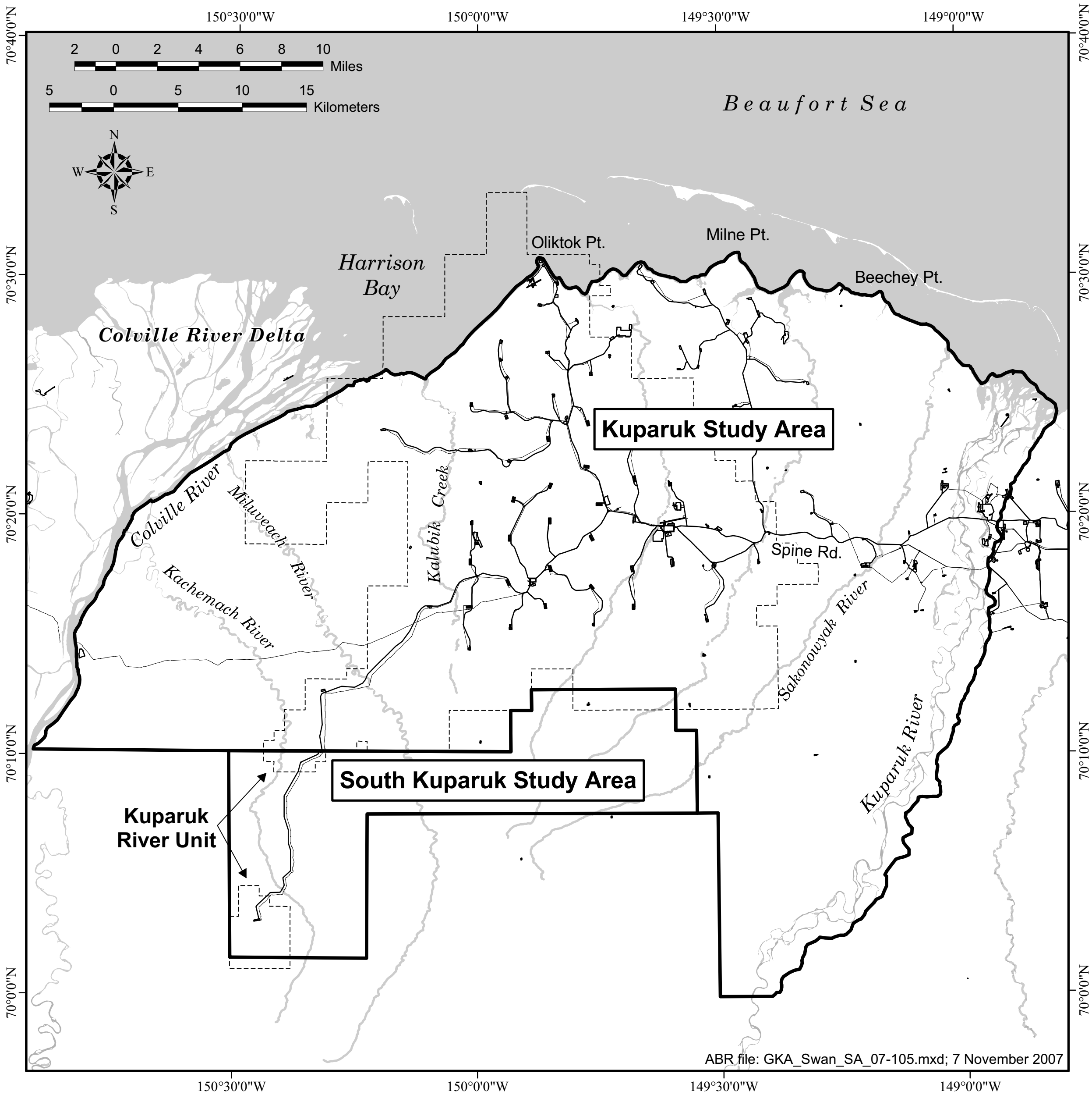

Figure 9. Aerial survey areas for Tundra Swans in the Kuparuk Oilfield, Alaska, 2012.

The number of swans in the Kuparuk study area has increased significantly since 1989. While the number of nests has increased in that time period, the rate of increase is modest ($y = 1.3461x + 71.424$, $P = 0.02$) compared to the rate of increase in numbers of adult swans ($y = 12.287x + 296.2$, $P < 0.01$). The rate of increase is largely being driven by large numbers of non-breeding swans with paired swans contributing the most to the increase.

Table 9. Numbers of Tundra Swans and nests observed during June aerial surveys in the Kuparuk study area, Alaska, 1989–2012.

		Observed Number of Adults			Estimated Number of Adults[a]	
Year	Number of Nests	With Nests	Without Nests	Total	Breeders	Nonbreeders
1989	45	71	190	261	90	171
1990	77	126	170	296	154	142
1991	81	115	275	390	162	228
1992	79	128	233	361	158	203
1993	70	118	231	349	140	209
1994	50	67	257	324	100	224
1995	107	181	284	465	214	251
1996	122	215	269	484	244	240
1997	75	121	242	363	150	213
1998	108	203	372	575	146	359
1999	73	119	235	354	170	208
2000	85	142	361	503	166	333
2001	83	149	280	429	166	263
2002	115	195	294	489	230	259
2003	74	114	309	423	148	275
2004	92	141	244	385	184	201
2005	89	149	248	397	178	219
2006	95	142	235	377	190	187
2007	116	189	323	512	232	280
2008	101	165	415	580	202	378
2009	96	152	360	512	192	320
2010	78	124	514	638	156	482
2011	106	171	442	613	212	401
2012	101	153	562	715	202	513

[a] The estimated number is based on the assumption that all nests are attended by a nesting pair, so breeders = nests × 2, whereas nonbreeders = total adults – breeders.

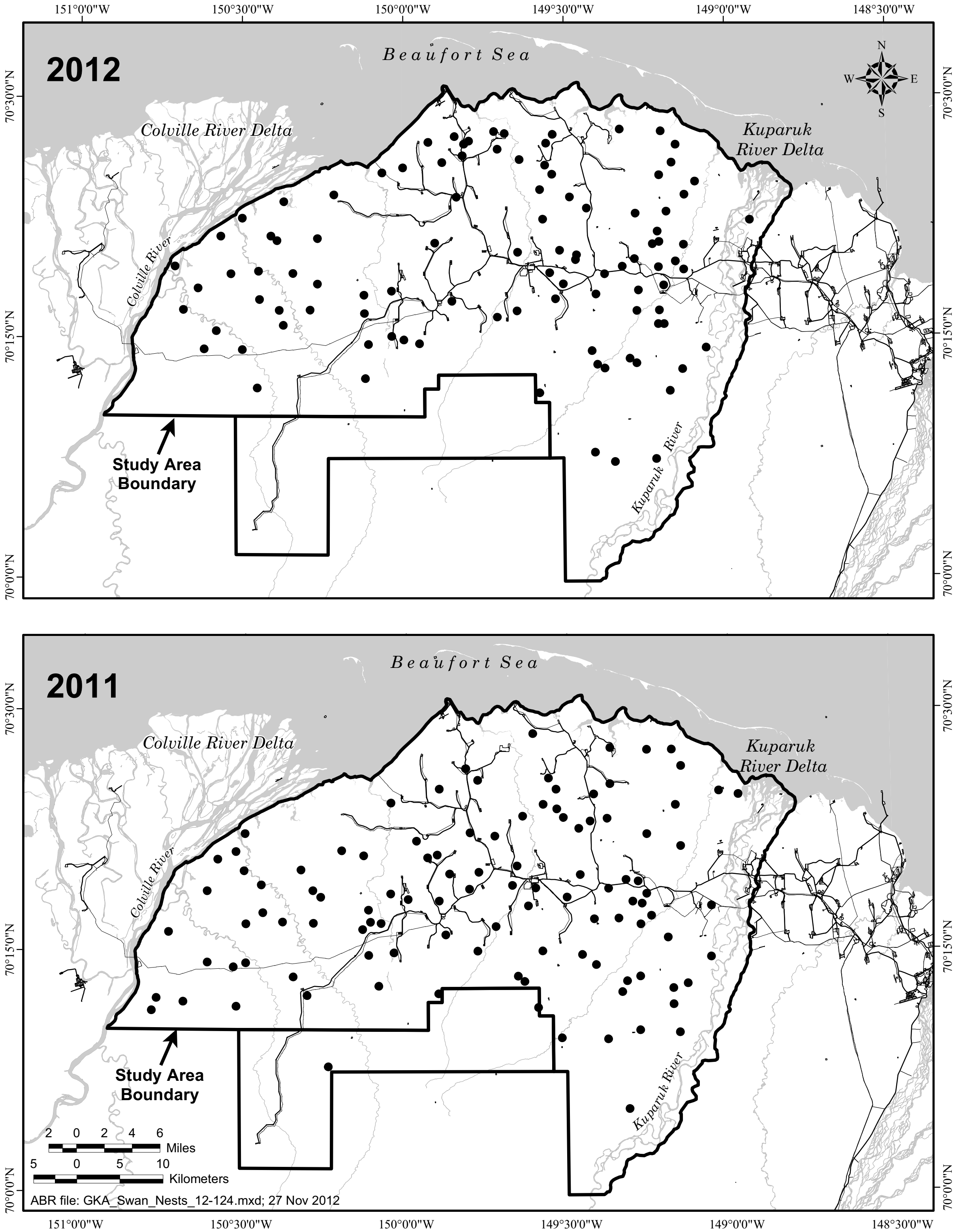

Figure 10. Locations of Tundra Swan nests in the Kuparuk and Kuparuk South study areas, Alaska, June 2011 and 2012 (see Figure 9 for study area boundaries).

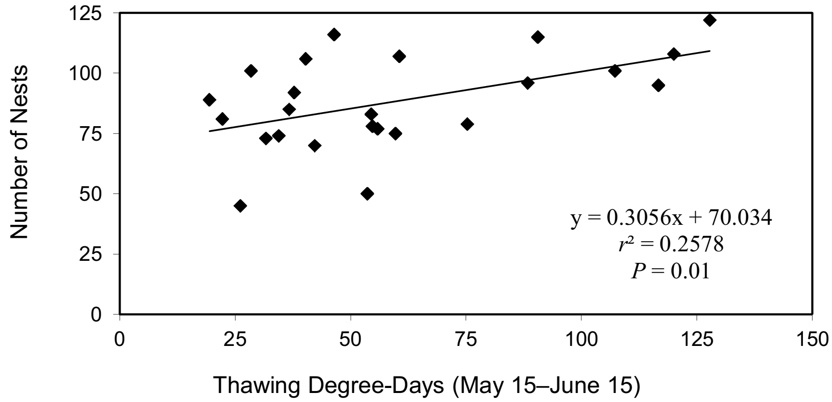

Figure 11. Plot of the relationship between annual numbers of Tundra Swan nests and cumulative thawing degree-days, 15 May–15 June, in the Kuparuk study area, Alaska, 1989–2012.

Table 10. Numbers of Tundra Swans and broods observed during August aerial surveys in the Kuparuk study area, Alaska, 1989–1993 and 1995–2012. No brood-rearing survey was conducted in 1994.

	Number of		Mean	Observed Number of Adults					Estimated Number of Adults[a]	
Year	Broods	Young	Brood Size	with Broods	without Broods	Total	Total Swans	Percent Young	Breeders	Nonbreeders
1989	45	103	2.3	84	319	403	506	20.4	90	313
1990	75	208	2.8	147	285	432	640	32.5	150	282
1991	69	175	2.5	134	373	507	682	25.7	138	369
1992	73	194	2.7	145	339	484	678	28.6	146	338
1993	72	179	2.5	141	332	473	652	27.5	144	329
1995	82	222	2.7	159	343	502	724	30.7	164	338
1996	99	271	2.7	187	331	518	789	34.3	198	320
1997	60	134	2.2	118	483	601	735	18.2	120	481
1998	74	172	2.3	141	391	532	704	24.4	148	384
1999	45	110	2.4	92	372	464	574	19.2	90	374
2000	56	113	2.0	107	579	686	799	14.1	112	574
2001	71	151	2.1	141	413	554	705	21.4	142	412
2002	69	173	2.5	137	342	479	652	26.5	138	341
2003	60	113	1.9	118	358	476	589	19.2	120	356
2004	97	211	2.2	185	385	570	781	27.0	194	376
2005	57	111	1.9	111	346	457	568	19.5	114	343
2006	87	171	2.0	135	318	483	654	26.1	174	309
2007	81	180	2.2	158	416	574	754	23.9	162	412
2008	97	256	2.6	182	508	690	946	24.5	194	496
2009	33	68	2.1	65	763	828	896	7.6	66	762
2010	39	74	1.9	75	702	777	851	8.7	78	699
2011	103	232	2.3	197	537	734	966	24.0	206	528
2012	72	161	2.2	141	778	919	1080	14.9	144	775

[a] The estimated number is based on the assumption that all broods are attended by a pair, so breeders = broods × 2, whereas nonbreeders = total adults – breeders.

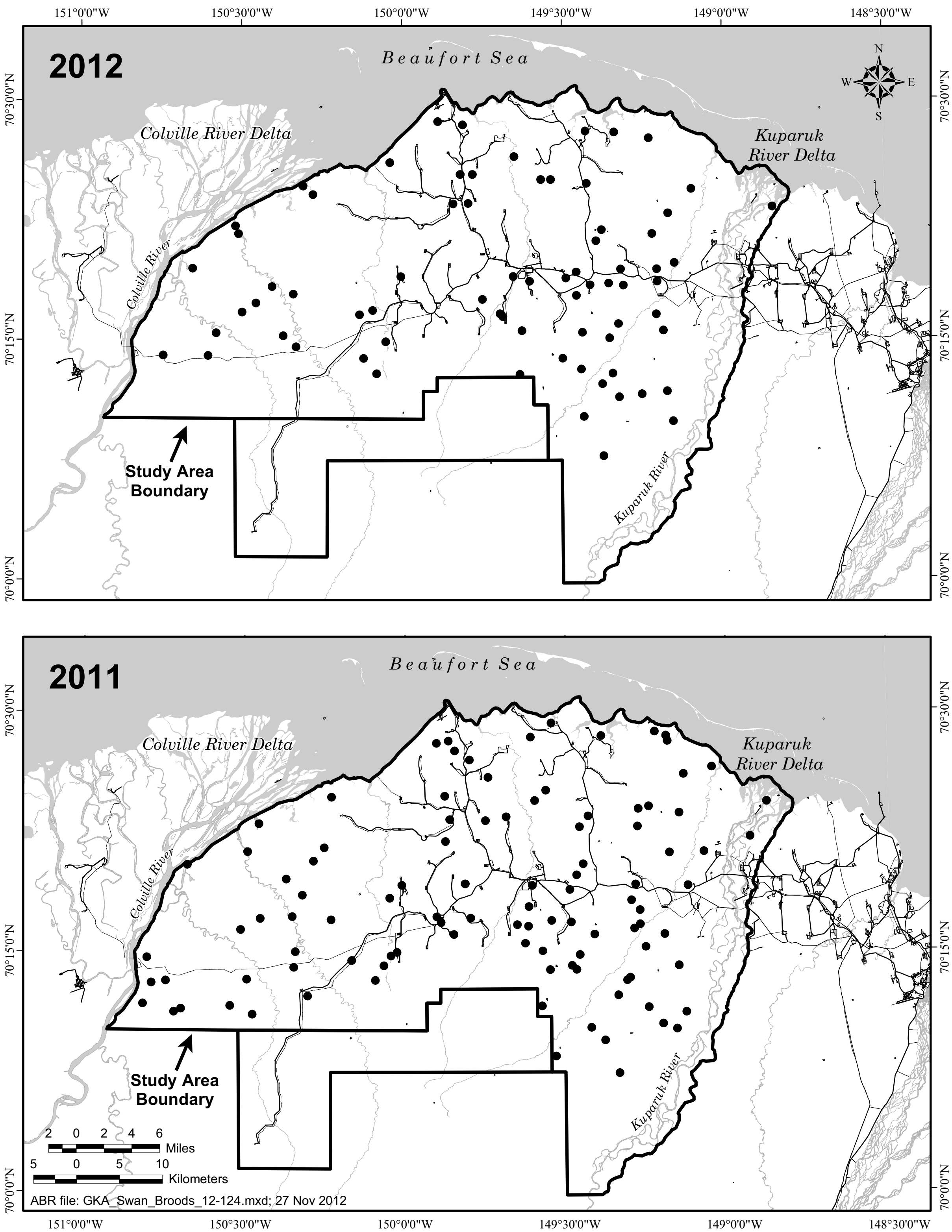

Figure 12. Locations of Tundra Swan broods in the Kuparuk and Kuparuk South study areas, Alaska, August 2011 and 2012 (see Figure 9 for study area boundaries).

BRANT

Less than 5 percent of the Pacific Flyway population of Brant breeds on the Arctic Coastal Plain (ACP) of Alaska (Sedinger et al. 1993). Prior to the mid-1980s, information on the distribution, abundance, and nesting success of Brant in this area was collected only sporadically. In 1966, King (1970) surveyed the entire Arctic Coastal Plain of Alaska and reported large flocks of nonbreeding Brant (~25,000 total) and a small number of brood-rearing Brant, the first indication of a nesting population on the Arctic Coastal Plain (ACP). In the late 1970s to early 1980s, Gavin (1977, 1980) also noted locations of nesting Brant during aerial surveys of the central Arctic Coastal Plain where oil production was taking place.

Within the oilfields, Brant can be found breeding in scattered smaller colonies (e.g., Surfcote and near Lake Colleen in Prudhoe Bay, near CPF-3 and DS-2C in Kuparuk, and near C Pad in the Milne Point area) and in several larger colonies (e.g., the Howe Island colony on the Sagavanirktok River delta and the Colville River delta colony). Locations of breeding colonies outside the oilfields are less well known, but some small colonies have been mapped in areas surveyed between Kasegaluk Lagoon and the western Colville River delta (Ritchie et al. 2009). Brood-rearing areas used by Brant are better known, as they are usually located in confined areas of coastal salt marsh along the Beaufort Sea, including the Fish Creek area, Colville River delta, Oliktok Point and Milne Point areas, the mouth of the Putuligayuk River, and the Sagavanirktok River.

Since the mid-1980s, Brant have received considerable attention from both the oil industry and regulatory agencies because of the substantial declines in the Pacific Flyway population that principally breeds on the Yukon-Kuskokwim Delta (Raveling 1984, Sedinger et al. 1993). On the ACP surveys of northern Alaska, trends have not been uniform. Broad regional surveys conducted during early to mid June since 1992 have shown an increase of Brant on the ACP over the past 2 decades (Larned et al. 2012), however, this trend may have resulted in part from an influx of early failed breeders from the Yukon-Kuskokwim Delta where numbers of nesting Brant have continued to decline since 1992 (Wilson 2011). Coastal brood surveys conducted between the Colville River delta and Barrow have shown an increase in the number of brood-rearing adult Brant and goslings as well as a substantial increase in the number of adult molting Brant since 1995 (Burgess et al. 2012). Numbers of brood-rearing Brant have been increasing on the Colville River delta since 1988 (Johnson et al. 2012), and numbers of Brant nests appear to have remained stable or increased since 1995 in 23 small colonies between Fish Creek and Barrow (Burgess et al. 2012). Data from Larned et al. (2012) suggest that Brant may have begun expanding their range inland from the coast in parts of the ACP. In contrast, Brant nest numbers have decreased on the Sagavanirktok River delta since 1993 (LGL, Inc., unpublished data, ABR, Inc., unpublished data). Within the Kuparuk study area, it is likely that most post-breeding Brant east of the Kuparuk River originate in the Sagavanirktok River delta where nest numbers have been declining, and most post-breeding Brant west of the Kuparuk River come from islands in the Colville River delta, where numbers have been increasing.

Brant are traditional in their use of nesting and brood-rearing areas and, hence, are potentially vulnerable to changing conditions in those areas. Brood-rearing Brant, in particular, are sensitive to various types of disturbance associated with oil development, including noise and vehicular and aircraft traffic. For example, studies in the Lisburne Development Area in Prudhoe Bay found that Brant were responsive to vehicular disturbances at greater distances during brood-rearing than they were during pre-nesting and nesting (Murphy and Anderson 1993). In contrast, Brant nesting in a colony near CPF-3 in the Kuparuk Oilfield were not significantly disturbed by noise from that facility (Hampton et al. 1988). Thus, the specific disturbance type and relative distance of birds to the disturbance are important factors in determining the relative effects of oilfield-related disturbance on Brant.

Beginning in 1988, surveys supported by ARCO Alaska, Inc. (now ConocoPhillips Alaska), have focused specifically on the distribution of nesting and brood-rearing Brant within the Kuparuk Oilfield. Since the early 1990s, aerial surveys have been conducted almost annually during brood-rearing. Snow Geese (*Chen caerulescens*) were added to the survey in 2005 to document increased use of the area by brood-rearing Snow Geese from the rapidly expanding Snow Goose colony on the Colville River delta to the west (Johnson et al. 2012). The objective of the 2012 brood-rearing survey was to count Brant and Snow Goose adults and goslings and to locate their brood-rearing/molting areas between Heald Point and the Miluveach River along the Arctic Coast.

2012 RESULTS

One aerial survey was conducted on 25 July 2012 to locate brood-rearing areas used by Brant and Snow Geese and to count numbers of adults and goslings along 3 sections of the Beaufort Sea coast between the Sagavanirktok and Colville rivers (Figure 13). Over all 3 sections, 9 brood-rearing (adults and young) groups and 9 molting (adults without young) groups of Brant were recorded, for a total count of 994 birds (771 adults and 223 goslings; Figures 14 and 15; Appendix 8).

Brant productivity was low in 2012. The total number of goslings was the fifth lowest among 23 years of surveys, and the total number of brood-rearing adults (269) was the second lowest (Figure 14; Appendix 8). Brant goslings comprised 22% of the total number of Brant counted, which was the fifth lowest percentage and well below the long-term mean of 33%. Numbers of brood-rearing adults and goslings were well below average in sections 3 and 4, and near average in section 5.

In the overall study area, more molting adults without goslings were counted in 2012 than in any other year (Figure 14; Appendix 8). The number of molting adults was the highest ever recorded in Section 4, where several molting groups were observed between Oliktok Point and Milne Point (Figure 15). Similarly, several molting groups were observed in section 5 along the west bank of Prudhoe Bay, and the number of molting adults in that section was the eighth highest on record and well above average. No molting adults without goslings were observed in Section 5, which is typical of that section: between 1989 and 2012, 99% of all adults in Section 5 have been accompanied by goslings (Figure 15; Appendix 8), indicating that the coastal zone between the Miluveach River and Kalubik Creek is used by Brant almost exclusively for brood rearing rather than for molting by failed breeders. In contrast to Section 5, only 50% of all adults observed in Section 3 during 1989–2012 were accompanied by goslings. Brant in Section 3 likely come from colonies in the Sagavanirktok River delta, where Brant numbers have been declining in recent years.

During the brood-rearing survey, 34 groups of Snow Geese were observed, containing the highest number of both adults (975) and goslings (1,035) recorded since surveys began in 2005 (Table 11). Most Snow Geese were located in Section 5 on the east bank of the Colville River (Figure 16), where 24 groups comprising 701 adults and 763 goslings were observed. Sections 4 and 5 both had the highest numbers of adults and goslings ever recorded, reflecting substantial growth of the Colville River delta nesting colony in recent years. Numbers of Snow Geese using section 3 also have increased since surveys began in 2005 (Table 11). Birds in this section likely originate from colonies to the east, such as the large colony on Howe Island near the mouth of the Sagavanirktok River.

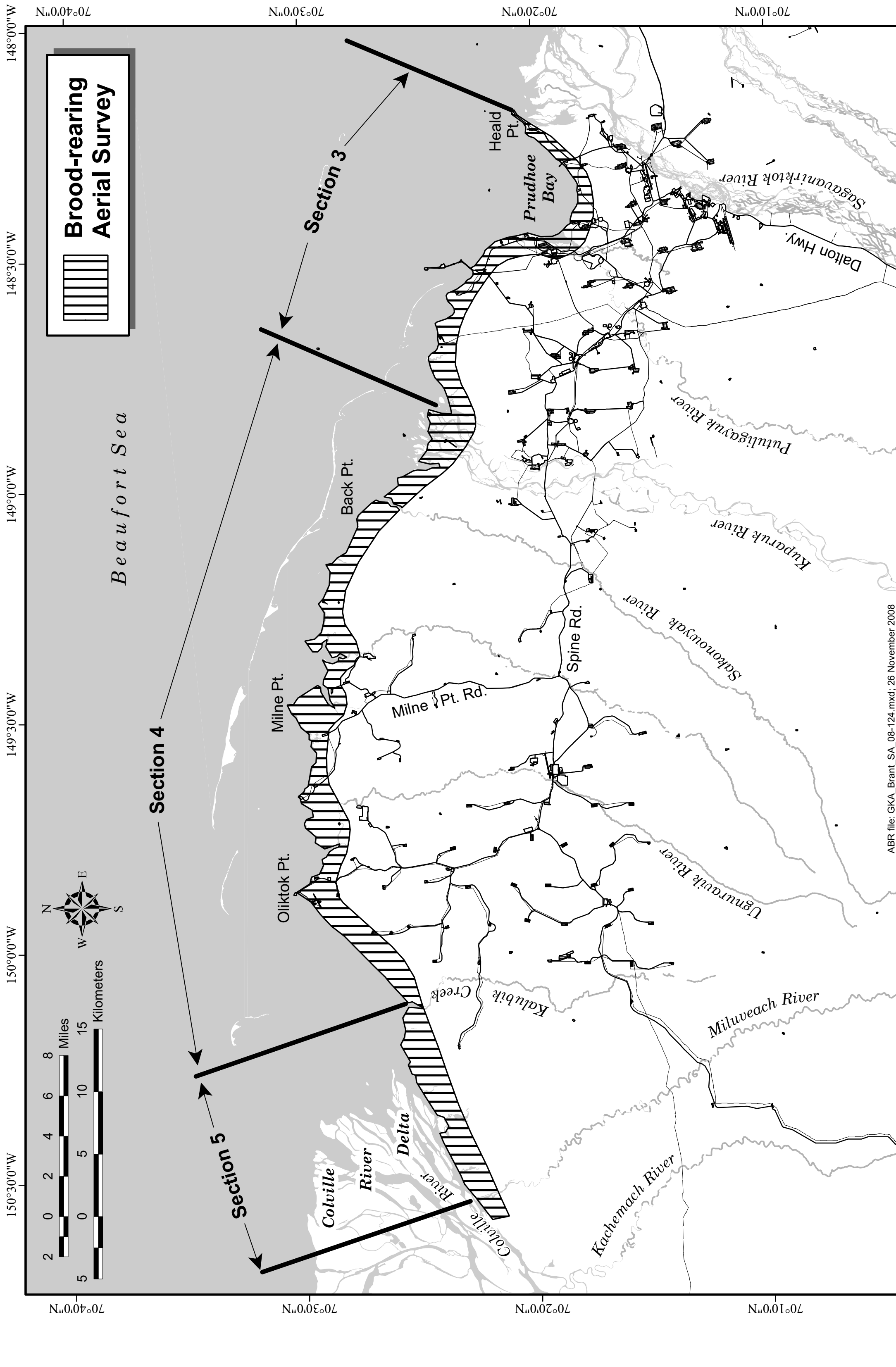

Figure 13. Aerial survey area for brood-rearing/molting Brant between the Colville and Sagavanirktok rivers, Alaska, July 2012.

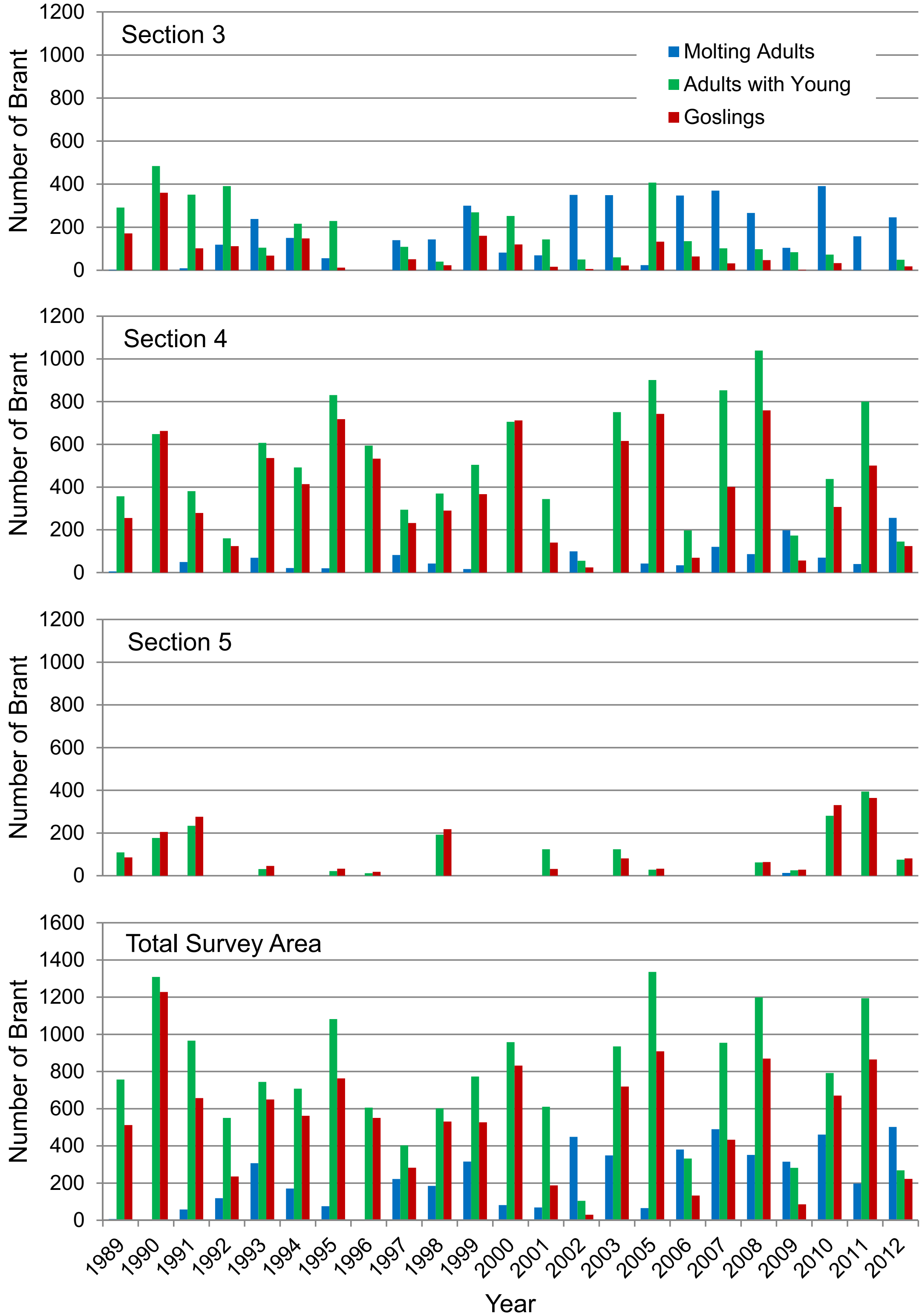

Figure 14. Numbers of brood-rearing (adults and young) and molting (adults only) Brant observed during aerial surveys of coastal sections between the Colville and Sagavanirktok rivers, Alaska, late July and early August 1989-2012. Counts were either from visual observations or aerial photographs taken during the surveys.

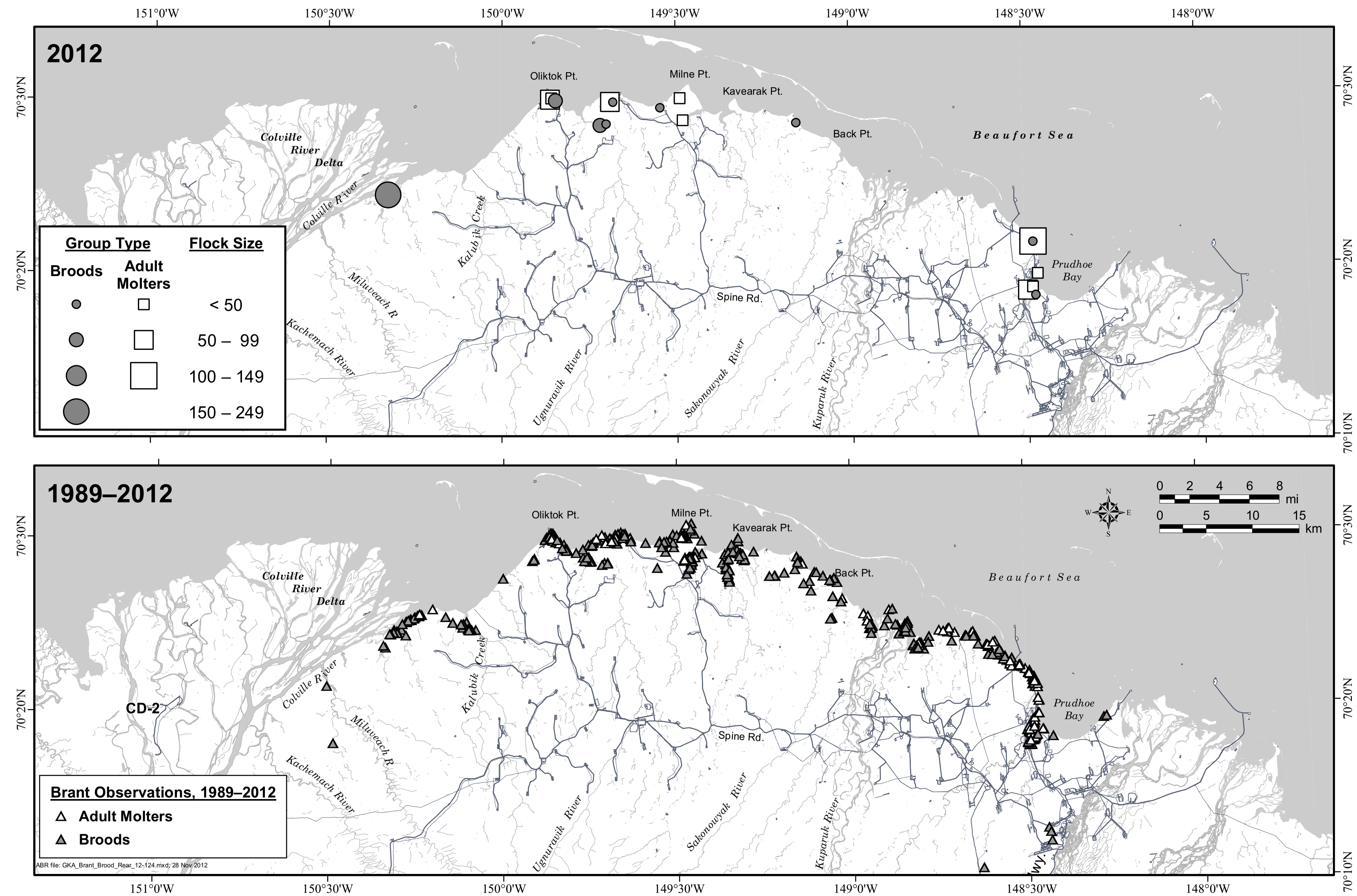

Figure 15. Locations and sizes of brood-rearing (adults and young) and molting (adults only) groups of Brant between the Colville and Sagavanirktok rivers, Alaska, 2012 (top) and cumulative observations, 1989–2012 (bottom).

Table 11. Numbers of brood-rearing (adults and young) and molting (adults only) groups of Snow Geese observed during aerial surveys in late July along 3 coastal sections between the Colville and Sagavanirktok rivers, Alaska, 2005–2012.

	Section 3 Heald Point to Kuparuk River				*Section 4* Kuparuk River to Kalubik Creek				*Section 5* Kalubik Creek to Miluveach River				Total Survey Area			
	Brood-rearing		Molting		Brood-rearing		Molting		Brood-rearing		Molting		Brood-rearing		Molting	Grand
Year	Adults	Young	Adults	Total	Adults	Young	Adults	Total	Adults	Young	Adults	Total	Adults	Young	Adults	Total
2005	0	0	0	0	0	0	0	0	18	16	0	34	18	16	0	34
2006	8	16	0	24	0	0	0	0	230	239	0	469	238	255	0	493
2007	8	8	3	19	0	0	0	0	188	107	0	295	196	115	3	314
2008	76	73	0	149	81	112	0	193	241	229	0	470	398	414	0	812
2009	0	0	113	113	0	0	6	0	361	84	120	565	361	84	239	684
2010	63	87	123	273	113	143	10	256	505	301	46	852	681	531	179	1,391
2011	88	52	65	205	68	101	0	169	588	761	0	1,349	744	914	65	1,723
2012	72	82	57	211	145	190	0	335	686	763	15	1,464	903	1,035	72	2,010

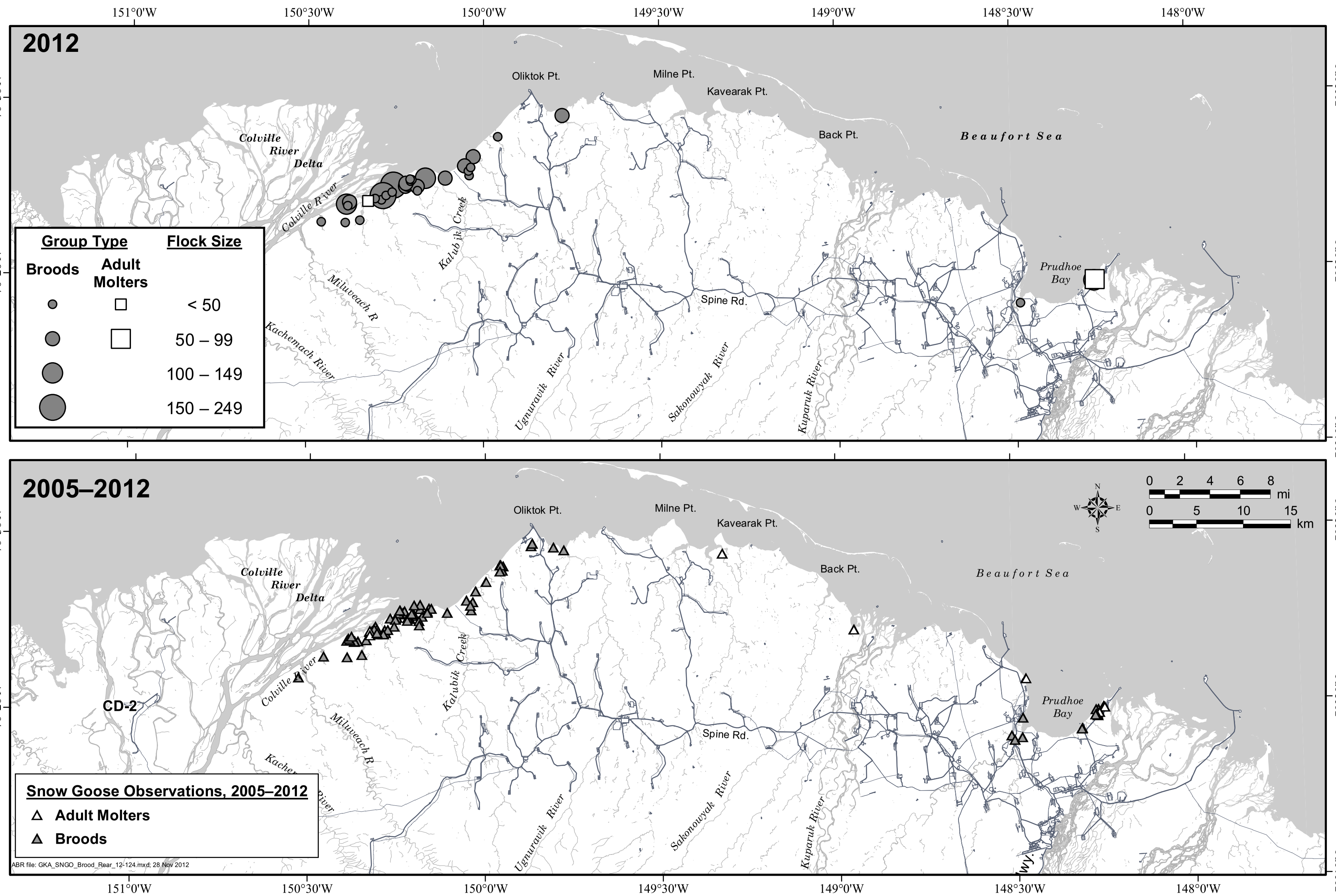

Figure 16. Locations and sizes of brood-rearing (adults and young) and molting (adults only) groups of Snow Geese between the Colville and Sagavanirktok rivers, Alaska, 2012 (top) and cumulative observations, 2005–2012 (bottom).

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Appendix 1. Methods for avian surveys in the Kuparuk Oilfield, Alaska, 2012.

Brief summaries of methods used for aerial and road surveys, and ground nest searches and nest fate assessments for eiders are presented below; complete methods are presented in Anderson et al. (2004, 2005).

AERIAL SURVEYS

The following table summarizes the aerial survey methods used for pre-nesting eiders, nesting and brood-rearing Tundra Swans, and for brood-rearing/molting Brant.

Species	Eiders	Tundra Swan		Brant
Season	Pre-nesting	Nesting	Brood-rearing	Brood-rearing
Aircraft	C-185/206	C-185/206	C-185/206	SuperCub/Scout
Flight Altitude	30–50 m	150 m	150 m	
Flight Speed	145 kph	145 kph	145 kph	
Number of Observers	2	2	2	1
Survey Type	E-W transects (fixed-width)	E-W transects[a] (fixed-width)	E-W transects[a] (fixed-width)	Coast and selected embayments
Transect Spacing	0.5 miles	1.6 km	1.6 km	None, circling of larger groups
Transect Width	400 m (200 m each side)	800 m (400 m each side)	800 m (400 m each side)	na
Percent Coverage of Study Area	50%	100%	100%	na
Data Collection Media	Photo-mosaic maps/ audio tape	Photo-mosaic maps/USGS topographic maps/ aerial photographs taken of nest sites	Photo-mosaic maps	USGS topographic maps/ aerial photographs taken of large groups

[a] This survey followed the standard protocol of the U.S. Fish and Wildlife Service for swan surveys (USFWS 1987b, 1991).

EIDER ROAD SURVEYS

Road surveys in the Kuparuk Oilfield encompassed all habitats within ~500 m of the road system. The road to the farthest south Meltwater drill site (DS-2P) was surveyed only once to look for areas of suitable habitats for eiders; if none was found, this area was not included in subsequent surveys. In brief, the methodology for road surveys was for a single observer in a truck to drive the roads and count and map (on 1:1000-scale photo-mosaic maps of the oilfield, and electronically on an ArcPad ®-equipped computer) all eiders seen, regardless of distance from the road. In addition to the main roads (Spine Road, Oliktok Point Road) in the oilfield, we surveyed all secondary roads to drill and mine sites, and surveyed around the perimeter of the gravel pad at each drill site to count any eiders near the pad but not visible from the road. The entire study area was surveyed every two days (1/2 of area each day). All observations of eiders were digitized and added to the geographic information system (GIS) database initiated in 1993. Distances of Spectacled Eider observations to the nearest oilfield facility (road or pad) were determined using GIS.

EIDER NEST SEARCHES AND NEST FATE

Ground searches for eider nests were conducted at selected locations based on where repeated sightings of breeding pairs occurred during the road surveys in 2012 and where nests were located in 2011. Searchers walked the perimeters of all waterbodies in the selected area and searched for active (females present and incubating) or failed (nest scrapes or bowls) eider nests. Most Spectacled Eiders nest within 25 m of waterbodies, but searches extended out to at least 50 m to ensure coverage. No artificial eggs implanted with temperature sensors (thermistored eggs) were placed in Spectacled Eider nests in order to minimize disturbance to already flushed hens. Three time-lapse digital cameras (Reconyx R-75) were deployed at active Spectacled Eider nests and located within 30 m of the nest and programmed to record 1 image every 30 seconds. Nests of eiders that had already failed before the ground searches began were classified as "unknown eider" and a sample of down with contour feathers were taken from the nest as was a sample from any active nest with sufficient down where the bird was flushed.

During July, all nests that still were active when initially located were revisited to determine their final fate (apparent nest success). A nest was considered to be successful if at least one egg hatched (based on presence of a membrane[s] separated from the shell [indicative of hatch] in the nest bowl). Down samples similar to those collected in June were collected at the time of the fate check. The time-lapse cameras were retrieved when the nests were checked for nest fate and the data (.jpg files) downloaded to DVDs for later review in the office to determine incidences of nest predation. Distances of nests were estimated to the nearest water (any type) and permanent waterbody and nest locations were mapped on the aerial photographs or maps (1:1000), or GPS coordinates were taken at the nest site, so that distance to the nearest oilfield facility (road or pad) could be determined later using GIS.

After field work was completed, all nest locations were digitized and added to the GIS database. Random samples of 10 contour feathers from each unknown eider nest and a selection of known eider nests were mounted on acid-free paper. Six biologists classified feathers from 6 unknown eider nests and 12 known nests. The species of each feather sample was unknown to the biologist at the time of classification in order to reduce bias. Feathers were classified as striped, brown-speckled, gray-speckled, or no markings. If ≥70% of feathers were striped and/or brown-speckled, the nest was classified as "probable Spectacled Eider". If ≤50% of feathers were striped and/or brown-speckled, the nest was classified as "probable King

Eider". If the percentage of striped plus brown-speckled feathers was between 51% and 69%, the nest was classified as an unidentified eider.

TUNDRA SWAN ANALYSES

For the analysis of the tundra swan survey data, some assumptions were made. One assumption was that a pair of swans is associated with each nest or brood. The raw survey data includes many observations of a single swan with either a nest or brood, but it is likely that the other swan is out of view at the time of the survey. Therefore, the summaries presented include both the raw survey data and an estimation of the actual number of breeding and non-breeding swans. Breeders are estimated by multiplying the number of nests (or broods) by 2 and non-breeders are estimated by subtracting the estimated number of breeders from the total number of adult swans seen. Estimated nesting success falls into 3 categories: good, fair and poor and is calculated by the number of broods seen divided by the number of nests. This is an estimate only as the brood-rearing survey occurs late in the brood-rearing period, so can not account for brood loss during the intervening time from hatching. Nesting success is estimated as good if it is ≥80%, fair success if ≥ 60% and <80%, and poor success if <60%.

DATA MANAGEMENT AND GIS PROTOCOLS

After the field surveys are completed all data are entered into databases and proofed. Data collected without accompanying GPS locations (generally all field-mapped data, such as from road surveys and aerial surveys) are provided to the GIS staff for digitizing using the Kuparuk basemap. Final maps are prepared for proofing by the field project leader and standard CPAI protocols are followed in the preparation of databases, metadata, and other map products that are submitted to CPAI for addition to their centralized geodatabase. All field photographs are also compiled following CPAI protocols and submitted along with the databases and GIS products.

Appendix 2. Numbers of Spectacled and King eiders counted on road surveys in the Kuparuk Oilfield, Alaska, 5–17 June 2012. Eiders ≤500 m and >500 m from the survey route are reported separately because only eiders ≤500 m from the survey route were used in the analyses.

	Spectacled Eider								King Eider							
	≤500 m				>500 m				≤500 m				>500 m			
Date	Males	Females	Pairs	n	Males	Females	Pairs	n	Males	Females	Pairs	n	Males	Females	Pairs	n
5 June	7	8	6	6					48	41	29	23	4	4	4	2
6 June	5	5	5	4	1	1	1	1	35	33	33	18	1	1	1	1
7 June	7	6	6	7					39	37	36	22	4	4	1	2
8 June	2	2	2	2	2	1	1	2	24	23	20	15	19	19	19	3
9 June	5	4	4	5					18	17	16	14	1	1	1	1
10 June	1	1	1	1					27	25	32	15	9	8	8	6
11 June	1	0	0	1	1	0	0	1	22	15	15	20	6	3	3	4
12 June	6	4	4	5					28	22	22	16	3	2	2	2
13 June	1	1	1	1					21	17	17	16	4	2	2	1
14 June	9	6	6	7					30	20	20	16				
15 June	5	3	3	4	1	1	1	1	20	16	16	18				
16 June	2	2	1	3					32	19	18	23	7	3	12	6
17 June	7	3	2	7					16	9	9	11	3	1	1	2
18 June	4	1	1	4					12	6	6	5	2	0	0	1
Total	62	46	42	57	5	3	3	5	372	300	289	232	63	48	54	31

Appendix 3. Nest-site characteristics of eider nests found during ground searches in the Kuparuk Oilfield, June 2012.

Species	General Location	Nest Fate	Clutch Size	Number of Membranes	Habitat	Waterbody Type	Distance to Nearest (m): Waterbody	Distance to Nearest (m): Water	Distance to Nearest (m): Oilfield Infrastructure[a]
Spectacled Eider	DS-1E	Failed	3	0	Nonpatterned Wet Meadow	Sedge Marsh	11.3	1.0	150.4
Spectacled Eider	DS-1E	Failed	4	0	Sedge Marsh	Sedge Marsh	0	0.1	649.6
Spectacled Eider	DS-1E	Successful	?	3	Sedge Marsh	Sedge Marsh	0	1.0	269.0
Spectacled Eider	DS-1Y	Failed	4	0	Sedge Marsh	Sedge Marsh	0	8.0	844.9
Spectacled Eider	DS-2F	Successful	?	3	Young Basin Wetland Complex	Young Basin Wetland Complex	0	50.0	282.7
Spectacled Eider	DS-2F	Failed	4	0	Young Basin Wetland Complex	Young Basin Wetland Complex	0	10.0	269.4
Spectacled Eider	DS-2V	Failed	3	0	Moist Sedge-Shrub Meadow	Deep Open Water without Islands	0.1	1.0	399.2
Spectacled Eider	DS-2Z	Failed	?	0	Nonpatterned Wet Meadow	Sedge Marsh	13.1	75.0	392.6
Spectacled Eider	DS-3O	Successful	?	4	Human Modified	Shallow Open Water without Islands	125.1	1.0	8.2
Spectacled Eider	CPF-2	Successful	?	4	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	0.1	109.6
Probable Spectacled Eider	DS-1Y	Failed	?	0	Sedge Marsh	Sedge Marsh	0	4.0	861.1
Probable Spectacled Eider	DS-2H	Failed	?	0	Nonpatterned Wet Meadow	Shallow Open Water with Islands or Polygonized Margins	36.1	15.0	476.0
King Eider	DS-1E	Failed	5	0	Nonpatterned Wet Meadow	Shallow Open Water with Islands or Polygonized Margins	6.7	5.0	400.2
King Eider	DS-1Y	Failed	4	0	Sedge Marsh	Sedge Marsh	0	1.0	757.5
King Eider	DS-2C	Failed	?	0	Sedge Marsh	Sedge Marsh	0	75.0	389.4
King Eider	DS-2V	Failed	?	0	Moist Sedge-Shrub Meadow	Deep Open Water without Islands	9.0	8.0	326.2
King Eider	DS-2Z	Failed	?	0	Sedge Marsh	Sedge Marsh	0	0.1	95.8
King Eider	DS-2Z	Failed	?	0	Sedge Marsh	Sedge Marsh	0	20.0	312.4

Appendix 3. Continued.

Species	General Location	Nest Fate	Clutch Size	Number of Membranes	Habitat	Waterbody Type	Distance to Nearest (m) Waterbody	Distance to Nearest (m) Water	Distance to Nearest (m) Oilfield Infrastructure[a]
King Eider	CPF-3	Failed	2	0	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	1.0	571.4
King Eider	CPF-3	Failed	?	0	Sedge Marsh	Sedge Marsh	0	1.0	511.8
King Eider	CPF-3	Failed	5	0	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	3.0	389.9
Probable King Eider	DS-1E	Successful	6	2	Sedge Marsh	Sedge Marsh	0	2.0	335.7
Probable King Eider	DS-1Y	Successful	?	4	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	5.0	887.3
Probable King Eider	DS-2C	Failed	?	0	Sedge Marsh	Sedge Marsh	0	2.0	572.8
Probable King Eider	DS-2C	Failed	?	0	Sedge Marsh	Sedge Marsh	0	75.0	414.0
Probable King Eider	DS-2C	Failed	4	0	Sedge Marsh	Sedge Marsh	0	1.0	414.4
Probable King Eider	CPF-3	Failed	2	0	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	1.0	259.6
Probable King Eider	CPF-3	Failed	5	?	Old Basin Wetland Complex	Shallow Open Water with Islands or Polygonized Margins	18.4	10.0	711.7
Probable King Eider	Pit E	Failed	?	0	Shallow Open Water without Islands	Shallow Open Water without Islands	0	1.0	155.0
Unidentified Eider[b]	DS-1E	Unknown	?	?	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	—	572.2
Unidentified Eider[b]	DS-1Y	Unknown	?	?	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	—	697.1
Unidentified Eider[b]	DS-1Y	Unknown	?	?	Shallow Open Water with Islands or Polygonized Margins	Shallow Open Water with Islands or Polygonized Margins	0	—	700.1
Unidentified Eider[b]	DS-1Y	Unknown	?	?	Shallow Open Water with Islands or	Shallow Open Water with Islands or	0	—	706.0

Appendix 3. Continued.

Species	General Location	Nest Fate	Clutch Size	Number of Membranes	Habitat	Waterbody Type	Distance to Nearest (m)		
							Waterbody	Water	Oilfield Infrastructure[a]
Unidentified Eider	CPF-3	Failed	4	0	Polygonized Margins Shallow Open Water with Islands or Polygonized Margins	Polygonized Margins Shallow Open Water with Islands or Polygonized Margins	0	3.0	255.8

[a] Oilfield infrastructure includes roads, pads, and processing facilities.
[b] Nests were located on islands that were inaccessible during nest searches and fate visit; species identity could not be confirmed.

Appendix 4. Numbers of Tundra Swans, nests and broods observed during June and August aerial surveys in the South Kuparuk study area, Alaska, 1989–2012.

	Nesting				Brood-rearing					
		Observed Number of Adults					Observed Number of Adults			
Year	Number of Nests	with Nests	without Nests	Total	Number of Broods	Number of Young	with Broods	without Broods	Total	Total Swans
1989		2	2	4				2	2	2
1990	1							2	2	2
1991			5	5						
1992			2	2						
1993										
1994										
1995										
1996		1	1	2						
1997	1		2	2				1	1	1
1998	1		7	7	1	1	1			1
1999		2	5	7				7	7	7
2000	1		2	2				3	3	3
2001		2	2	4				2	2	2
2002	1	1	5	6	1	1	2		2	3
2003	1		4	4				3	3	3
2004			6	6						
2005		1	4	5				2	2	2
2006	1	2	5	7				2	2	2
2007	1	2	2	4	1	4	2		2	6
2008	0	0	7	7	2	6	4	3	7	13
2009	0	0	6	6	0	0	0	6	6	6
2010	0	0	7	7	0	0	0	8	8	8
2011	2	3	11	14	0	0	0	0	0	0
2012	0	0	16	16	0	0	0	2	2	2

Appendix 5. Numbers of Tundra Swans and nests (by USGS quadrangle) observed during aerial surveys in the Kuparuk and South Kuparuk study areas, Alaska, 22–25 June 2012.

Location (USGS Quadrangle)	Adults with Nests				Adults without Nests					
	Pairs	Single Adults	Total	Number of Nests	Pairs	Single Adults	Flocks	Flocked Swans	Total	Total Swans
Beechey Point										
A-4	3	6	12	9	18	10	1	3	58	70
A-5	0	4	4	4	12	13	1	3	35	39
B-4	17	9	43	26	39	24	4	14	127	170
B-6	18	14	50	32	58	40	3	10	162	212
Harrison Bay										
A-1	3	1	7	4	16	11	3	12	52	59
A-2	0	1	1	1	5	4	1	7	20	21
B-1	11	11	33	22	21	19	5	31	100	133
B-2	0	3	3	3	10	10	0	0	24	27
Total	52	49	153	101	179	131	18	80	578	731

Appendix 6. Densities (number/km²) of Tundra Swans nests and adults in the Kuparuk study area (2379.7 km²), Alaska, 1989–2012. Densities were not calculated for the smaller South Kuparuk study area (357.7 km²).

		Adults		
Year	Nests	With Nests	Without Nests	Total
1989	0.02	0.03	0.08	0.11
1990	0.03	0.05	0.07	0.12
1991	0.03	0.05	0.12	0.16
1992	0.03	0.05	0.10	0.15
1993	0.03	0.05	0.10	0.15
1994	0.02	0.03	0.11	0.14
1995	0.04	0.08	0.12	0.20
1996	0.05	0.09	0.11	0.20
1997	0.03	0.05	0.10	0.15
1998	0.03	0.09	0.16	0.24
1999	0.04	0.05	0.10	0.15
2000	0.03	0.06	0.15	0.21
2001	0.03	0.06	0.12	0.18
2002	0.05	0.08	0.12	0.21
2003	0.03	0.05	0.13	0.18
2004	0.04	0.06	0.10	0.16
2005	0.04	0.06	0.10	0.17
2006	0.04	0.06	0.10	0.16
2007	0.05	0.08	0.14	0.22
2008	0.04	0.07	0.17	0.24
2009	0.04	0.06	0.15	0.22
2010	0.03	0.07	0.20	0.27
2011	0.04	0.09	0.17	0.26
2012	0.04	0.08	0.22	0.30

Appendix 7. Numbers of Tundra Swans and broods (by quadrangle) observed during aerial surveys in the Kuparuk and South Kuparuk study areas, Alaska, 16–18 August 2012.

Location (USGS Quadrangle)	Brood Groups						Non-brood Groups					Total		
	Pairs	Single Adults	Total Adults	Broods	Young	Mean Brood Size	Pairs	Single Adults	Flocks	Flocked Swans	Total Adults	Adults	Swans	Percent Young
Beechey Point														
A-4	7	0	14	7	12	1.7	24	6	2	11	65	79	91	13.2
A-5	4	0	8	4	9	2.3	16	7	4	18	57	65	74	12.2
B-4	18	0	36	18	42	2.3	62	34	4	14	172	208	250	16.8
B-5	22	1	45	23	54	2.3	83	36	3	9	211	256	310	17.4
Harrison Bay														
A-1	4	0	8	4	11	2.8	17	4	4	16	54	62	73	15.1
A-2	1	0	2	1	3	3.0	4	2	1	11	21	23	26	11.5
B-1	12	2	26	14	27	1.9	41	22	12	53	157	183	210	12.9
B-2	1	0	2	1	3	3.0	15	4	3	9	43	45	48	6.3
Total	69	3	141	72	161	2.2	262	115	33	141	780	921	1082	14.9

Appendix 8. Numbers of brood-rearing (adults and young) and molting (adults only) groups of Brant observed during aerial surveys of coastal sections between the Colville and Sagavanirktok rivers, Alaska, late July and early August 1989–2012. Counts were either from visual observations or aerial photographs taken during the surveys.

	Section 3 Heald Point to Kuparuk River				*Section 4* Kuparuk River to Kalubik Creek				*Section 5* Kalubik Creek to Miluveach River				Total Survey Area			
	Brood-rearing		Molting		Brood-rearing		Molting		Brood-rearing		Molting		Brood-rearing		Molting	Grand
Year[a]	Adults	Young	Adults	Total	Adults	Young	Adults	Total	Adults	Young	Adults	Total	Adults	Young	Adults	Total
1989	291	171	2	464	357	255	5	617	109	86	0	195	757	512	7	1,276
1990	484	360	0	844	648	663	0	1,311	177	205	0	382	1,309	1,228	0	2,537
1991	351	102	9	462	381	279	49	709	234	276	0	510	966	657	58	1,681
1992	391	112[b]	119	622[b]	160	124	0	284	0	0	0	0	551	236	119	906
1993	105	68	238	411	607	536	69	1,212	31	46	0	77	743	650	307	1,700
1994	216	148	150	514	492	414	21	927	0	0	0	0	708	562	171	1,441
1995	229	12	56	297	831	718	20	1,569	22	33	0	55	1,082	763	76	1,921
1996	ns[c]	ns	ns	ns	594	533	0	1,127	12[d]	18[d]	0[d]	30[d]	606	551	0	1,157
1997	109	51	140	300	294	232	82	608	ns	ns	ns	ns	403	283	222	908
1998	40	23	143	206	370	290	42	702	192	218	0	410	602	531	185	1,318
1999	269	160	300	729	504	367	16	887	0	0	0	0	773	527	316	1,616
2000	252	120	82	454	706	712	0	1,418	0	0	0	0	958	832	82	1,872
2001	143	16	69	228	344	140	0	484	124	32	0	156	611	188	69	868
2002	50	6	350	406	55	24	99	178	0	0	0	0	105	30	449	584
2003	60	22	349	431	751	616	0	1,367	124	81	0	205	935	719	349	2,003
2004	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
2005	407	133	24	564	901	743	42	1,686	28	33	0	61	1,336	909	66	2,311
2006	135	64	347	546	197	69	34	300	0	0	0	0	332	133	381	846
2007	102	32	370	504	853	401	120	1,374	0	0	0	0	955	433	490	1,878
2008	98	47	266	411	1,039	759	86	1,884	62	64	0	126	1,199	870	352	2,421
2009	84	2	104	190	173	56	198	427	25	28	13	66	282	86	315	683
2010	73	33	391	497	438	307	70	815	281	331	0	612	792	671	461	1,924
2011	0	0	158	158	800	501	40	1,341	394	364	0	758	1,194	865	198	2,257
2012	49	18	246	313	145	124	256	525	75	81	0	156	269	223	502	994

[a] Numbers for 1989–1993 and 1996 are a mean from two surveys; numbers for 1994, 1995, 1997–2012 are from one survey only