



ANNUAL REPORT

**SURVEYS FOR NESTING AND  
BROOD-REARING BRANT AND LESSER SNOW GESE,  
BARROW TO FISH CREEK DELTA, ALASKA, 2010**

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Prepared for  
**North Slope Borough**  
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## EXECUTIVE SUMMARY

- In 2010 we continued to monitor Lesser Snow Goose and Brant populations in the region between Barrow and the Fish Creek delta, northern Alaska. As in previous years we visited pre-selected Brant nesting colonies, visited the Snow Goose colony on the Ikpikpuk River delta during incubation (aerial survey and photo census) and after hatch (ground visit for nest-fate searches), and conducted brood-rearing surveys for Brant and Snow Geese. We did not conduct banding on the Ikpikpuk River delta because of a near complete failure of that nesting colony; however, we did band Snow Geese on the Colville and Sagavanirktok River deltas. Methods were similar to 2009, except we employed a stratified random sampling design during our nest fate surveys in 2010 in an attempt to improve estimates of numbers, nest success, and productivity.
- Twenty-one of the 23 (91%) monitored Brant colonies were occupied in 2010 (427 nests). Nest numbers were 12% higher than in 2009 and were about 39% higher than the 16-year average. Colony occupancy was similar to the average for this subset of monitoring colonies (~88%). Even with a reduced number of monitoring colonies, this program continues to suggest that the small population of Brant is relatively stable in the region, with substantial interannual variation in colony size at individual colonies.
- In July 2010, 22,494 Brant in 154 groups were estimated in the area between Barrow and Fish Creek. This estimate included 18,808 adults in groups without broods, 2,679 adults in groups with broods, and 1,007 goslings. The number of adult birds was the highest recorded since surveys began, while the number of goslings was only the sixth-highest on record, slightly higher than the 15-year mean. However, the number of brood-rearing/molting adult Brant in our study area appears to have increased from 2,000–5,000 prior to 2001 to 8,000–21,000 after 2001, primarily due to an increase in the number of adults in groups without broods. As in previous years, most Brant broods were recorded in the Harrison Bay section.
- In 2010, nesting Snow Geese again were abundant and widely distributed across the Ikpikpuk River delta as they have been since 2006. Visual estimates from an aerial survey on 21 June, recorded nearly 9,100 Snow Geese, comprising ~3,400 possible nesting pairs and an additional ~2,330 flying birds on numerous islands on the Ikpikpuk River delta. Numbers from visual aerial estimates in 2010 were very similar to those recorded on the Ikpikpuk River delta in 2009.
- In an effort to improve our colony counts, a photo census of the Ikpikpuk Snow Goose colony was attempted on 21 June 2010. Compared to our visual estimates (3,400 pairs), at least 4,769 Snow Goose nests were identified on aerial photographs. Combined with visual observations of an additional ~2,330 flying birds recorded during the survey flight, 11,868 Snow Geese were recorded on the Ikpikpuk River delta in 2010.
- Although nests continue to be distributed widely across the entire delta, use of the western delta has decreased in recent years, and in 2010 only 13% of Snow Goose nests were located on the 5 islands with the longest history of use in what is now the western part of the colony (Table 3; Figure 11). Island F in the central delta now comprises the main nesting area of the colony, and increasing numbers of Snow Geese recently have nested farther inland in wet sedge tundra habitats that previously seemed uncharacteristic of Snow Goose nesting habitats in the region.
- As in 2009, nest success on the Ikpikpuk River delta was greatly reduced in 2010 due to the destruction of nests by bears. Bears have been important predators of Snow Goose nests on the Ikpikpuk and Sagavanirktok rivers and other parts of their range in previous years.
- In July 2010, 11,381 Snow Geese were estimated in 123 groups, including 10,614 adults in groups without broods. Numbers of adults were 27% lower than record numbers of adults in 2009, but still more numerous than most years since surveys began in 1995.

However, as expected from nest fate searches, broods and total number of young were very low: only 194 goslings (25% of brood groups). As in previous years, most Snow Geese (65%) were located in the Smith Bay section.

- Although banding was not conducted on the Ikpikpuk River delta in 2010, we continued to acquire band return information from the Snow Geese we banded on the delta from 2000–2008. In addition, we banded over 3,000 Snow Geese on the Colville and Sagavanirktok River deltas in 2010. The distribution of returns and recaptures identify wide-ranging wintering areas and migratory routes (e.g., 24 of the lower 48 states, 5 Canadian provinces, Alaska, 5 states of Mexico, and Russia) generally similar to those reported for Snow Geese banded in the Sagavanirktok River delta and for Western Arctic Snow Geese in Canada. However, a fairly large number of band returns (>50) from Snow Geese banded on the Ikpikpuk River delta have come from areas east of these main wintering and spring use areas (e.g., Arkansas, Illinois, Kentucky, Louisiana, and Mississippi, Manitoba, and Nunavut). These returns are in the primary migration routes and winter areas of the Central Arctic and Eastern Arctic populations of Lesser Snow Geese, which breed in the eastern Canadian arctic.
- A total of 908 or 11.1% of Snow Geese originally banded on the Ikpikpuk River delta have been recovered since 2000 (through 31 December 2010). Over all years, 61% of banded birds were captured as goslings, 45% of all returns are known-age birds <1 year old, and 7% of birds banded as goslings were reported dead within 1 year of banding. Most band returns are from fall migration (19%) and wintering areas (63%). Seventy-three percent of fall/winter returns in the United States have come from California. Other returns have originated in 22 other states, 5 Canadian provinces, and Mexico. There also have been 143 spring and summer recoveries including hunter kills in northern Alaska, Canada, the lower 48 states, and Mexico. Only 3 Snow Geese banded on the Ikpikpuk River delta have been recaptured at other Snow Goose colonies.
- Since 2000, we have recaptured 7.6% of Snow Geese (1,031) that we originally banded on the Arctic Coastal Plain, revealing some exchange among regional breeding populations. In addition, 44 of the Snow Geese that we captured were previously banded by others outside of Alaska; with most (72.7%) banded in the NWT and the remaining from Russia, Nunavut, and Manitoba. Most band returns are from fall migration (22.7%, September and October) and wintering (60.0%, November through February) areas. Fifty percent of fall and winter recoveries have come from California, with the remaining recoveries distributed across Canada, Mexico, and 23 of the other lower 48 states (excluding California). There also have been 186 spring (March through May) and summer (June through August) band returns reported.

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## INTRODUCTION

Proposed and potential oil development in areas west of the Colville River delta, within the National Petroleum Reserve–Alaska, prompted increased inventory and monitoring activities for wildlife resources in the area. Since the mid 1990s, the North Slope Borough (NSB) Department of Wildlife Management has supported a program to monitor the status and productivity of Brant (*Branta bernicla*) and Lesser Snow Geese (*Chen caerulescens caerulescens*; hereafter, Snow Geese) in the area west of the Colville River delta (Ritchie and Burgess, 1992, 1993; Ritchie and Flint 1994; Ritchie 1996, 1998a, 1998b, 2001; Ritchie and Rose 1996; Ritchie and Wildman 2000; Ritchie et al. 2002, 2004, 2006, 2007, 2008a, 2009, 2010; Ritchie and Shook 2003, 2005).

The major goal of this program has been to monitor the distribution, abundance, and status of colonial geese in the region. Annual breeding-pair surveys that are conducted by the U.S. Fish and Wildlife Service (USFWS) are inadequate for monitoring colonially nesting species. Similarly, annual molting goose surveys conducted by the USFWS in the Teshekpuk Lake area focus on non-breeding and non-local geese that molt in large lakes between Harrison and Smith bays, but do not include many of the coastal brood-rearing areas used by local breeders. Specific objectives of our surveys were to evaluate the annual abundance of nesting and brood-rearing Brant and Snow Geese, to assess elements of their productivity, including nesting success and gosling production, and to describe their distribution in the region. In addition, we have tried to improve our estimates of productivity for the rapidly growing Snow Goose colony on the Ikpikpuk River delta through annual banding (2000–2003, 2005–2008) and photo censuses of the colony (2009 and 2010).

This report presents the results of the seventeenth consecutive year of aerial surveys of Brant and Snow Goose nesting colonies in northern Alaska, west of the Colville River delta (1994–2009), and the fourteenth year for brood-rearing surveys (1995–1997 and 1999–2009, augmented by photo census since 2001). Ground-based searches also were conducted for the eleventh year at the Ikpikpuk Snow Goose colony in 2009 (1992–1993, 2001–2009). Banding of

brood-rearing Snow Geese has been accomplished annually in the Ikpikpuk/Piasuk River deltas (hereafter, Ikpikpuk River delta) since 2000, except in 2004 (unfunded), and 2009 and 2010 (due to the near complete failure of the colony, see below). In 2008 and 2010, with support from BP Exploration (Alaska) Inc., we banded Snow Geese on the Sagavanirktok River delta (no banding was conducted there in 2009 due to colony failure). In addition, after learning of failure at the Ikpikpuk colony in 2010, we banded Snow Geese in the Colville River delta. (Snow Geese also were banded on the Colville River delta in 2008 with assistance from ConocoPhillips Alaska, Inc.) Banding data from all locations are included in this report. A complete summary of the survey types and areas covered by ABR in the course of long-term monitoring of colonial geese for the NSB, 1991–2010, is presented in Appendix A.

## STUDY AREA

The study area for monitoring breeding Brant and Snow Geese covers much of coastal Arctic Alaska (Figure 1), although areas of focus have shifted during some periods since monitoring was initiated in 1991. Initial efforts in the 1990s extended from Kasegaluk Lagoon to the Colville River delta. Starting in 1996, nesting and brood-rearing aerial surveys were focused on the Beaufort Sea coast between Point Barrow and Fish Creek, just west of the Colville River delta (Figure 1). While brood-rearing surveys continued to cover all coastal wetlands in this area, the nesting surveys focused on monitoring the status of specific Brant colonies and 1 Snow Goose colony (in the Ikpikpuk River delta) (Figure 1).

The study area comprises coastal tundra with numerous oriented thaw-lakes and is part of the Arctic Coastal Plain Ecoregion, bounded on the north by the Beaufort Sea (Gallant et al. 1995) and generally within a few kilometers of the coast. Vegetation in the study area is dominated by wet-graminoid/herbaceous plant communities. Along the coast, gravel spits, unvegetated mudflats, and salt marsh are extensive in some areas.

The study area was divided into sections for reporting (Ritchie 1996). Sections 1 and 2 are located west of Barrow and are not included in this

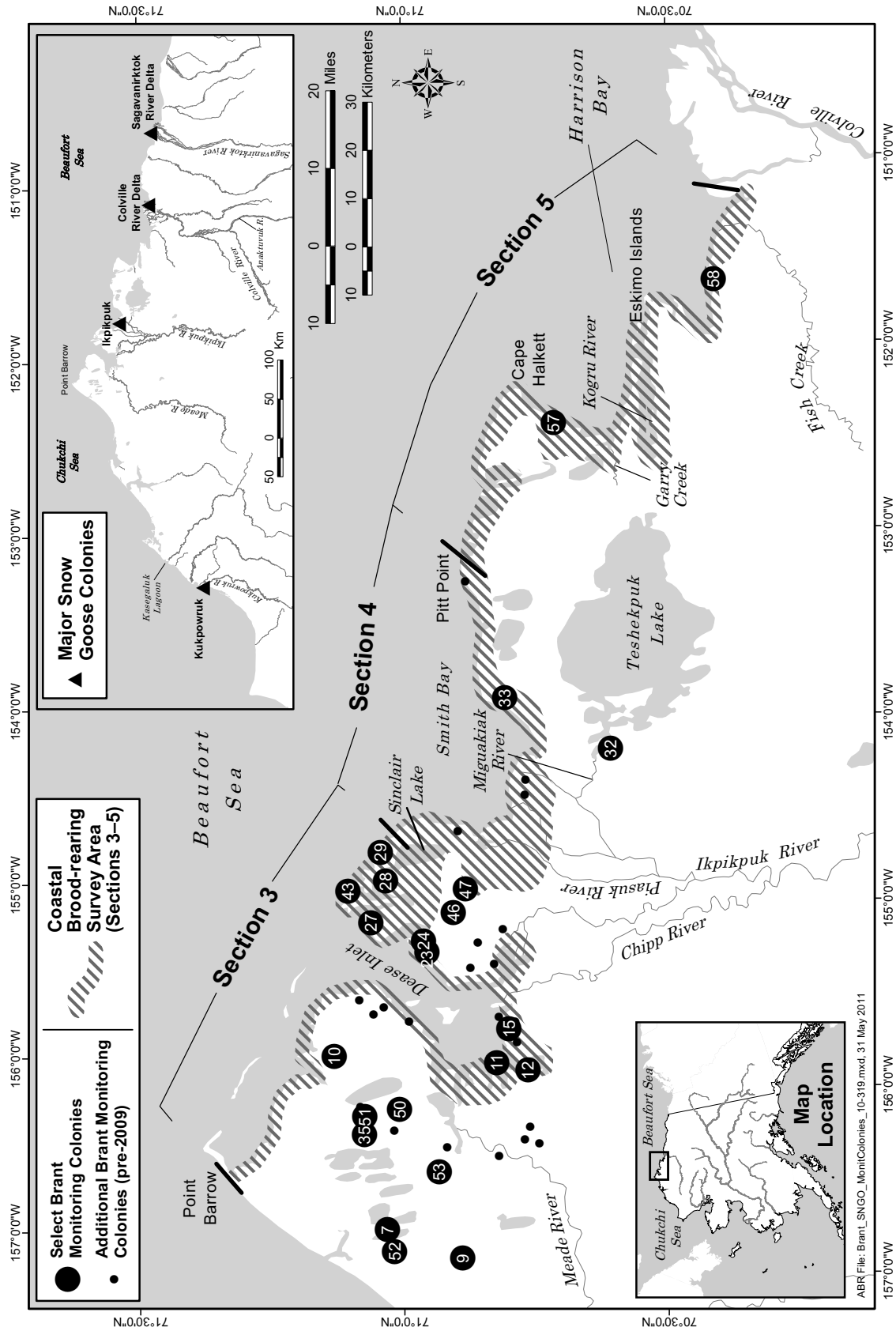


Figure 1. Study area for surveys to monitor breeding Brant and Snow Geese, including locations of 23 specific Brant colonies, 4 major Snow Goose colonies, and brood-rearing survey area along Alaska's northern coastline.

report as they have not been surveyed since 1995. The other 3 sections (3–5, Figure 1) have been surveyed annually since 1994, with minor adjustments made to their boundaries in 1997 (Ritchie 1998a). These 3 sections are:

- Dease Inlet (Section 3: Barrow to Sinclair Lake northwest of Smith Bay),
- Smith Bay (Section 4: Smith Bay and inland areas from Sinclair Lake to Pitt Point), and
- Harrison Bay (Section 5: Pitt Point to the western channel of the Colville River).

## METHODS

### BRANT COLONY MONITORING SURVEYS

Brant colony monitoring focused on 45 known nesting colonies between Barrow and Fish Creek, 1996–2008 (Figure 1). These 45 Brant colonies were thought to be representative of Brant breeding efforts in the region and were selected for long-term monitoring from all known colonies identified during more wide-ranging surveys in 1994 and 1995 (Ritchie 1996). To further reduce survey costs in 2009 and 2010, this group of Brant colonies was reduced to 23 of the consistently largest colonies.

A Cessna 185 aircraft with a pilot and 1 observer was used for colony monitoring. The aircraft was flown at 95–140 km/h and 30–100 m above ground level (agl) on 21 June 2010. We used an onboard geographic positioning system (GPS) to locate the 23 known Brant colonies for surveys, aided also by USGS 1:250,000-scale topographic maps. During all surveys, the single observer and the pilot (positioned on opposite sides of the aircraft) recorded numbers of adults and nests for each nesting location. The pilot aligned the plane to make the best pass for counting by the observer and also identified nest sites that might inadvertently be missed by the observer (e.g., in front of the plane). Colonies often were circled to afford better counts. A nest was recorded if either a down-filled bowl or an adult in incubation posture was observed. Male Brant typically flush in response to approaching aircraft and incubating females also occasionally flush, but empty Brant nests can be fairly conspicuous due to copious down.

### IKPIKPUK SNOW GOOSE COLONY MONITORING

#### NESTING PHOTO SURVEY

Since 1996, annual colony monitoring has also included an aerial survey of the Snow Goose colony in the Ikpikpuk River delta (Figure 1). Snow Goose nests in Brant colonies or observed opportunistically during the Brant colony survey are also recorded. With the rapid increase in the size of the Ikpikpuk colony, the aerial census has become increasingly difficult. So, we augmented our efforts in 2009 and 2010 with aerial photos in an effort to improve the accuracy of our estimates of nest numbers.

The 2010 aerial photo effort was conducted on 21 June using a Cessna 185 aircraft with a camera and aerial photography view port, flown at an air speed of 140–160 km/h (about 120–180 km/h ground speed) and 305 m above ground level (agl). We used an onboard geographic positioning system (GPS) and predetermined flight track lines spaced 200 m apart to cover the known and suspected breeding distribution of Snow Geese in the area. We used a Canon EOS 40D digital SLR camera (10.1 megapixel) mounted in the vertical ('belly-mounted') camera port and controlled by a laptop operated from the front seat. We used a 17–85 mm image-stabilizing camera lens, which was set to a focal length of 28 mm. The camera was programmed initially to take photos at 4-second intervals, but the interval was decreased to 3 seconds on westbound transects to compensate for increased ground speed on downwind segments.

Photographs were projected onto base imagery of the Ikpikpuk River delta in ArcGIS based on the GPS flight log and the exact time that each photograph was taken. Using this method, individual nests, although not perfectly geo-referenced, could be accurately assigned to nesting islands. Comparisons of features identifiable both on aerial photographs and on existing geo-referenced imagery of the Ikpikpuk River delta confirmed that plotted nest locations were accurate within about 30 m. For enumeration in photos, all pairs of Snow Geese on the ground (i.e., not flying) were considered to represent nesting pairs (Kerbes 1982). Birds in flight, small flocks on the ground, and single birds on the

ground were not considered to represent nests. Observations confirm that nesting male Snow Geese attend the incubating female, particularly during disturbances, and that aircraft disturbance rarely causes birds of either sex to flush from nest sites (Kerbes 1982, Burgess and Ritchie 1993).

#### NEST FATE SURVEY

We conducted a ground search of the Kukpowruk Snow Goose colony in 1992 and 1993 and of the Ikpikpuk Snow Goose colony 1992–1993 and 2001–2010. Similar ground searches of the Kukpowruk colony were conducted by NSB in 1995–2001, 2003, and 2007–2009 (R. Suydam, NSB, pers. comm.) and their data have been reported here. Ground searches were undertaken to enumerate, accurately map, and to assess the fate and productivity of Snow Goose nests. Typically we accessed the western half of the Ikpikpuk colony via fixed-wing aircraft and a ground crew of 3 surveyors supported by packrafts was allowed 5 days to search the major and most readily accessible islands in the western delta where nests typically have been most abundant (Ritchie et al. 2011). In recent years, since the rapid growth of the Ikpikpuk colony, we also conducted a low-altitude (<100 ft) helicopter survey in early August to count nests on islands that were not ground-searched (primarily the eastern half of the delta).

In an attempt to improve estimates of numbers and productivity, we employed a stratified random sampling design in 2010. Our goal was to develop a program better suited to monitoring the entire delta population of nesting geese. To select a stratified random sample of nest plots, we first created a systematic grid of points at 100-m intervals across non-mudflat areas of the Ikpikpuk River delta (Figure 2). We used aerial photography to differentiate mudflats from vegetated areas. Each point marked the center of a circular plot with a 50-m radius. Plots entirely covered by water (e.g., river channel, lakes) were excluded from further selection. The remaining plots were classified within 3 strata: high density, low density, or zero density of nests, based on our best information on the distribution of nests in previous years (e.g., Ritchie et al. 2010). A random sample of plots was selected from each of the 3 strata for

field surveys. We allocated the plots among strata based on an optimal allocation formula that takes into account the total number of plots in each stratum and the variability of observations within each stratum (estimated from previous years data; Schaeffer et al. 1996)

One hundred and sixty circular plots were randomly selected from the area historically used by Snow Geese on the Ikpikpuk River delta as well as adjacent, suitable habitats. These plots comprised 123 high density plots (areas used most often by Snow Geese for nesting), 27 low density plots (nest use has been recorded in the past 10 years), and 10 zero density plots (potentially suitable habitat but no previous nest use recorded). The ground crew was instructed that if all 160 plots could not be sampled, they ensure that surveyed plots were equally distributed across the delta and not lumped in any one area. A standard operating procedure describing options for sampling was created and carried in the field by the crew (Appendix B).

A field crew of 2 biologists visited the colony within 2 weeks after hatch and conducted nest-fate searches (6–8 July) at pre-selected plots. In 2010, an R-44 helicopter was used to establish a field camp and to move nest searchers between plots. On the ground, the center point of each plot was located using GPS and marked with a piece of survey lath. A 50-m length of nylon rope was used to delineate the circumference of the sampling area. The crew walked the perimeter of each plot and followed a zig-zag search pattern between the outer edges of the plot and the center, ensuring a complete search of the entire plot. If the center point of a plot was located in water, a GPS was used to determine the 50-m boundary.

Locations of nests in each plot were recorded using a handheld GPS. Nests were classified as *successful* if at least 1 eggshell fragment in the nest bowl was largely separated from a thickened shell membrane (Downing 1980), *unsuccessful* if eggshell fragments were firmly attached to papery shell membrane or if shell fragments were totally missing (Downing 1980). A few nests were classified as *unknown* when physical evidence seemed equivocal. All locations later were entered into a geographic information system (GIS) database (ArcGIS software).



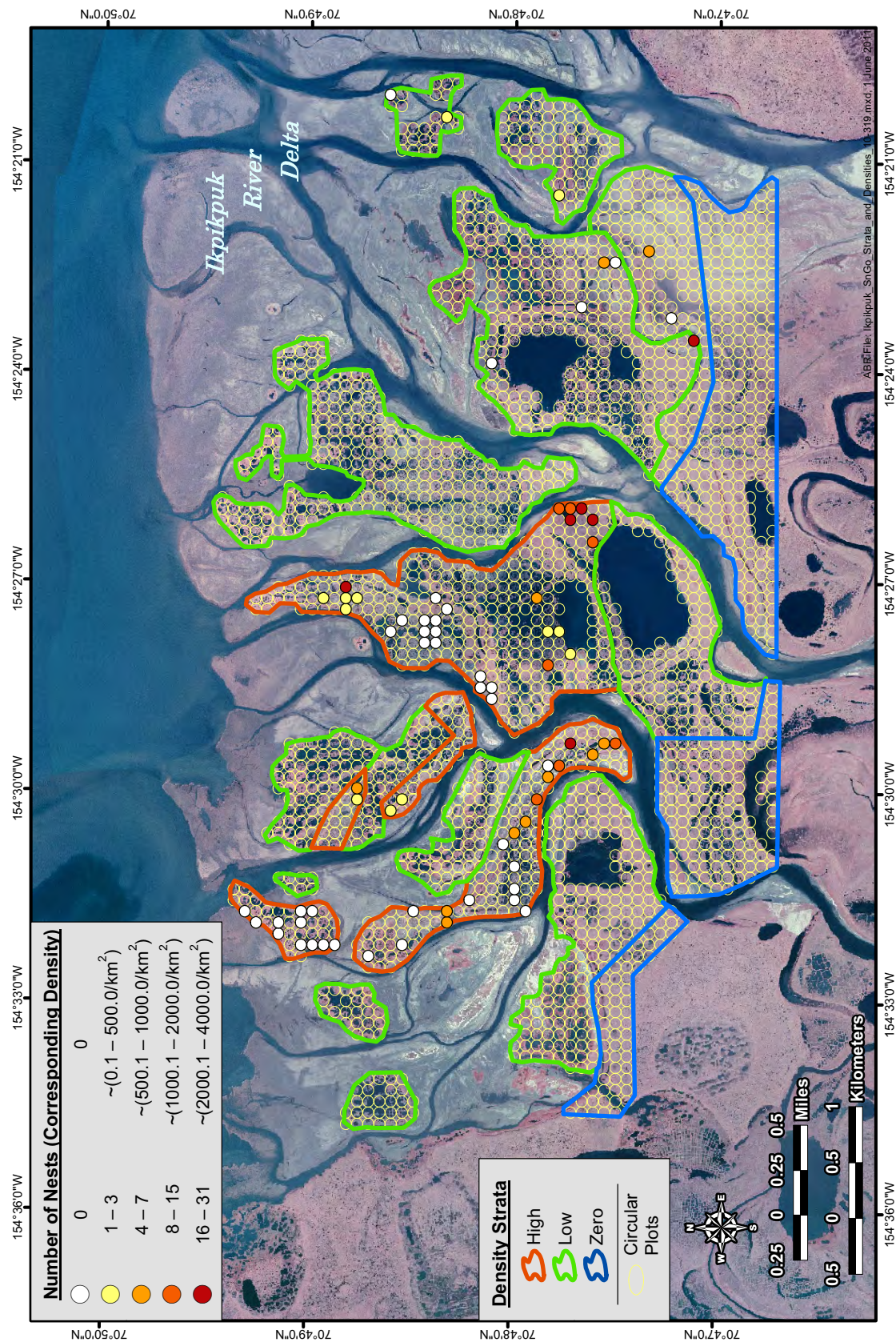


Figure 2. Grid of 50-m radius sample plots, stratification of the Ikpikuk Snow Goose colony by density, and randomly selected plots searched for Snow Goose nests in 2010.

We summarized nest numbers and nest fate (survival) by strata and then calculated the values for the entire area using the formulas for a stratified random sample (Schaeffer et al. 1996). For all calculations we assumed there were no nests in the zero density stratum although we were unable to sample plots in that stratum in 2010. For comparison, we used 2 methods to calculate the confidence interval for the total nests and nest survival. We calculated confidence intervals using parametric formulas for a stratified random sample (Schaeffer et al. 1996) and we used bootstrapping to calculate confidence intervals based on resampling of the data with replacement. We drew random selections (with replacement) of plots from each stratum that were equal to the total number of plots in that stratum. We then calculated the estimate of the total number of nests and the nest survival for the new data set. We repeated that process 5,000 times and then ranked the results for total nests and nest survival from 1 to 5,000. We calculated 95% confidence intervals by the 2.5% of lowest values and 2.5% of highest values and then determined the range of the remaining values.

### **BROOD-REARING SURVEYS**

The brood-rearing surveys are intended to provide information on the numerical abundance, distribution, and breeding success of Brant and Snow Geese across the study area. Brood-rearing surveys are best conducted several weeks after hatching, when goslings are large, no longer require brooding, and are easily enumerated. In 2010, the brood-rearing survey was conducted 27 July–3 August. The survey was flown by Piper Supercub aircraft at approximately 75–150 m agl and 120 km/h with a pilot and 1 observer. Locations of all Brant and Snow Geese were recorded with an onboard GPS (datum base: WGS 84). Information recorded for each group included species and numbers of adults and young. All locations later were entered into a GIS database (ArcGIS software).

Since 2002, to improve the accuracy of our counts of Snow Geese and Brant, we photographed all large (>50) brood-rearing groups, unless the group was too dispersed to photograph all birds. Many smaller groups also were photographed to test observer proficiency at estimating flocks of

various sizes. In 2010, photographs were taken with a handheld Canon PowerShot SX10 image stabilized digital camera (10.0 megapixel). Photographs were used to count the number of adults and goslings of each species and to identify color phase (white or blue) of Snow Geese. In 2008–2010, we also took digital photographs of some molting groups without broods, when it was possible to do so without making extra passes with the airplane.

In previous annual reports through 2008, comparisons of goose numbers among areas and years were based on visual estimates (not corrected by photo counts). In reports for 2009 and 2010, we replaced visual estimates with photo counts, when available, to provide the best possible estimate of numbers for each survey year (numbers for 2002–2008 in this report therefore will differ somewhat from those presented in annual reports for 2009–2010). Although photographs allowed precise enumeration of many individual groups, totals still represent minimal estimates because not all groups were photographed and corrected in any year.

### **SNOW GOOSE BANDING**

Banding was not undertaken on the Ikpikpuk River in 2010 due to the near complete failure of the colony caused by brown bears (*Ursus arctos*). However, we banded Snow Geese on the Colville River and Sagavanirktok River deltas using techniques described in previous reports (Ritchie et al. 2010). In addition, band recovery information on geese banded on the Sagavanirktok, Colville, and Ikpikpuk River deltas continued to be extracted from bimonthly reports from the USGS–BRD Bird Banding Lab to update our database. This report includes information on band returns through 31 December 2010 for all 3 locations.

## **RESULTS AND DISCUSSION**

### **SPRING AND SUMMER CONDITIONS**

Mean monthly temperatures in 2010 along the Beaufort Sea coast were generally average or slightly cooler in spring (arrival/nest initiation) compared to long-term mean records (NOAA 2010). In May, the mean monthly temperature was

0.1°C below the long-term mean in Barrow and 0.5°C below the long-term mean in Kuparuk and the Colville River delta. In June, the mean monthly temperature was 0.5°C below the long-term mean in Barrow and 1.3°C below the long-term mean in the Colville River delta and Kuparuk. However, temperatures were reported above average for several days in mid-June in the Kuparuk (Lawhead and Prichard 2011), which coincides with mid-incubation. Temperatures were above normal during brood-rearing (July and August; NOAA 2010).

Similarly, thaw degree summaries also suggest near-average conditions for Snow Geese at arrival and during incubation (Figure 3). During the period of waterfowl arrival and nest initiation (15 May–15 June), 55 cumulative thawing degree-days were recorded in the Kuparuk oilfield (Figure 3), very close to the 28-year mean ( $x = 54$ , range = 5–128 thawing degree-days). On the Colville River delta, 38 cumulative thawing degree-days were recorded at Colville Village, identical to the average value (range = 9–78 thawing degree-days).

In the Kuparuk oilfield, snow depth was close to the long-term maximum for most of May but melted quickly in early June and had melted at the Kuparuk Airstrip by 5 June; large areas with extensive drifts of snow remained at the time of an aerial caribou calving survey on 8–10 June, however (Lawhead and Prichard 2011). Breakup on the major rivers was earlier than average. Breakup on the Colville River was 8 days earlier than average, based on peak water levels on 23 May, compared to the historical peak (Michael Baker, Jr. Inc. 2009). Peak water levels on the Kuparuk River occurred around 14 May, 2 weeks earlier than the historical average of 28 May.

## BRANT

### COLONY MONITORING SURVEYS

All 23 monitoring colonies in the study area were surveyed 21–22 June 2010 (Figure 1, Table 1, Appendices A and C). Flight conditions were fair or good (i.e., no restrictive wind or visibility issues) on survey dates. No new colonies were identified in 2010. We recorded a minimum of 427 nests (Table 1). Nest numbers were 12% higher than in 2009 and were about 39% higher than the

16-year average ( $x = 307$  nests; range 215–427 nests; Table 1, Appendix C; 1994 is excluded from calculations due to incomplete survey in that year). The total number of Brant nests among the 23 monitored colonies appears to be increasing since surveys began in 1995 (Figure 4). Although the number of nests increased in the Smith Bay and Harrison Bay sections, most (61%) nests continued to be located in the Dease Inlet section (Table 1).

Twenty-one (91%) of the 23 visited colonies were occupied (i.e., at least 1 nest was present) in 2010, similar to the mean occupancy of ~88% at the same sites over the 16 years of complete surveys (Table 1). Nearly all of these monitoring colonies (96%) have been occupied in 11 or more years of surveys (Ritchie et al. 2011). Occupancy at these 23 colonies has ranged from 65% (1996) to 100% (2008).

### BROOD-REARING SURVEYS

We estimated 22,494 Brant in 154 groups in the area between Barrow and Fish Creek in 2010 (Table 2, Figure 5, Appendices D and E). This estimate included 18,808 adults in groups without broods, 2,679 adults in groups with broods, and 1,007 goslings. The number of adult birds was the highest recorded, and the number of groups the third-highest recorded since surveys began in 1995 (Table 2, Figure 5). The total number of goslings was the sixth-highest on record, but only slightly higher than the 15-year mean (995 goslings). The ratio of goslings to adults within brood-rearing groups was the fifth-lowest on record, with goslings comprising 27% of the total brood-rearing Brant in 2010, compared to the annual mean of 34% (Appendix F). Only 21% of all Brant groups were brood-rearing groups (i.e., goslings were present), which was the second-lowest percentage ever recorded and substantially lower than the mean of 33% brood-rearing groups over all 15 years of surveys.

The 3 years with the largest numbers of goslings were 2006, 2008, and 2004; and the 3 years with the largest numbers of adults in brood groups were 2006, 2004, and 2010 (Table 2). The brood-rearing data suggest a variable but generally increasing trend in the breeding population and productivity of Brant in the region since 1994 (Figure 5). However, the number of brood-rearing/molting adult Brant in our coastal

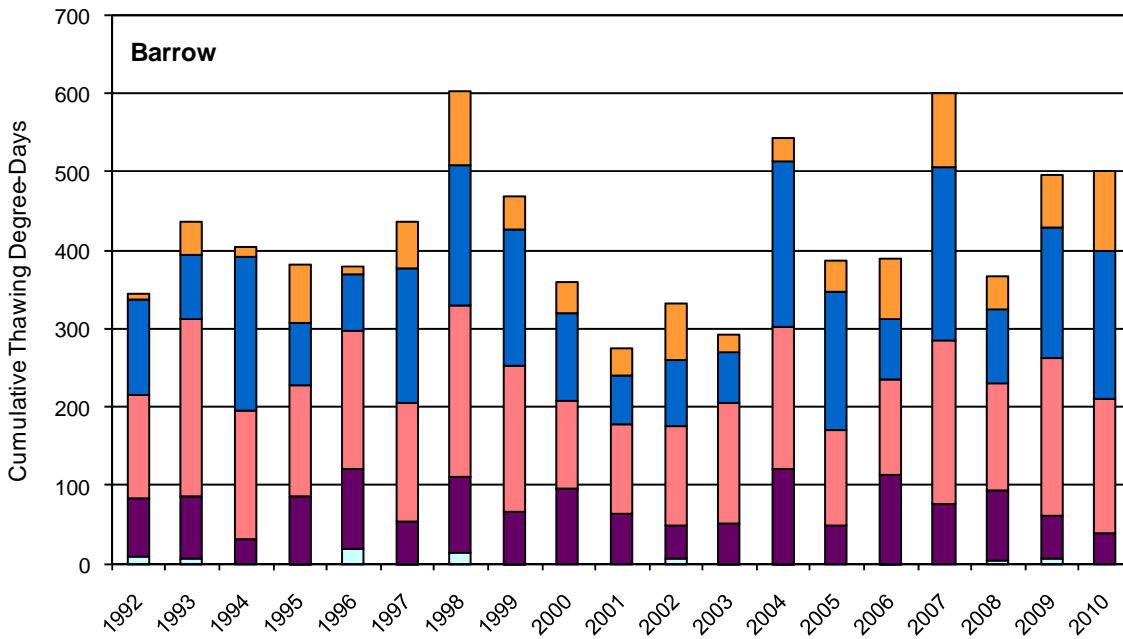
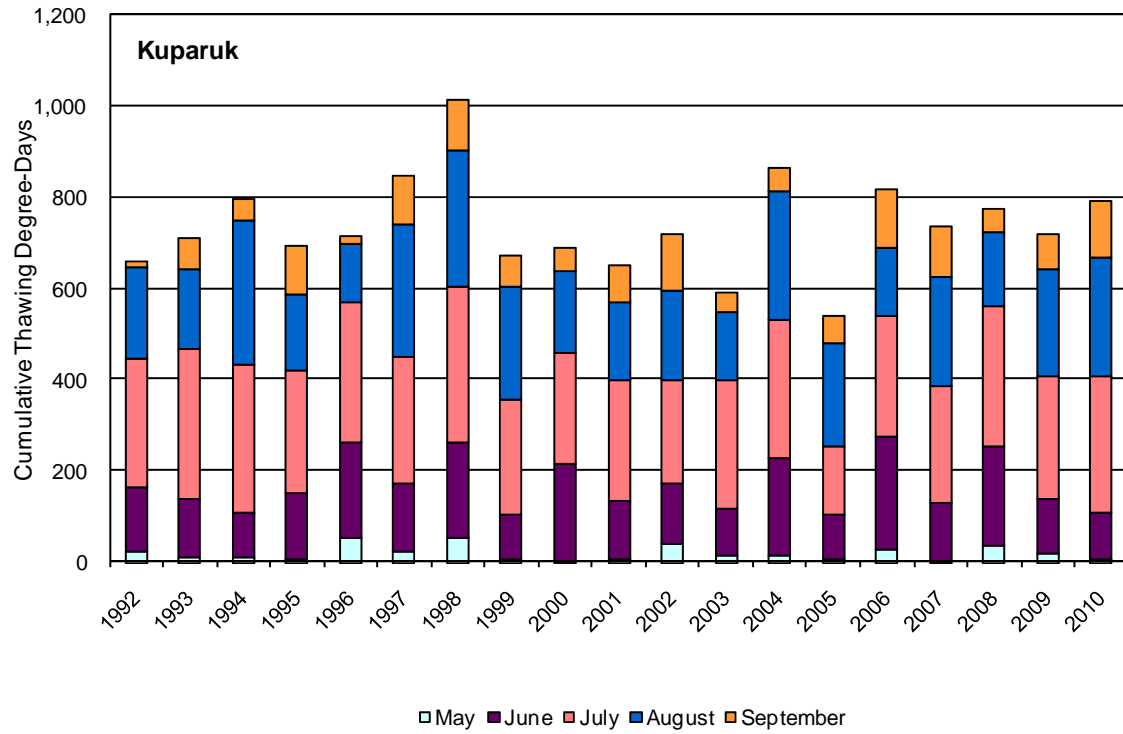


Figure 3. Thawing degree-days by month at the Barrow and Kuparuk airport meteorological stations, Alaska, 1992–2010.



Table 1. Number of Brant nests by survey section, number of monitoring colonies surveyed, and number and percent of colonies occupied, Barrow to Fish Creek, Alaska, 1994–2010.

Year	Nests			Total	Colonies		
	Dease Inlet	Smith Bay	Harrison Bay		No. Surveyed	No. Occupied	% Occupied
1994	90	44	nd <sup>a</sup>	134	21	13	61.9
1995	149	37	40	226	23	22	95.7
1996	113	38	64	215	23	15	65.2
1997	175	35	73	283	22	20	90.9
1998	147	35	72	254	23	18	78.3
1999	238	18	61	317	23	22	95.7
2000	198	47	77	322	23	22	95.7
2001	237	22	71	330	22	20	90.9
2002	161	23	43	227	23	21	91.3
2003	253	48	21	322	23	19	82.6
2004	197	75	53	325	23	21	91.3
2005	172	88	20	280	23	21	91.3
2006	215	62	41	318	23	22	95.7
2007	175	69	25	269	23	21	91.3
2008	327	49	50	426	23	23	100.0
2009	268	74	31	373	23	20	87.0
2010	262	107	58	427	23	21	91.3
<sup>b</sup> Mean	198.6	51.2	50.0 <sup>b</sup>	307.1 <sup>b</sup>	-	20	87.9
SD	60.8	24.7	19.2	64.0	-	2.6	

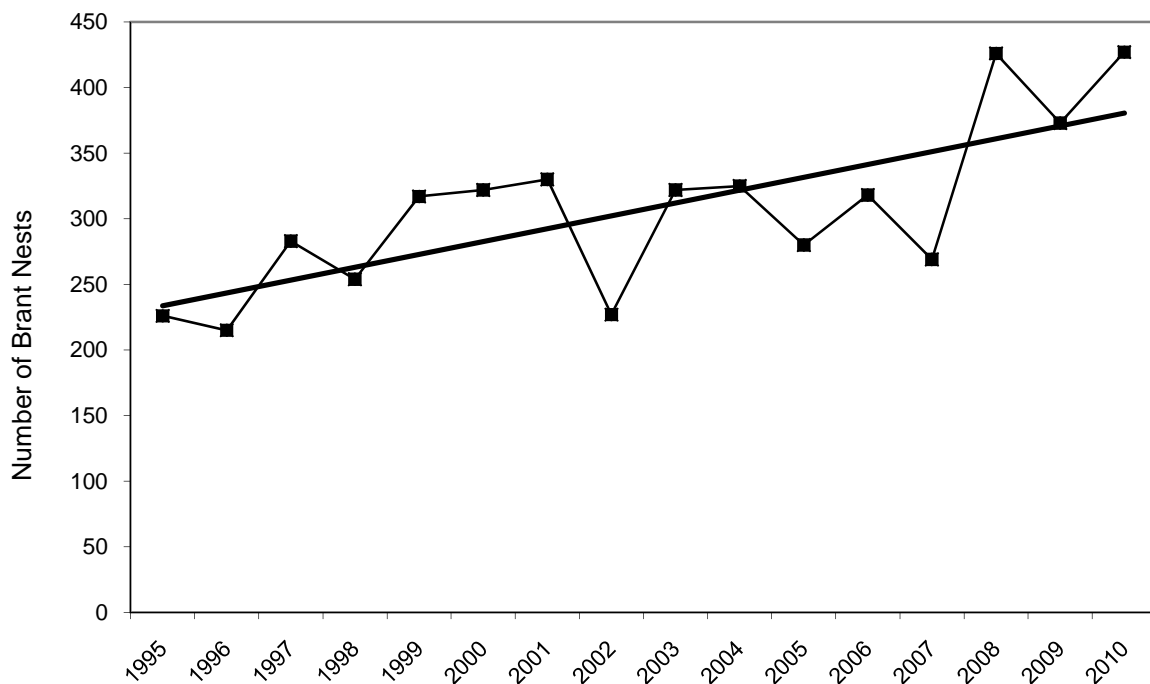
<sup>a</sup> nd = no data<sup>b</sup> Does not include 1994 data because Harrison Bay was incompletely surveyed in that year

Figure 4. Number of Brant nests in 23 monitoring colonies, 1994–2010, Barrow to Fish Creek, Alaska.

Table 2. Composition of Brant groups during brood-rearing surveys, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010.

Year	Total Groups	Brood Groups	Adults		Total Adults	Goslings	Total Birds in Brood Groups		% Goslings in Brood Groups	Total Birds	% Adults without Broods
			Without Broods	With Broods			Total in Brood Groups	Total			
1995	39	25	1,180	1,552	2,732	909	2,461	36.9	3,641	32.4	
1996	38	26	1,130	828	1,958	633	1,461	43.3	2,591	43.6	
1997	72	30	2,866	885	3,751	423	1,308	32.3	4,174	68.7	
1999	96	46	3,605	1,378	4,983	1,070	2,448	43.7	6,053	59.6	
2000	25	19	790	670	1,460	808	1,478	54.7	2,268	34.8	
2001	76	20	10,102	1,308	11,410	435	1,743	25.0	11,845	85.3	
2002	84	22	8,002	1,444	9,446	422	1,866	22.6	9,868	81.1	
2003	118	29	18,070	1,480	19,550	517	1,997	25.9	20,067	90.0	
2004	166	47	12,542	2,840	15,382	1,511	4,351	34.7	16,893	74.2	
2005	106	36	5,747	2,448	8,195	1,431	3,879	36.9	9,626	59.7	
2006	125	72	6,170	3,923	10,093	2,484	6,407	38.8	12,577	49.1	
2007	139	36	8,347	2,265	10,612	882	3,147	28.0	11,494	72.6	
2008	147	47	8,989	2,590	11,579	1,814	4,404	41.2	13,393	67.1	
2009	161	21	18,404	2,380	20,784	581	2,961	19.6	21,365	86.1	
2010	154	33	18,808	2,679	21,487	1,007	3,686	27.3	22,494	83.6	
Mean	103	34	8,317	1,911	10,228	995	2,906	34.1	11,223	65.9	
SD	47	14	6,273	908	6,712	592	1,428	9.5	6,763	18.9	



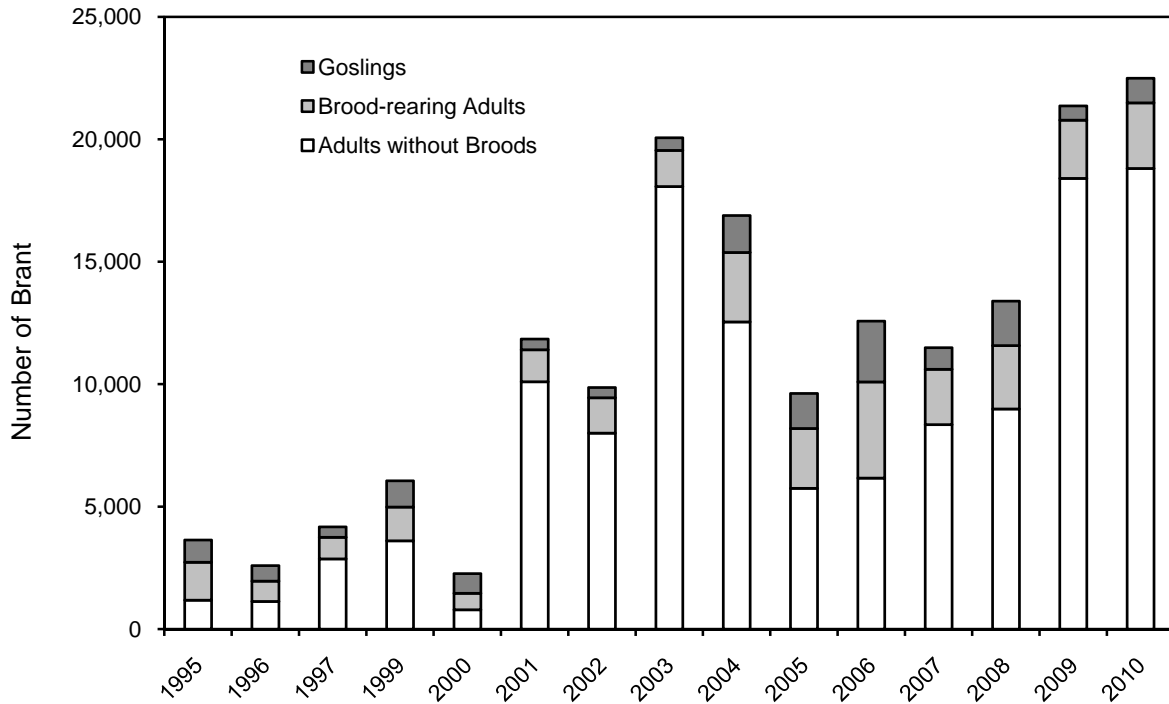


Figure 5. Numbers of adult Brant without broods, brood-rearing adult Brant, and goslings recorded during aerial surveys, Barrow to Fish Creek, Alaska, July 1995–1997 and 1999–2010.

study area appears to have increased from 2,000–5,000 prior to 2001 to 8,000–21,000 after 2001 (Table 2), primarily due to an increase in the number of adults in groups without broods (Figure 5).

The distribution of brood-rearing and molting Brant among the 3 sections of the Beaufort Sea coast varies among years. In 2010, as in most years of this study, the Harrison Bay section contained the greatest number of Brant adults and goslings (Figure 6). The proportion of Brant found in the Harrison Bay section tends to be higher in years when the total number of Brant is higher, and the increase in total numbers typically is due to an increase in the numbers of adults in groups without broods. Spikes of Brant groups without broods in the Harrison Bay section probably result from an influx to the Teshekpuk Lake molting area of non-breeding and failed breeding birds from other areas of northern and western Alaska (see discussion below). This pattern may be evident in 2010, when numbers were 149% higher in Harrison Bay than in the other 2 sections

combined, and the total number of Brant and the number of adults without broods both were the highest ever recorded.

Although we believe that our coastal brood-rearing survey provides good information on the regional abundance of breeding Brant, it must be acknowledged that brood-rearing groups of Brant are also known to use inland habitats on the North Slope (Stickney and Ritchie 1996). In most parts of the North Slope, the number of brood-rearing Brant in inland habitats appears to be relatively small. One exception to this rule, however, may be the extensive area of large lakes north and east of Teshekpuk Lake, where large numbers of Brant occur regularly during July. However, an intensive study of movements in the molting area in 2007 and 2008 indicated that most flightless adult Brant with goslings in the Teshekpuk Lake molting area moved into the outer coastal zone by late July (Lewis et al. 2010a). Our late July coastal surveys therefore should provide fairly good estimates of the locally breeding population of Brant.

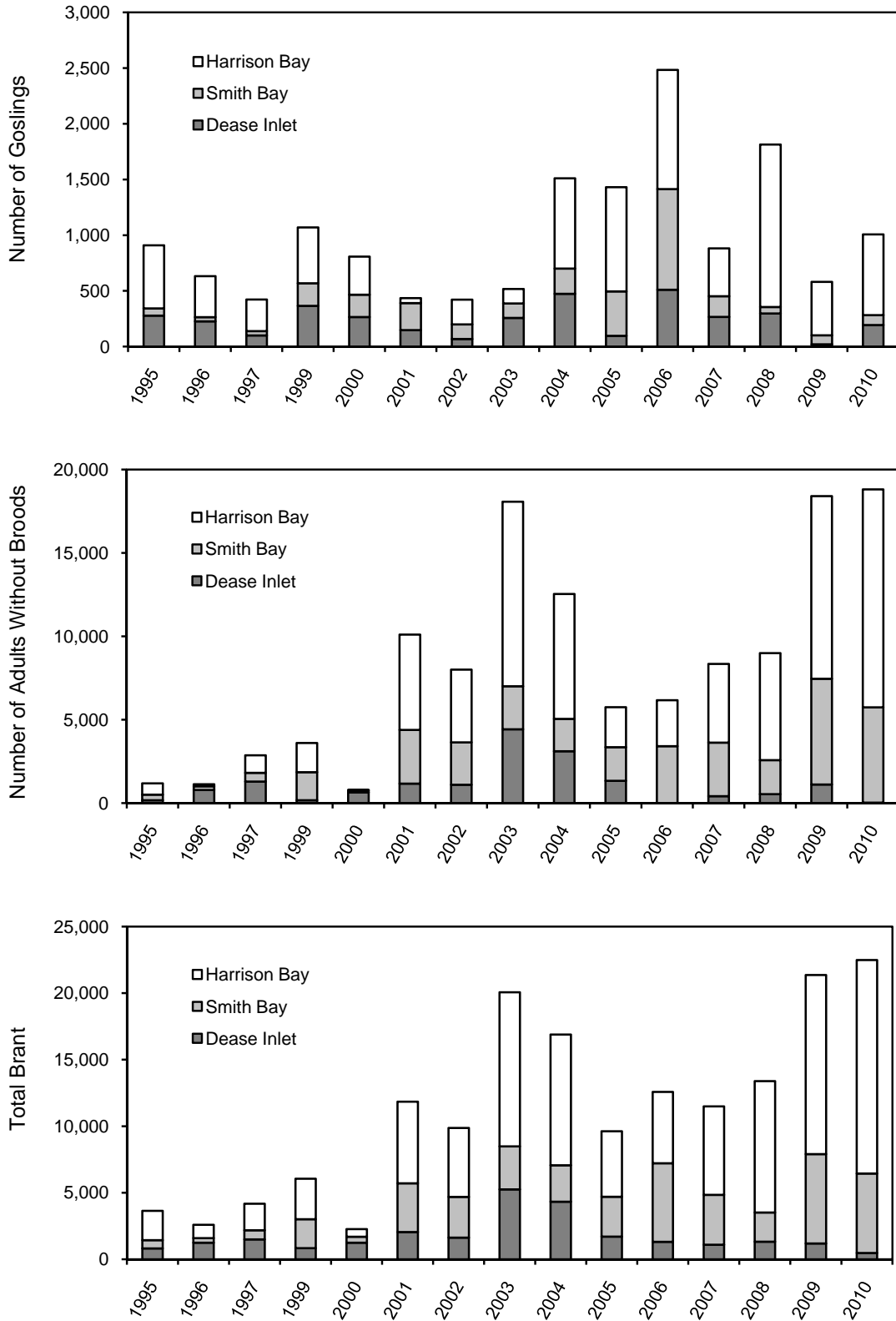


Figure 6. Distribution of Brant goslings, adults without broods, and total birds among 3 sections of the Beaufort Sea coast, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010.

Although brood-rearing groups are present in the molting area, most of the Brant in the Teshekpuk Lake area are failed and non-breeding birds that have migrated into the area from distant nesting areas, including other regions of the North Slope (Lewis et al. 2010b) as well as the Yukon-Kuskokwim Delta (hereafter, the Y-K Delta) (Derksen et al. 1979, King and Hodges 1979). On the North Slope in 2007, researchers radio-tagged Brant whose nests had failed near Barrow, Dease Inlet, and on the Colville River delta and subsequently documented many of these failed breeders in both coastal and inland portions of the Teshekpuk Lake molting area (Lewis et al. 2010b). Notably, of 19 Brant trapped at failed nests in the Colville River delta, at least 12 molted in the Teshekpuk Lake area. Of 7 failed breeders tracked from colonies near Dease Inlet and Barrow in 2007, 4 molted on inland lakes and 2 molted in coastal lakes in the Teshekpuk Lake molting area, and 1 molted in a coastal lake outside of the Teshekpuk Lake molting area.

Additional evidence suggests a molt migration to Teshekpuk Lake from the Y-K Delta. In 2003, for example, when productivity of Brant on the Y-K Delta was particularly low due to predation and flooding (C. Nicolai, Univ. of Nevada Reno, pers. comm.), we observed record numbers of Brant in our study area. A further comparison of the number of Brant nests in 5 colonies on the Y-K Delta (data from Wilson 2010) with the number of adults without young in our survey area suggests a molt migration of non- or failed-nesting Brant to coastal North Slope areas covered by our surveys. Since 1995 (the first year of our survey), the estimated total number of nests at those 5 Y-K Delta colonies has decreased at a rate of about 885 nests/yr ( $R^2 = 0.44$ ,  $P = 0.01$ ; Figure 7), while the number of molting adults in our survey area has increased by about 952 birds/yr ( $R^2 = 0.49$ ,  $P = 0.005$ ; Figure 7). We found a strong negative correlation between the annual estimate of nests on the Y-K Delta and the number of molting adults without young in our survey area (Pearson  $r = -0.82$ ,  $n = 14$ ,  $P < 0.01$ ; Figure 8). Wilson (2010) attributed variation in numbers of Brant nests on the Y-K Delta to factors such as flooding and predation.

Based on the numbers of goslings, annual productivity for Brant in our study area was highest in 2004, 2005, 2006 and 2008; lowest in 1997, 2001, 2002 and 2003 (Figure 9). Summing thawing degree-days for May through July at Barrow, the coldest years were 2005, 2002, and 2001 and the warmest years were 1998, 2004, and 1996. At Kugaruk, the coldest years were 2005, 1999, and 2007 and the warmest years were 1998, 1996, and 2008. Over the 15 years of Brant surveys, thawing degree-days in both Barrow and Kugaruk appear to correlate poorly with overall productivity of Brant in this region, except in 2006 and 2008, when warmer than average Kugaruk temperatures corresponded with high productivity, and in 2007, when colder Kugaruk temperatures corresponded with low productivity.

## SNOW GEESE

### IKPIKPUK COLONY MONITORING SURVEYS

#### Visual Aerial Survey Estimate of Nest Numbers

In 2010, Snow Geese were widely distributed across the Ikpikuk River delta as they have been since 2006. In a visual estimate from an aerial survey on 21 June, we recorded nearly 9,100 Snow Geese, comprising ~3,400 possible nesting pairs and an additional ~2,330 flying birds on numerous islands on the Ikpikuk River delta. Numbers from visual aerial estimates in 2010 were very similar to those recorded on the Ikpikuk River delta in 2009 (9,400; Ritchie et al. 2010).

#### Aerial Photographic Nest Census

The 2010 photo survey of the Ikpikuk Snow Goose colony was also conducted on 21 June in good survey conditions, with clear skies and 15–20 knot winds from the ENE. We flew 25 east–west transects that ranged from 9 to 11 km in length. We began on the outer delta north of the colony and proceeded southward, ending south of the apparent southern extent of nests. Transects extended well past the extent of nests on both the east and west sides of the colony. The photography session lasted 2 hr 42 min, and 2,059 photographs were taken over the delta (including off transect during turns). Nesting pairs of Snow Geese were easily identifiable on the photographs and nests could readily be enumerated. At least 4,769 Snow Goose

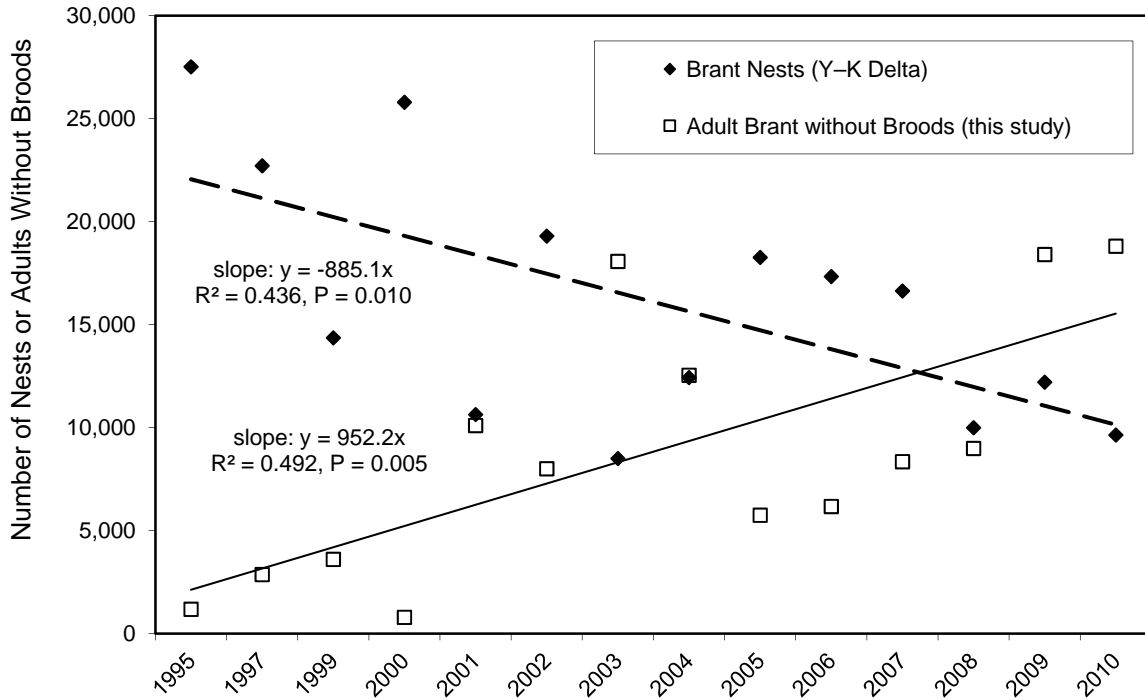


Figure 7. Estimated total number of Brant nests in 5 nesting colonies on the Yukon–Kuskokwim Delta (dashed line; from Wilson 2010) and number of adult Brant in groups without broods between Barrow and Fish Creek, Alaska, 1995, 1997, and 1999–2010 (years in which data were available from both areas).

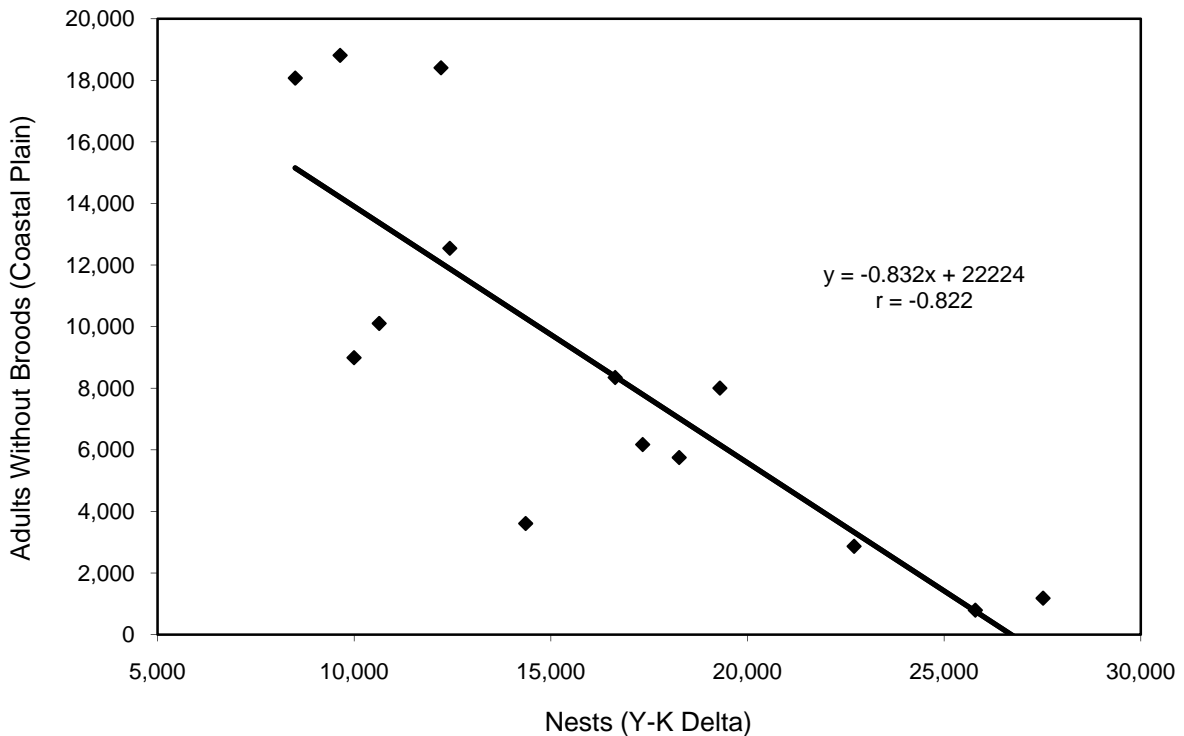


Figure 8. Correlation between the estimated total number of Brant nests in 5 nesting colonies on the Yukon–Kuskokwim Delta (Wilson 2009) and the number of adult Brant in groups without broods between Barrow and Fish Creek, Alaska, 1995, 1997, and 1999–2010 (years in which data were available from both areas).

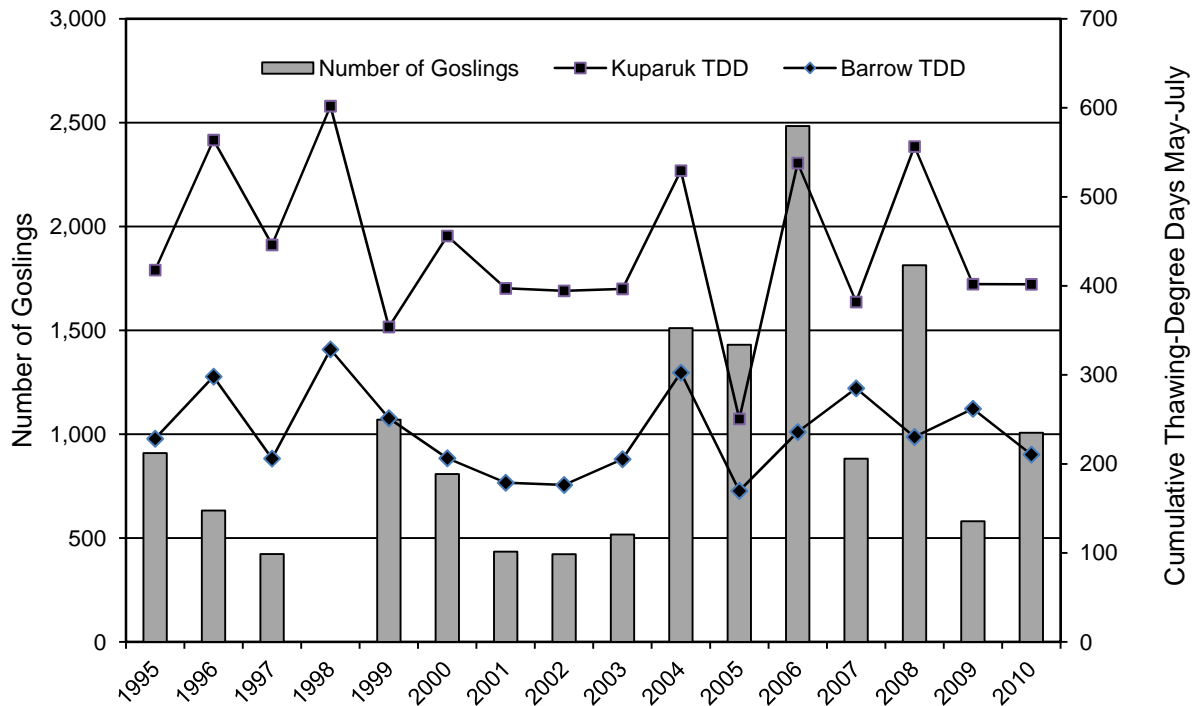


Figure 9. Number of Brant goslings between Barrow and Fish Creek and cumulative thawing-degree days (TDD) May through July at Barrow and at Kuparuk airport meteorological stations, 1995–2010.

ests were identified on aerial photographs (Table 3, Figure 10), and an additional ~2,330 flying birds were estimated during the survey flight, for an estimated total of 11,868 Snow Geese on the Ikpikuk River delta.

Photographic coverage of the Ikpikuk nesting colony was nearly 100%. The northern half of Island G (Figure 11) was inadvertently omitted from the survey transects, and narrow gaps occurred between adjacent photographs on the first 3 westbound transects due to strong easterly winds. Thereafter, we decreased the interval between photographs from 4 to 3 seconds on all westbound transects to achieve overlap between adjacent images and 100% photographic coverage of the remainder of the survey area. During the survey, Island G was visually estimated to contain 10 nests, and this estimate is included in all tables and figures in this report. Gaps between adjacent photographs in the northernmost 3 westbound transects did not appear to intersect any dense nesting areas, and we believe that the probable omission of a small number of nests had little impact on our results.

Nests were distributed widely across the entire delta in 2010 (Figure 11). Use of the western delta has decreased in recent years, and in 2010 only 13% of Snow Goose nests were located on the 5 islands with the longest history of use (i.e., Islands A–E) in the western part of the colony (Table 3; Figure 11). For the third year in a row, the largest number of nests (1,848; 39%) was located on Island F, centrally located in the Ikpikuk River delta. With increases in use in recent years, Island F now comprises the main nesting area of the colony, and increasing numbers of Snow Geese recently have nested farther inland on Islands F, L, and O, in wet sedge tundra habitats that previously seemed uncharacteristic of Snow Goose nesting habitats in the region.

#### Estimated Number of Nests from Stratified Random Sampling

Fifty-one percent (81 of 160) of the predetermined nest sampling plots were accessed by the nest fate crew in July 2010. Seventy plots were visited in the high density stratum and 11 plots were visited in the low density stratum.

Table 3. Number of Snow Goose nests by nesting island in 2010 and historical use of nesting islands in the Ikpiqpuq River delta colony, 1992–2010.

Island <sup>a</sup>	2010 Nests	Years Used	Number of Years Used
A	15	1999–2004, 2006–2010	11
B	21	1993–2010	18
C	22	1993–2010	18
D	384	1999–2010	12
E	186	1992–2010	19
F	1,848	2001, 2004–2010	8
G	10	2001, 2009–2010	3
H	12	2001, 2004, 2006, 2008–2010	6
I	36	2001, 2004, 2006, 2008–2010	6
J	838	2001, 2005–2010	7
K	119	2006, 2009–2010	3
L	663	2006–2010	5
M	26	2001, 2005–2010	7
N	144	2001, 2005–2010	7
O	422	2005–2008, 2010	5
P	0	2008	1
Q	0	2008–2009	2
R	7	2010	1
Other locations <sup>b</sup>	16	2010	
Total	4,769		

<sup>a</sup> See Figure 10

<sup>b</sup> Small numbers of Snow Geese nested peripherally to the main colony on unnamed islands in 2010

Unfortunately no zero density stratum nest plots were sampled and, for all calculations, we assumed there were no nests in the zero density stratum (Table 4; Figure 2). Of plots surveyed, only 36 plots had nests within their boundaries (31 high density plots and 5 low density plots), while the remaining 45 plots did not have nests.

Three-hundred and six nests were located within sampled plots; 268 were in high density plots (mean = 3.83 nests/plots, max = 30 nests/plot) and 38 were in low density plots (mean = 3.45 nests/plots, max = 27 nests/plot). Based on the number of nests in sampled plots we estimated that there were 5,291 nests in the low density stratum (95% C.I. = 34–12,511), 2,452 nests in the high density stratum (95% C.I. = 1,502–3,402), and a total estimate of 7,743 nests with very wide confidence intervals (95% C.I. = 462–14,988; Table 5). The large confidence intervals resulted mainly from high variability in the low density stratum which was caused by a single plot with 27

nests (the second highest total for all 81 plots). The small number of plots sampled within this stratum was inadequate to estimate a precise population, given the large variability. If that single plot was dropped from the analysis, the estimate for the low density stratum drops to 1,685 nests (95% C.I. = 14–3,356) the estimated total number of nests drops almost in half to 4,137 (95% C.I. = 2,215–6,049), closer to our visual estimate earlier in June 2010.

#### Nest Fate and Colony Success

During searches of ground plots, only 8 nests of 292 nests of known fate (2.7%) were determined to have been successful; the fate of 14 nests was recorded as unknown. Four out of 258 nests with known fates were successful (1.6%) in the high density plots and 4 out of 34 nests with known fates were successful (10.5%) in the low density plots (Table 4).



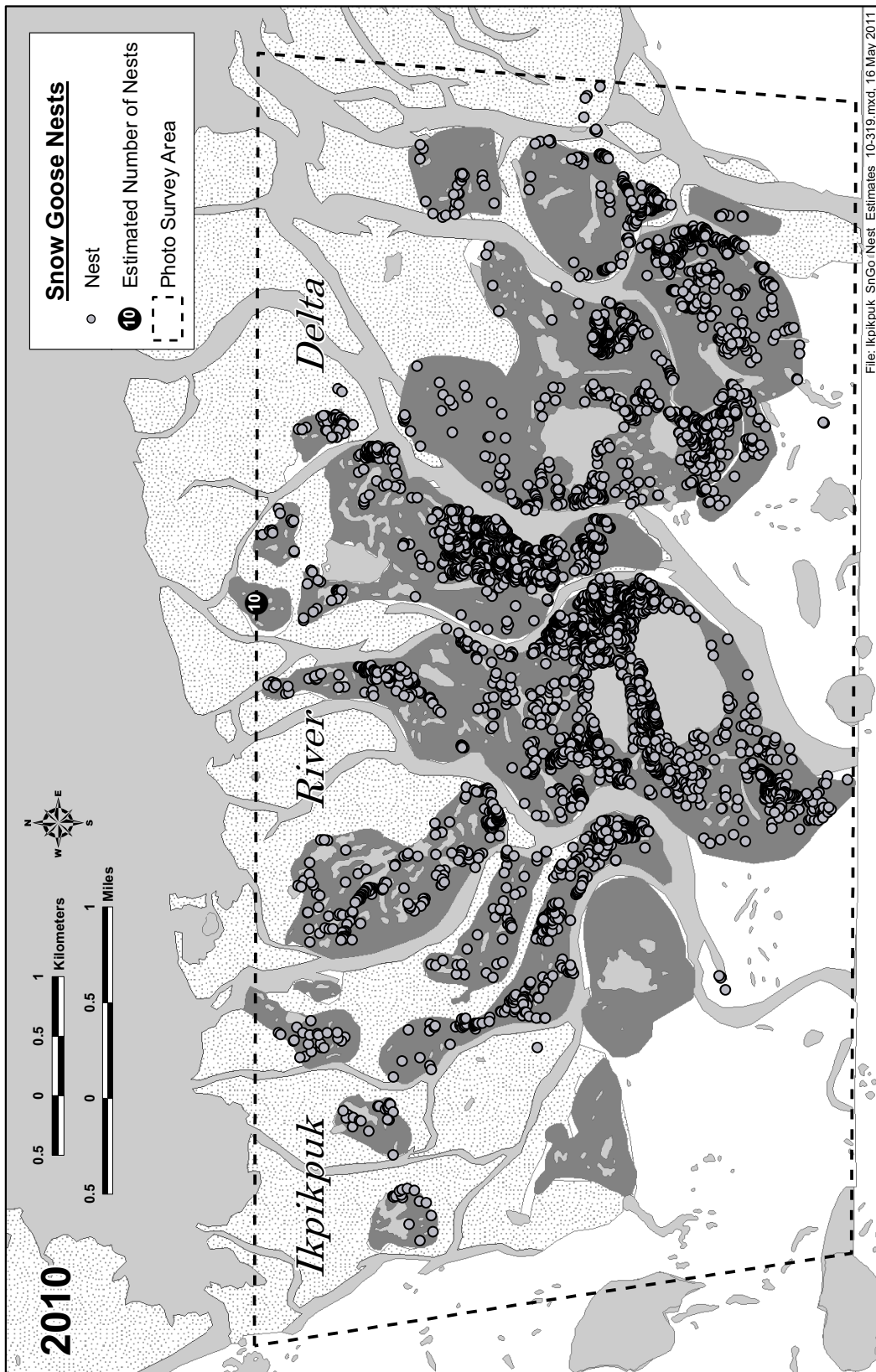


Figure 10. Distribution of Snow Goose nests from aerial photo census of the Ikpikpuk River delta, 2010.

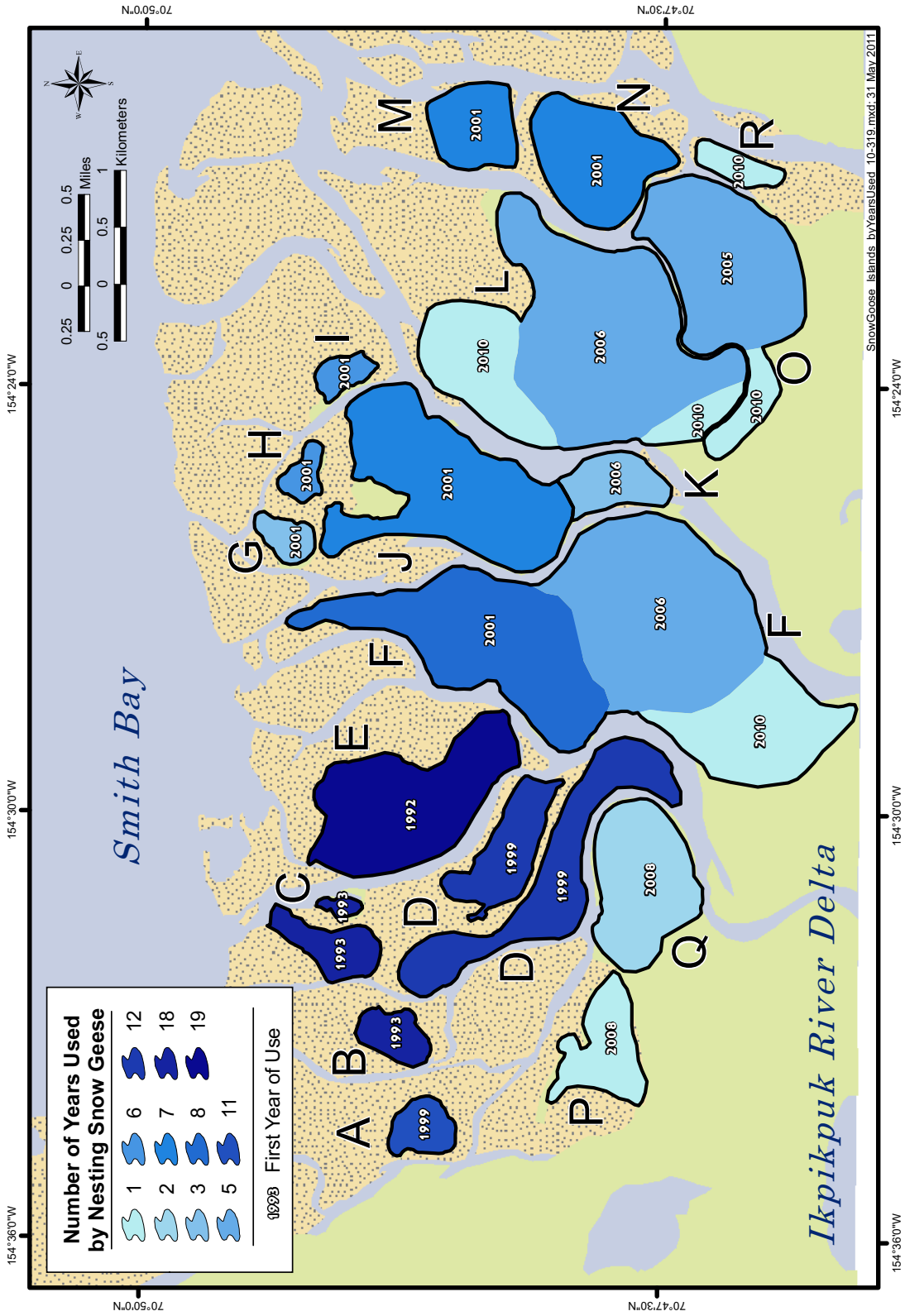


Figure 11. Number of years that each island on the Ikipkupuk River delta has been used by nesting Snow Geese and first year of use of each island, 1992–2010.

Table 4. Number of plots, search areas, number of nests, and nest fate of Snow Geese in each density stratum on the Ikpikpuk River delta, 2010.

Strata	Area (km <sup>2</sup> )	Area Searched (km <sup>2</sup> )	Number of Plots Searched	Nest Fate		
				Successful	Unsuccessful	Unknown
Low Density	12.03	0.086	11	4	30	4
High Density	5.03	0.550	70	4	254	10
Total	17.06	0.636	81	8	284	14

Table 5. Mean and 95% confidence intervals of estimated number of Snow Goose nests and nest survival, Ikpikpuk River delta, 2010.

	Strata	Mean	95% C.I.
Total Nests	Low	5,291	34–12,511
	High	2,452	1,502–3,402
	Total	7,743	462–14,988
Nest Survival (%)	Low	11.8	0–31.7
	High	1.5	0–4.3
	Total	8.5	0–22.9

Using 4,769 total nests from the 2010 photo census, we were able to assess the fate of approximately 6% of nests. Nest survival was estimated as 11.8% in the low density stratum and 1.5% in the high density stratum but the confidence interval for the low density stratum was very high due to the small number of plots in that stratum (Table 5). The overall nest survival was estimated as 8.5% but also had a large confidence interval (95% C.I. = 0–22.9). Although the nest survival rate estimate for the low density stratum is based on just 34 nests it is plausible that the survival rate would be higher in low density nesting areas than in the high density nesting areas where bear predation was likely to be concentrated.

Evidence at nest sites indicated that brown bears caused the majority of nest failures and no evidence of other avian or mammalian predators was recorded; tracks of at least 4 bears and their feces and disturbed (e.g., overturned) nests were found throughout the colony. Interestingly, 4 brown bears also destroyed most nests in the

colony in 2009 (a sow and 2 cubs and a single adult; B. Person, NSB, pers. comm.). Brood-rearing surveys, described below, also revealed a substantial decline in productivity in the Ikpikpuk colony in 2010, furthering evidence of widespread destruction of nests by bears.

Bear predation has frequently affected nesting Snow Geese in northern Alaska. In 2009, the Ikpikpuk and Kukpowruk colonies both were severely affected by brown bears (W. Larned, USFWS, pers. comm.; Ritchie et al. 2010; Appendix G). Brown bears have also eaten eggs and killed some adult Snow Geese at a colony on the outer Colville River delta (J. Helmericks, Golden Plover Air, pers. comm.). In the 1990s, the Howe Island Snow Goose colony was severely affected by brown bears and for several years Snow Geese nested in very low numbers on the Sagavanirktok River delta. Substantial brown and polar bear nest predation has been reported at Snow Goose colonies in eastern and central Arctic Canada (e.g., Rockwell and Gormezano 2009).

## BROOD-REARING SURVEYS

Brood-rearing surveys enumerated 109 molting groups and 14 brood-rearing groups of Snow Geese between Barrow and Fish Creek in 2010 (Appendix H). The 11,381 total Snow Geese in the region during brood-rearing surveys in 2010 was the fourth-highest ever recorded, but represents the second straight year of decline (Table 6, Figure 12, Appendices H and I). This estimate included 10,614 adults in groups without broods, 573 adults in groups with broods, and 194 goslings. The number of adult birds was the third-highest recorded since surveys began in 1995, but represented a decline from the previous 2 years likely owing to the lack of recruitment of second year birds due to low nest success in 2009 (Figure 12). Broods were present in only 14 groups (11%). The total number of young was slightly higher than in 2009 (also a year when the Ikpikpuk colony was largely decimated by brown bears), but was otherwise lower than in any year since 1997 when the estimated total (adults plus young) was only 620 Snow Geese. The ratio of goslings to adults in brood rearing groups was 25.3% in 2010, the second-lowest year on record (higher only than 2009), and substantially lower than the annual mean of 47.7% for 1995–2010 (Table 6, Figure 13).

As in previous years, most Snow Geese (65%) were located in the Smith Bay section (Figure 14, Appendix I); however this percentage was lower than in any year since 1997. Most of the remaining Snow Geese (34%) were found in the Harrison Bay section, with approximately 1% in the Dease Inlet section. Gosling numbers were well below average in all 3 sections in 2010, but particularly in the Smith Bay section, where the total number of goslings (143) was 7.5% of the 15-year average (Appendix I). Observations during June surveys and records of nesting in the past (Ritchie et al. 2000) suggest that although birds in all 3 sections could have originated from the nesting colony on the Ikpikpuk River delta (in the Smith Bay section), it is likely that many of the broods recorded in the Harrison Bay section originated from small colonies between Cape Halkett and Fish Creek, including those documented in recent years near the Kogru River mouth and Garry Creek (Figure 14). Although gosling numbers were well

below average in the Harrison Bay section in 2010 (33% of the 15-year mean), the decrease was modest compared to the near-total loss of production from the Ikpikpuk colony due to brown bear predation, further suggesting that broods in the Harrison Bay section originated outside the Ikpikpuk River delta colony.

The rapidly increasing population of Snow Geese in the region also has been documented by the Teshekpuk Lake molting goose surveys, which have been conducted annually since 1982 (Mallek 2011). Numbers of molting Snow Geese (goslings not included) first exceeded 500 geese in 1997, 1,000 in 1999, and 2,000 in 2001. Numbers continued to increase from 2003–2009, breaking 4,000 in 2006, and exceeding 6,000 in 2007 and 2009. Numbers were the third highest on record (5,468) in 2010 (Mallek 2011). While these numbers parallel increases in the number of breeding Snow Geese in local colonies, it is unknown whether these large numbers of molting Snow Geese are associated with the local breeding colonies, and unknown numbers of failed breeders or non-breeding Snow Geese may migrate into the Teshekpuk area from colonies farther afield, as has been demonstrated for Brant and other geese in the region, perhaps including birds associated with Canadian or Russian colonies.

We identified 13 adult blue-phase geese on photos of brood-rearing Snow Geese in 2010, representing 4.2% of all adult Snow Geese in these photos. Blue-phase Snow Geese in the groups we have captured for banding have ranged from 1–5% of total birds since 2000 (Ritchie 2001; Ritchie et al. 2002, 2004, 2006, 2007, 2008a, 2011; Ritchie and Shook 2003, 2005). Prior to rapid growth of the Ikpikpuk colony, blue-phase Snow Geese rarely were observed in northern Alaska (<1% on Howe Island, Johnson and Troy 1987; also Ritchie et al. 2000) and blue-phase geese represent only a small percentage (<0.5%) of the nearest mainland Snow Goose colonies in western Canada (J. Hines, CWS, pers. comm.). In contrast, blue-phase Snow Geese are much more common in nesting colonies in the eastern Canadian arctic (Dzubin 1979). The higher percentage of blue-phase geese in our study area suggests the possibility of immigration from such colonies in eastern Canada or a “founder effect” (e.g., resulting from a handful of blue-phase

Table 6. Composition of Snow Goose groups during brood-rearing surveys, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010.

Year	Total Groups	Brood Groups	Adults Without Broods	Adults With Broods	Total Adults	Goslings	Total Birds in Brood Groups	% Goslings in Brood Groups	Total Birds
1995	13	13	0	198	198	232	430	54.0	430
1996	7	4	107	63	170	85	148	57.4	255
1997	22	10	384	98	482	138	236	58.5	620
1999	31	23	278	515	793	624	1,139	54.8	1,417
2000	42	29	485	623	1,108	910	1,533	59.4	2,018
2001	31	19	422	352	774	241	593	40.6	1,015
2002	37	27	115	1,591	1,706	1,150	2,741	42.0	2,856
2003	48	44	38	1,952	1,990	2,210	4,162	53.1	4,200
2004	69	50	1,062	2,644	3,706	3,456	6,100	56.7	7,162
2005	74	43	2,995	1,513	4,508	1,331	2,844	46.8	5,839
2006	152	143	211	7,590	7,801	8,744	16,334	53.5	16,545
2007	119	83	2,095	4,089	6,184	3,454	7,543	45.8	9,638
2008	279	206	3,591	9,355	12,946	8,306	17,661	47.0	21,252
2009	162	20	14,509	607	15,116	155	762	20.3	15,271
2010	123	14	10,614	573	11,187	194	767	25.3	11,381
Mean	81	49	2,460	2,118	4,578	2,082	4,200	47.7	6,660
SD	74	56	4,313	2,825	4,998	2,850	5,648	11.7	6,733

individuals being present during the founding of the Ikpikpuk colony). A blue-phase goose was recorded in Smith Bay as early as 1981 when the Ikpikpuk colony probably comprised fewer than 50 pairs (Johnson and Troy 1987).

#### SNOW GOOSE BANDING AND BAND RETURNS

No Snow Geese were banded on the Ikpikpuk River delta in 2010 due to the almost complete destruction of the colony by brown bears and the consequent lack of production. However, we did band Snow Geese on the Colville and Sagavanirktok River deltas, where brood-rearing groups were more numerous.

We banded Snow Geese at 2 sites on the Colville River delta on 31 July and 1 August: Kalubik Creek (east of the Colville River delta) and the north-central Colville River delta (Appendix J). High winds (30–50 km/h) forced the cancellation of a third day of banding. We captured 1,160 geese consisting of 570 adults, 590 goslings, and 1 goose of unknown (unrecorded) age. Approximately equal numbers of males and

females were banded and 10 adults and 10 goslings were blue phase birds (Table 7). Among geese captured in 2010, 77 adults (6.6%) had been banded in previous years (hereafter referred to as recaptures). No bird was handled more than once in 2010 and none of the recaptured birds at the Colville River delta were blue phase. Of the 77 adult recaptures, 69 were originally banded on the Colville River delta (63 in 2008 by Ritchie et al. [2009] and 6 in 2001 by Noel et al. [2002]). Four birds captured on the Colville River delta in 2010 were previously banded on the Sagavanirktok River delta in 2008 (Ritchie et al. 2008) and 3 were banded on Banks Island in the Northwest Territories (Appendix J). One additional recaptured goose was banded in Alaska, but complete banding information was not available from the Bird Banding Lab at the time this report was prepared.

We also banded Snow Geese at 9 sites on the Sagavanirktok River delta and 2 sites on the Kadleroshilik River delta from 1 to 4 August (Appendix J). We captured 1,802 Snow Geese consisting of 1,081 adults, 717 goslings, and 4 geese of unknown age. Approximately equal

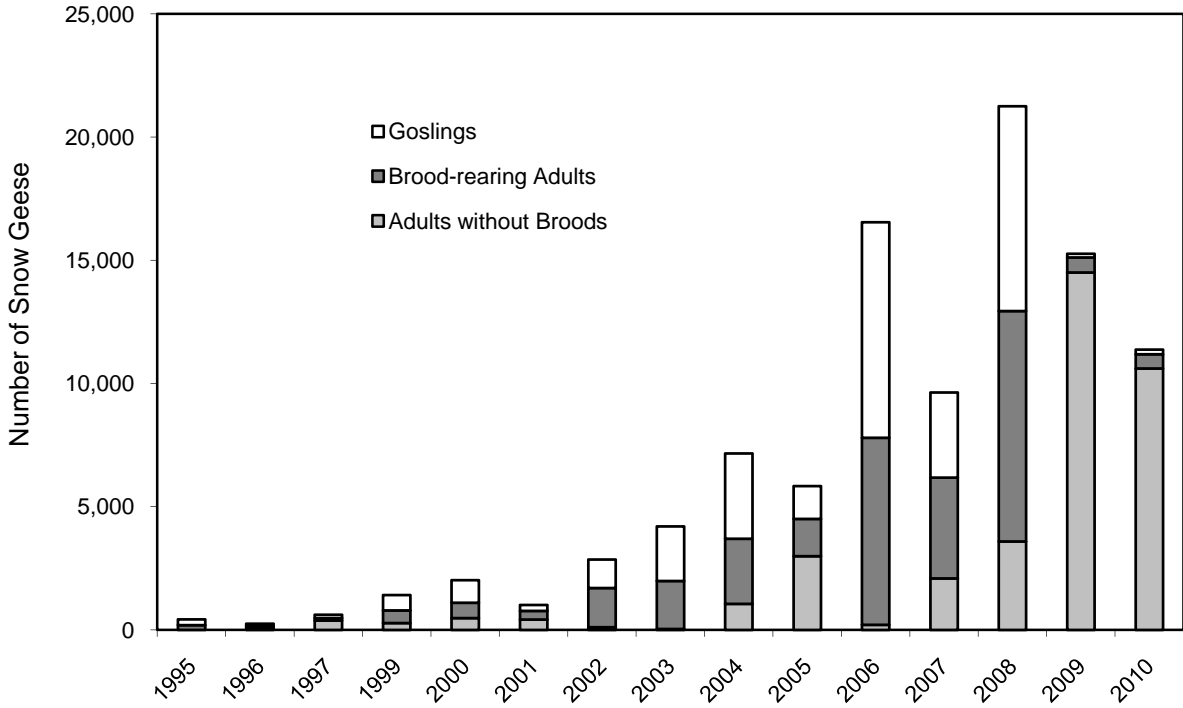


Figure 12. Numbers of adult Snow Geese without broods, brood-rearing adult Snow Geese, and goslings recorded during aerial surveys, Barrow to Fish Creek, Alaska, July 1995–1997 and 1999–2010.

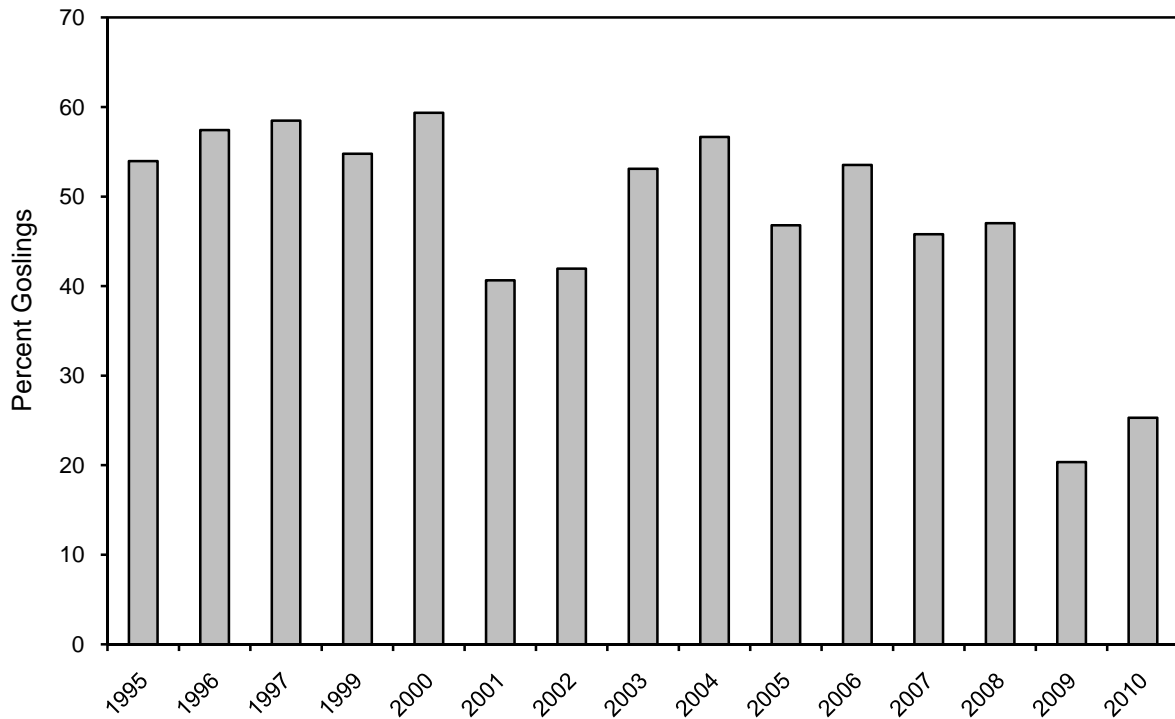


Figure 13. Percent goslings in Snow Goose brood-rearing groups, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010.

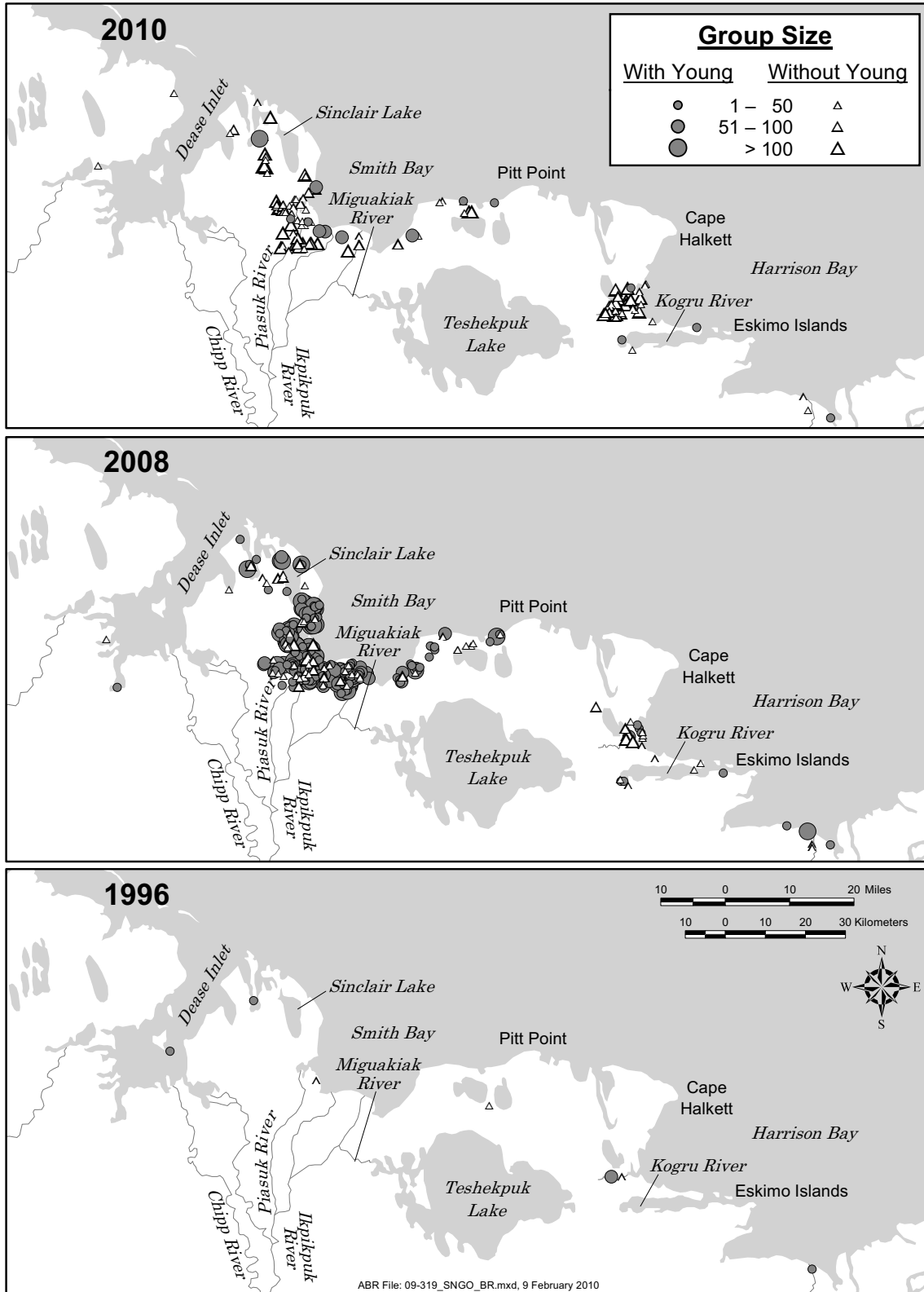


Figure 14. Distribution of Snow Goose brood-rearing groups and groups without young, Barrow to Fish Creek, Alaska, 1996 (when no nests were located at the Ikpikpuk colony), 2008 (when record numbers of nests were recorded at the Ikpikpuk colony), and 2010.

Table 7. Summary of age, sex, and color phase of Snow Geese banded or recaptured at 2 sites on the Colville River delta, Alaska, 31 July and 1 August 2010.

Location	Color phase	New bands <sup>a</sup>						Recaptures			Foreign recaptures <sup>b</sup>		
		Adults		Goslings		Adults		Adults		Adults		Adults	
		Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
Kalubik Creek #2	White	97	114	211	112	94	206	29	18	47	8	3	11
	Blue	3	1	4	1	-	1	-	-	-	-	-	-
	Subtotal	100	115	215	113	94	207	29	18	47	8	3	11
North Central Colville delta	White	132	138	270	173	200	373	11	5	16	0	2	2
	Blue	2	4	6	7	2	9	-	-	-	-	-	-
	Subtotal	134	142	276	180	202	382	11	5	16	0	2	2
Total		234	257	491	293	296	589	40	23	63	8	5	13

<sup>a</sup> Does not include 2 birds of unknown sex and 1 bird of unknown age and sex<sup>b</sup> Foreign recaptures are birds banded by someone other than ABR but recaptured during ABR banding operations; exclude 1 goose of unknown age and sex banded in Alaska



numbers of males and females were banded and 9 adults and 8 goslings were blue phase birds (Table 8). One of the blue phase birds was a recapture. Excluding geese (7 adults and 1 gosling) that were handled multiple times in 2010 (because they mixed with larger unbanded groups after release), 136 birds were recaptures (7.4%); 127 of these were birds banded by ABR on the Arctic Coastal Plain, 118 on the Sagavanirktok River delta in 2008 and 8 on the Ikpikpuk River delta prior to 2010. Nine were recaptures not originally banded by ABR: 6 banded on Banks Island in the Northwest Territories, 1 banded in Coral Harbor, Nunavut (a blue goose), and 2 banded on the Sagavanirktok River delta (1 in 1993 and another in 2001) (Appendix K). At the time this report was prepared, complete banding information was not available from the Bird Banding Lab for several birds listed here and for 1 bird, an apparent foreign recapture that is not listed here pending corrected data reports from the banding lab. More detailed information on banding in the Sagavanirktok River delta can be found in Stickney et al. (2011).

Since banding began in 2000, we have recaptured 1,031 Snow Geese which represents 7.6% of 13,545 Snow Geese processed during our banding operations on the Arctic Coastal Plain. These recaptures included 32 birds originally banded in Northwest Territories, 3 banded in Nunavut, 1 banded in Manitoba, 8 banded in Russia, and 987 birds banded by us and recaptured at our banding stations on the Arctic Coastal Plain (including 11 banded on the Colville River delta [prior to 2008] and 14 banded near the Sagavanirktok River delta [prior to 2000]; Appendix K).

After 9 years of banding activities, some evidence is emerging of the level of exchange among regional breeding populations of Snow Geese on the Arctic Coastal Plain (Table 9). Eight birds originally banded on the Ikpikpuk/Piasuk River deltas were recaptured on the Sagavanirktok/Kadleroshilik deltas and 1 was recaptured on the Colville River delta. To date, none of the birds captured on the Colville or Sagavanirktok River deltas have been recaptured on the Ikpikpuk delta, but 4 birds banded on the Sagavanirktok were recaptured on the Colville, and 1 bird banded on the Colville was recaptured on the Sagavanirktok. Additional evidence of

mixing among all 3 regional populations is provided by recaptures of birds banded by LGL: 2 birds originally banded on the Sagavanirktok/Kadleroshilik deltas (Johnson 2000) were recaptured on the Ikpikpuk and 4 were recaptured on the Colville delta; and 1 bird banded on the Colville (Noel et al. 2002) was recaptured in the Sagavanirktok/Kadleroshilik deltas.

Snow Geese are known to have strong female biased natal philopatry (Cooke et al. 1975). Among the 20,604 Snow Geese of known sex that were banded on the Arctic Coastal Plain between 1980 and 2010 (including this study, Johnson 2000, and Noel et al. 2002), 51% were female. Among Snow Geese banded and then recaptured by ABR on the Arctic Coastal Plain, 651 (65.9% of known sex birds) were females and 337 were males (Table 9). We used a chi-square test of independence and Fisher's exact significance test to determine if the sex ratio of recaptured birds differed from the sex ratio of birds banded for each colony. We limited our analysis to birds that were recaptured in the same colony where they were initially banded and to birds banded by ABR. For each colony, we calculated the total number of birds of each sex that were banded in all years except the most recent year of banding. We excluded the most recent year because birds banded in the most recent year could not be recaptured. We compared these totals to the numbers of birds of each sex that were recaptured in each colony in subsequent years (Appendix L). In each of the 3 colonies, the sex ratio of banded birds was close to 50:50 but with slightly more females than males (Appendix L). The sex ratio changed significantly between banding and recapture on the Ikpikpuk River delta ( $P < 0.001$ ) and the Sagavanirktok River delta ( $P = 0.007$ ), but the difference was not significantly different from zero in the Colville River delta ( $P = 0.085$ ).

No banding has been conducted in the Kukpowruk River delta, the westernmost breeding population on the Arctic Coastal Plain and it remains unclear whether Snow Geese nesting on the Arctic Coastal Plain of Alaska are part of one regional breeding population or several separate ones.

We also continue to acquire and summarize data on band returns from banding activities during 2000–2008 and 2010. As of 31 December 2010, band returns from all 3 banding locations

Table 8. Summary of age, sex, and color phase of Snow Geese banded or recaptured at 11 sites in the Sagavanirktok River delta, Alaska, 1–4 August 2010.

Location	Color Phase	New bands <sup>a</sup>						Recaptures <sup>b</sup>						Foreign recaptures <sup>c</sup>		
		Adults			Goslings			Adults			Adults			Adults		
		Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total
West Howe Island	White	31	36	67	61	49	110	22	13	35	-	-	-	-	-	-
	Blue	1	2	3	2	3	5	1	0	1	-	-	-	-	-	-
	Subtotal	32	38	70	63	52	115	23	13	36	-	-	-	-	-	-
Endicott Road East #1	White	17	13	30	13	10	23	4	4	8	-	-	-	-	-	-
Endicott Road East #2	White	81	93	174	86	77	163	16	8	24	-	-	-	-	-	-
	Blue	1	1	2	0	2	2	-	-	-	-	-	-	-	-	-
	Subtotal	82	94	176	86	79	165	16	8	24	-	-	-	-	-	-
Endicott Road East #3	White	99	101	200	14	12	26	7	4	11	1	1	2	-	-	-
Endicott Road North	White	29	34	63	40	44	84	4	3	7	-	-	-	-	-	-
	Blue	-	-	-	1	0	1	-	-	-	-	-	-	-	-	-
	Subtotal	29	34	63	41	44	85	4	3	7	-	-	-	-	-	-
Central Delta #1	White	27	34	61	30	31	61	4	3	7	-	-	-	-	-	-
Sag North Delta	White	40	39	79	36	24	60	5	3	8	0	1	1	-	-	-
	Blue	0	2	2	-	-	-	-	-	-	0	1	1	-	-	-
	Subtotal	40	41	81	36	24	60	5	3	8	0	2	2	-	-	-
Foggy Island	White	29	29	58	35	17	52	1	1	2	-	-	-	-	-	-
East Dock	White	9	12	21	20	14	34	3	1	4	-	-	-	-	-	-
Kadleroshilik Delta East	White	70	64	134	31	31	62	8	5	13	1	2	3	-	-	-
	Blue	1	0	1	-	-	-	-	-	-	-	-	-	-	-	-
	Subtotal	71	64	135	31	31	62	8	5	13	1	2	3	-	-	-
Kadleroshilik Delta North	White	25	25	50	17	17	34	4	2	6	0	1	1	-	-	-
Total		460	485	945	386	331	717	79	47	126	2	6	8	-	-	-

<sup>a</sup> Does not include 3 birds of unknown age and sex and 1 male of unknown age

<sup>b</sup> Recaptures exclude 8 geese that were captured or recaptured twice during banding operations (total of 10 recaptures); also excludes 1 bird banded by ABR but awaiting corrected data from the banding lab

<sup>c</sup> Foreign recaptures are birds banded by someone other than ABR but recaptured during ABR banding operations; excludes 1 goose of unknown sex banded in NWT and 2 geese banded in NWT and Alaska but awaiting corrected data from the banding lab

Table 9. North Slope recaptures of Snow Geese originally banded by ABR at the Ikpikpuk/Piasuk River delta (2000–2003 and 2005–2008), the Colville River delta (2008 and 2010), and the Sagavanirktok/Kadleroshilik River deltas (2008 and 2010) and of Snow Geese originally banded by LGL at the Colville River delta (2001) and the Sagavanirktok/Kadleroshilik River deltas (1980–1993).

Banding Location	Total Banded <sup>a</sup>		Recapture Location						
	Female	Male	Ikpikpuk/Piasuk deltas		Colville delta		Sagavanirktok/Kadleroshilik deltas		
			Female	Male	Female	Male	Female	Male	
Banded by ABR (2000–2010)									
Ikpikpuk/Piasuk deltas	4,197	3,985	514	244	0	1	5	3	
Colville delta	886	895	0	0	39	23	1	0	
Sagavanirktok/Kadleroshilik deltas	1,277	1,240	0	0	2	2	80	46	
Banded by LGL (recaptures include birds banded 1989–2001)									
Colville delta (2001) <sup>b</sup>	36	34	0	0	0	11	1	0	
Sagavanirktok/Kadleroshilik deltas (1980–1993) <sup>c</sup>	4,072	3,982	0	2	2	2	7	3	

<sup>a</sup> excludes birds of unknown sex

<sup>b</sup> see Johnson (2000)

<sup>c</sup> see Noel et al. (2002)

(Ikpikpuk, Sagavanirktok, and Colville) have been reported by the USGS Bird Banding Laboratory from 24 of the lower 48 states (744), from 5 Canadian provinces (294), from Alaska (33), from 5 states of Mexico (17), and from Russia (2) (Table 10, Figure 15). Forty-four of the Snow Geese that we captured were previously banded by others outside of Alaska: 32 were banded in the NWT, 8 on Wrangel Island (Russia), 3 in Nunavut, and 1 in Manitoba (Appendix K). The distribution of returns and recaptures suggests wide-ranging wintering areas and migratory routes generally similar to those reported for Snow Geese banded 1980–1990 on the Sagavanirktok River delta (Johnson 1996) and Western Arctic Snow Geese in Canada (Kerbes et al. 1999). However, a fairly large number of band returns from Snow Geese banded since 2000 on the Ikpikpuk River delta were peripheral to or east of the main loci for wintering and spring use areas of the earlier Sagavanirktok River delta birds and the Western Arctic Snow Goose population. Some of these locations include Arkansas (26 geese), Illinois (2), Kansas (16), Kentucky (2), Louisiana (6), Mississippi (1), Manitoba (3), and Nunavut (1; Appendix M). Although there is a fair amount of mixing between populations, particularly for male birds, these eastern states and provinces are in the primary migration routes and wintering areas used by the Central- and Eastern-Canadian Arctic breeding populations of Lesser Snow Geese (Bellrose 1976, Francis and Cooke 1992).

A total of 908 of 8,197 (11.1%) the bands we placed on Snow Geese on the Ikpikpuk River delta have been recovered since 2000 (through 31 December 2010) (Table 11). All but 5 recoveries have been hunter killed birds or birds otherwise reported dead. Four recoveries were of birds banded by us that were recaptured and released alive during banding operations at other colonies (see below). One was an injured bird caught in 2008 that was later released alive. The largest number of band recoveries occurred in 2008 (183) and the smallest number in 2001 (12). Over all years, 60.5% of bands were placed on birds that were captured as goslings (or known-age birds); 67.0% of band recoveries were from birds that were banded as goslings; and 6.5% of birds banded as goslings were reported dead within 1 year of banding (Table 11). Overall recovery rates ranged

from 8.2% for birds banded in 2008 (2 years ago, no banding was conducted in 2009) to 18.1% for birds banded in 2000; the average return rate over all years was 11.1%. The oldest known-age bird (i.e., banded as a gosling) was 8 years old when the band was returned, but the oldest unknown age bird was at least 9 years old when the band was returned.

Most band returns are from fall migration (defined by the banding lab as September and October) and wintering (November through February) areas (Table 12). Of 1,090 total band returns from the 3 banding locations (through 31 December 2010), 60.0% were in winter (654) and 22.7% in fall (247). All but 14 of these fall and winter recoveries were hunter returns; 13 of the remaining recoveries were described as “found dead,” “dog kill,” “collected,” or “car-killed.” Just one winter recovery, an injured bird found in Texas, was reported alive. Half of all fall and winter recoveries have come from California (450 of 901 558 fall/winter returns). The remaining fall and winter recoveries were distributed across Canada (255; Alberta, Saskatchewan, Manitoba, and Northwest Territories), Mexico (16 fall/winter returns; Chihuahua, Durango, Sonora, and Tamaulipas), and 23 of the other lower 48 states (excluding California, 180 fall/winter returns; Figure 15).

There also have been 186 spring (March through May) and summer (June through August) bands reported of Snow Geese marked from our 3 banding locations on the Arctic Coastal Plain (Table 12); most of these were also hunter kills, and all but 8 were reported as dead. Twenty-nine of 31 spring and summer records from Alaska were hunter kills (14 from Barrow, 1 from Ikpikpuk River delta, and the rest from 7 other locations in northern Alaska). Twenty-six of the 33 spring and summer records from Canada were hunter kills (15 from Northwest Territories, 1 from Nunavut, 7 from Saskatchewan, 2 from Manitoba, and 1 from Alberta). Ninety-six of 100 spring and summer recoveries from the lower 48 states were hunter kills; the 1 spring/summer record from Mexico was a bird that was found dead. A total of 7 Snow Geese banded on the Ikpikpuk River delta in 2003 were recaptured, processed, and released during banding activities at other Snow Geese colonies: 5 on Banks Island (3 females and 1 male, all banded

Table 10. Band returns (through 31 December 2010) by season, region, and year, from Snow Geese banded in the Ikpiqpuk River delta region, Alaska, 2000–2008.<sup>a</sup>

Season Region	Year of Band Return <sup>b</sup>												
	2000	2001	2002	2003	2004 <sup>c</sup>	2005	2006	2007	2008	2009 <sup>e</sup>	2010 <sup>e</sup>	Total	
Fall <sup>d</sup>													
Canada	6	2	7	23	4	13	25	21	39	6	7	153	
Lower 48	–	–	–	1	1	–	–	–	2	5	1	10	
Subtotal	6	2	7	24	5	13	25	21	41	11	8	163	
Winter <sup>d</sup>													
Canada	1	–	–	–	–	3	–	6	3	–	–	13	
Lower 48	9	4	24	45	29	59	99	105	109	54	11	548	
Mexico	–	2	–	3	–	1	2	4	–	2	–	14	
Subtotal	10	6	24	48	29	63	101	115	112	56	11	575	
Spring <sup>d</sup>													
Alaska	–	–	–	2	1	6	–	4	3	3	6	25	
Canada	–	–	–	1	2	1	3	3	1	9	4	24	
Lower 48	–	3	3	6	4	2	13	18	24	18	9	100	
Mexico	–	–	–	–	–	1	–	–	–	–	–	1	
Subtotal	–	3	3	9	7	10	16	25	28	30	19	150	
Summer <sup>d</sup>													
Alaska	–	1	–	–	1	–	–	1	1	2	–	6	
Canada	–	–	–	–	1	1	–	6	1	–	–	9	
Russia	–	–	–	–	1	1	–	–	–	–	–	2	
Subtotal	–	1	–	–	3	2	–	7	2	2	–	17	
Season unknown <sup>d</sup>													
Canada	–	–	–	–	–	–	–	–	–	1	–	1	
Lower 48	–	–	–	–	–	–	1	–	–	1	–	2	
Subtotal	–	–	–	–	–	–	1	–	–	2	–	3	
Total	16	12	34	81	44	88	143	168	183	101	38	908	

<sup>a</sup> Numbers may differ from previous annual reports (e.g., Ritchie et al. 2011) due to more accurate date allocation.

<sup>b</sup> Year of band return is defined as March–February and records may have a different calendar year than the year listed in this table.

<sup>c</sup> No banding occurred in 2004, 2009, or 2010.

<sup>d</sup> Fall = September and October; winter = November through February; spring = March through May; and summer = June through August. Returns with dates reported as “hunting season” by the Bird Banding Laboratory were assigned approximate dates based on hunting season dates in the reported state; those with postmarked or unknown date: were listed as “Season unknown” and listed under the postmark year.

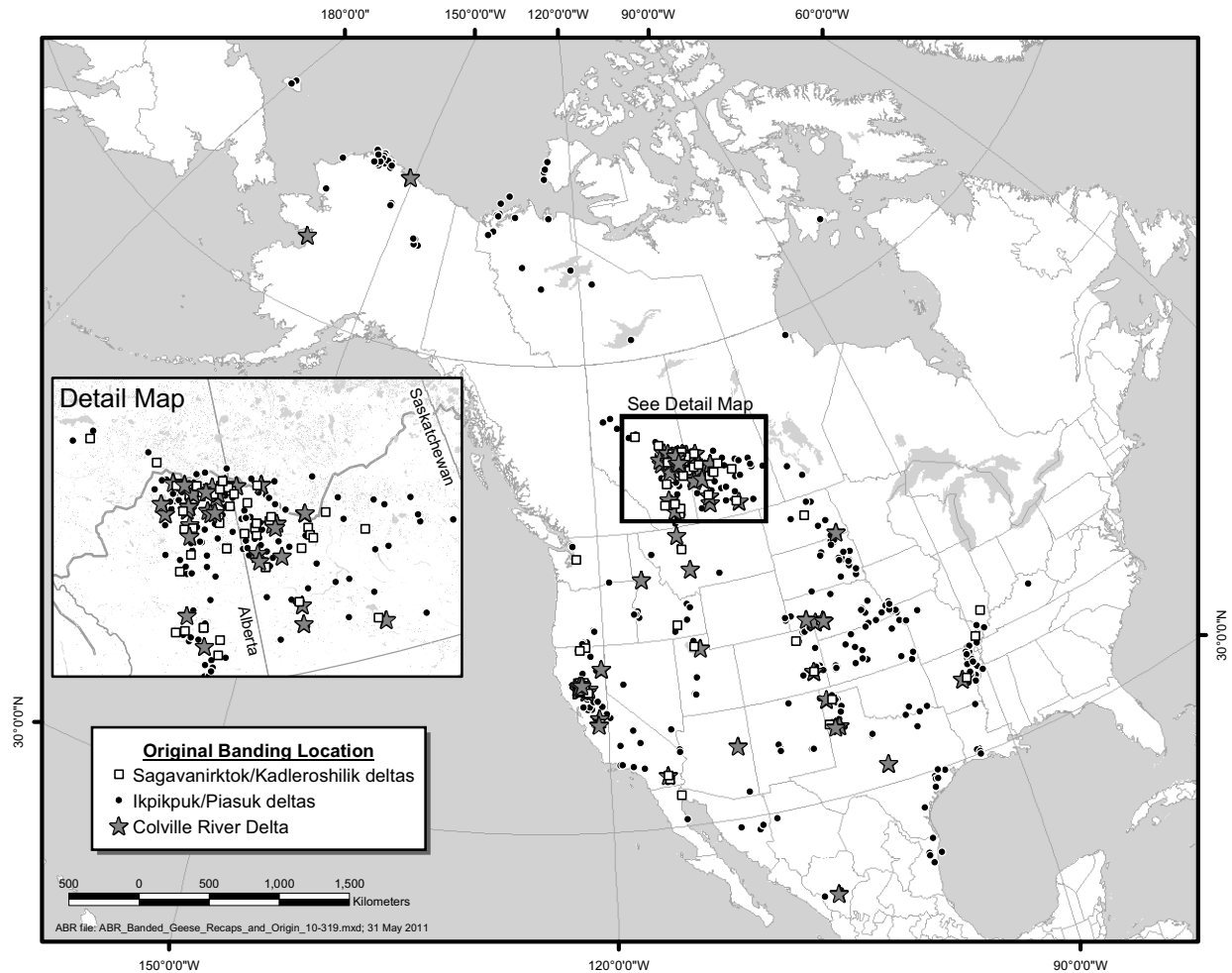


Figure 15. Locations of band recoveries from Snow Geese banded on the Colville River delta and the Sagavanirktok River delta in 2008, and the Ikpikpuk River delta, 2000–2010.

as goslings) and 2 on Wrangel Island, Russia (a female banded as a gosling and a male banded as an adult). The distribution of recoveries appears to be similar among the 3 banding/breeding locations (Figure 15).

### SUMMARY AND CONCLUSIONS

In 2010, we continued our annual surveys and monitoring of Brant colonies and Snow Geese nesting on the Ikpikpuk River delta. For Brant, we estimated numbers of nesting Brant at a sample of 23 of the largest of the 45 Brant colonies that we have monitored annually between 1995 and 2009. Brant occupied 91% of the 23 monitored colonies in 2010, with an estimated 427 nests at these

colonies. Brant nest numbers increased 12% from 2009 and were about 39% higher than the 15-year average. Estimates of Brant numbers during brood-rearing surveys in 2010 indicated 22,494 Brant in 154 groups (21,487 adults and 1,007 goslings). The total number of Brant was the highest ever recorded. The number of goslings was only slightly higher than the 15-year mean (995 goslings). Despite near-average productivity in the region, as indicated by the number of goslings, the number of adult Brant without broods was the highest ever recorded. Most Brant (72%) were located in the Harrison Bay section of the western Beaufort coast, 27% were in the Smith Bay section, and 5% were in the Dease Inlet section. Peak numbers of Brant in western Beaufort coastal areas

Table 11. Summary of band returns, 2000–2010 (through 31 December 2010) by year class (years from banding date) for Snow Geese banded in the Ikpikpuk River delta region, Alaska.

	Year of Banding								Total
	2000	2001	2002	2003	2005	2006	2007	2008	
Total birds banded	227	160	822 <sup>d</sup>	1,075 <sup>d,e</sup>	1,253 <sup>a,d</sup>	1,755 <sup>b,f</sup>	1,693	1,212	8,197
Goslings banded	142	69	414	682	700	1,135	1,036	783	4,961
% Goslings	62.6	43.1	50.4	63.4	55.9	64.7	61.2	64.6	60.5
Age of goslings at return									
0	13	6	22	43	47	81	61	49	322
1	3	4	7	22	23	23	26	18	126
2	2	2	7	12	13	25	8	6	75
3	1	1	3	9	6	8	–	–	28
4	1	–	4	8	3	1	–	–	17
5	1	–	9	12	1	–	–	–	23
6	–	–	5	5	–	–	–	–	10
7	2	–	1	3	–	–	–	–	6
8	–	–	1	–	–	–	–	–	1
Total returns for birds banded as goslings	23	13	59	114	93	138	95	73	608
% of goslings returned at age zero	9.2	8.7	5.3	6.3	6.7	7.1	5.9	6.3	6.5
% of returns at age zero	5.7	3.8	2.7	4	3.8	4.6	3.6	4	3.9
Adults banded	85	91	408	393	551	619	657	429	3,233
% Adults	37.4	56.9	49.6	36.6	44.0	35.3	38.8	35.4	39.4
Minimum age <sup>c</sup> of adults at return									
1	7	1	8	18	13	19	22	16	104
2	1	1	8	7	15	4	13	9	58
3	3	1	7	9	8	13	9	1	51
4	1	1	5	1	8	4	1	–	21
5	1	1	6	3	9	–	–	–	20
6	1	–	8	8	2	–	–	–	19
7	–	2	4	4	–	–	–	–	10
8	2	–	6	2	–	–	–	–	10
9	1	1	1	–	–	–	–	–	3
10	1	–	–	–	–	–	–	–	1
Total returns for birds banded as adults	18	8	53	52	55	40	45	26	297
Total returns (all ages)	41	22 <sup>g</sup>	112	167 <sup>g</sup>	148	179 <sup>g</sup>	140	99	908
% of bands returned to date	18.1	13.8	13.6	15.5	11.8	10.2	8.3	8.2	11.1

<sup>a</sup> Includes 2 birds of unknown age

<sup>b</sup> Includes 1 bird of unknown age

<sup>c</sup> Bands returned within 1 year of placement are from birds at least 1 year old

<sup>d</sup> Includes 1 bird captured and released alive at Banks Island, NWT, Canada

<sup>e</sup> Includes 2 birds captured and released alive at Wrangel Island, Russia

<sup>f</sup> Includes 2 birds captured and released alive at Banks Island, NWT, Canada

<sup>g</sup> Includes 3 birds of unknown age, encounter dates for these birds are unknown

Table 12. Band returns of Snow Geese (through 31 December 2010) by season, region, and state. Snow Geese were banded at the Ikpikpuk River delta, 2000–2003 and 2005–2008, and at the Colville River delta and Sagavanirktok River delta/Foggy Island Bay areas, 2008 and 2010.

Region State/Province/District	Season <sup>a</sup>				Unknown <sup>b</sup>	Total
	Fall	Winter	Spring	Summer		
Alaska	–	–	26	7	–	33
Canada						
Alberta	145	14	1	1	1	162
Manitoba	1	–	2	–	–	3
Northwest Territories	1	–	14	7	–	22
Nunavut	–	–	–	1	–	1
Saskatchewan	90	4	12	–	–	106
Lower 48						
Arizona	–	3	–	–	–	3
Arkansas	–	23	3	–	–	26
California	4	446	5	–	1	456
Colorado	–	16	31	–	–	47
Idaho	–	7	4	–	–	11
Illinois	–	2	–	–	–	2
Iowa	–	1	2	–	–	3
Kansas	–	15	1	–	–	16
Kentucky	–	2	–	–	–	2
Louisiana	–	6	–	–	–	6
Mississippi	–	1	–	–	–	1
Missouri	–	7	5	–	–	12
Montana	1	19	–	–	–	20
Nebraska	1	3	21	–	1	26
Nevada	–	2	–	–	–	2
New Mexico	–	8	–	–	–	8
North Dakota	–	1	7	–	–	8
Oklahoma	–	2	1	–	–	3
Oregon	2	3	2	–	–	7
South Dakota	–	1	19	–	–	20
Texas	–	45	5	–	–	50
Utah	–	2	4	–	–	6
Washington	2	3	–	–	–	5
Wyoming	–	2	2	–	–	4
Mexico						
Baja California Norte	–	–	1	–	–	1
Chihuahua	–	1	–	–	–	1
Durango	–	3	–	–	–	3
Sonora	–	7	–	–	–	7
Tamaulipas	–	5	–	–	–	5
Russia						
Chukotka (Wrangel Island)	–	–	–	2	–	2
Total	247	654	168	18	3	1,090

<sup>a</sup> Seasons defined by the banding lab as: fall = September and October; winter = November through February; spring = March through May; summer = June through August.

<sup>b</sup> Date reported as a postmark date by Bird Banding Lab. No approximate date could be assigned.



occur when large numbers of failed and non-breeding Brant occur in the Harrison Bay section near Teshekpuk Lake.

We also visited the Snow Goose colony on the Ikpikpuk River delta, as we have for the previous 19 years. Nearly 9,100 Snow Geese were estimated at the colony in late June. The best estimate from the photo census was 4,769 nests, which is approximately the same as in 2008 and 2009. Until 2008, the Ikpikpuk colony continued to grow at a remarkable rate, and nesting success ranged from 48–97%. In 2009 and again in 2010, at least 4 brown bears caused a near-total failure of nests throughout the entire colony. Bears also were major nest predators at the Ikpikpuk colony in 2002, lowering success to 63% in that year. During brood-rearing surveys in 2010, 11,381 Snow Geese were recorded, including 11,187 adults and 194 goslings. Although the total number of Snow Geese was the fourth highest in the 15-year record, the number of goslings was the lowest since 2001. As in most previous years, most Snow Geese were located in the Smith Bay section (64%), but this percentage was lower than in any year since 1997. Most of the remaining Snow Geese (34%) were located in the Harrison Bay section and only 1% were located in the Dease Inlet section. It is likely that many of the broods recorded in the Harrison Bay section originated from small colonies between Cape Halkett and Fish Creek.

In 2010, 4.2% of adult Snow Geese in aerial survey photographs during brood-rearing were blue phase birds. Among birds handled during banding since 2000, approximately 1–5% annually were blue phase. Prior to the rapid expansion of the Ikpikpuk colony in 1999, blue phase Snow Geese were rarely observed in northern Alaska. Fewer than 1% of birds handled during banding 1980–1993 in the Sagavanirktok River delta (Johnson and Troy 1987) were blue phase.

Snow Geese were banded at 2 sites on the Colville River delta (1,160 geese) and 9 sites in the Sagavanirktok/Kadleroshilik River deltas (1,802 geese) in 2010. Since 2000, we have recaptured 1,031 Snow Geese, or 7.6% of 13,545 Snow Geese processed during banding operations by ABR on the Arctic Coastal Plain. Recaptures include 32 birds originally banded in Northwest Territories, 3 in Nunavut, 1 in Manitoba, 11 on the Colville River delta (prior to 2008), 14 on the

Sagavanirktok River delta (and environs, prior to 2000), 8 banded in Russia, and 962 banded by us and recaptured on the Arctic Coastal Plain. Small numbers of recaptures provide evidence of exchange among regional breeding populations on the Arctic Coastal Plain and similar numbers of male and female Snow Geese appear to have changed breeding locations. The distribution of band recoveries appears to be similar among the 3 banding/breeding locations at which we have banded. In general, the distribution of band returns from migration and wintering areas is similar to Western Arctic Snow Geese from western Canada and the Sagavanirktok River delta. However, a growing number of band returns suggest some level of mixing with the larger populations of Snow Geese that nest in central and eastern arctic Canada, winter in the Gulf States, and migrate in the central and eastern flyways.

Our goal, to develop more efficient but precise estimates of nesting success and nest numbers, was only partially realized in 2010. We were motivated to explore better estimates because nest failure events in previous years did not appear to be well captured by our earlier sampling methods. Specifically, our earlier ground-based efforts occurred only in the historical geographic center of the colony, and we suspected that rates of nest failure may not have been representative. In some previous years, failures may have been patchily distributed in such a large colony. Regarding the total numbers of nests in the colony, the rate of growth of the colony has compromised our ability to count nesting pairs visually during aerial surveys and ground surveys in the historical geographic center of the colony also indicated that aerial counts were biased low. An additional motivation was to reduce costs associated with surveys used for various estimates.

Unfortunately, the stratified random sample effort required more field time than was envisioned. Our original plans were to sample at least 160 plots, but we were only able to assess nest fate within about half of those plots. Re-extending the survey period to 4–5 days probably would allow access to these additional plots and the increased sample size would greatly improve the precision of estimates.

Additionally, our pre-sampling stratification was inaccurate in 2010. Specifically, the low

density stratum yielded a relatively high mean number of nests and a high variance in number of nests. This error in stratification resulted in inflated estimates of total nests and high variance in the estimate. However, stratification accuracy will improve in subsequent years, based on data acquired in 2010.

Snow Goose breeding populations have been expanding in North America since at least the 1960s (Kerbes 1983, Kerbes et al. 1983, McCormick and Poston 1988, Alisauskas and Boyd 1994) perhaps due to increased availability of agricultural resources in wintering areas (Davis et al. 1989). Over-population of breeding colonies has led to long-term degradation of some nesting areas and arctic coastal salt marshes used for brood-rearing (Kerbes et al. 1990, Ganter et al. 1995, Srivastava and Jefferies 1996), decreased growth and survival of goslings (Cooch et al. 1991, Williams et al. 1993, Gadallah and Jefferies 1995), and dispersal of young breeders to higher quality breeding areas (Ganter and Cooke 1998).

In our study area on the North Slope of Alaska, the fairly large increases in the number of molting Brant are correlated with concurrent larger increase in Snow Goose numbers, especially in the Smith Bay region, and low nesting success of Brant colonies in western Alaska. Prior studies have demonstrated higher nest success in larger Brant colonies compared to smaller colonies (Raveling 1989) and have linked increased predation rates on Brant nests to reduced populations of alternative prey species (Anthony et al. 1991), generally supporting the theory that Brant may benefit from greater numbers of Snow Geese. Increases in numbers of Brant in the region appear, however, to result largely from increases in numbers of molt migrants in the Teshekpuk Lake molting area and, although the number of Brant nests among the monitored colonies has increased since 1995, the number of goslings counted in the study area during brood-rearing surveys has fluctuated widely and shows no strong trend.

In the long term, one might predict a negative impact on Brant from a substantial increase in Snow Goose numbers due to competition for or degradation of salt marsh habitats used by both species during brood rearing. Intense grazing by Brant, focused exclusively on above-ground

biomass, appears to have no lasting deleterious effects on salt marsh grazing lawns (Person et al. 1998). In contrast, Snow Geese remove rhizomes and meristematic tissue by grubbing in the spring, which can result in long-term degradation of these plant communities in the vicinity of nesting colonies (e.g., Kerbes et al. 1990, Abraham and Jefferies 1997), potentially reducing available brood-rearing habitat for both species.

We recommend continued monitoring of Brant and Snow Geese in the study area. Nesting and brood-rearing surveys should continue to be used to monitor numbers and productivity of both species. Efforts to photo-census the Ikpikpuk Snow Goose colony should continue and, if the colony is successful, ground-search efforts at the colony should be adjusted to ensure representative sampling of nests for evaluation of nest fate and to focus less on enumerating and mapping nests. Banding efforts should continue at the Ikpikpuk Snow Goose colony and at other large colonies, as possible, in years of reasonably good productivity, to better understand the relationships between colonies and populations. Continued monitoring of Brant and Snow Goose numbers and distribution in the region will provide managers valuable and timely information on the status of these species and the potential for negative competitive interactions of Brant with the rapidly increasing population of Snow Geese.

We recommend that the stratified random sampling method be reapplied in 2011 with the original objective to census ~160 plots, now estimated to require at least 5 field days, which is similar to past efforts that focused on the historical geographic center of the colony. We believe that this sample design and sample size will improve estimates of nesting success and colony size.

Another goal of the 2010 Snow Goose monitoring program was to assess the use of aerial photography for obtaining a more accurate estimate of the number of nests in the colony (see Ritchie et al. 2009). Initiated in 2009, methods for that effort have improved and may become superior to the stratified random ground-surveys described above. Preliminary analyses suggest, however, that aerial photo analyses continue to be labor-intensive relative to ground surveys and that additional improvements are needed for an

accurate and efficient census. We propose that the 2 efforts be combined in 2011; specifically, that the aerial photos be used to more accurately stratify ground-search plots. This also would improve estimates of nesting success. Recent technical advances in automating the display of the digital aerial photos in their approximate geographic locations should allow a rapid means to accurately stratify plots in the several weeks between the 2 surveys.

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Appendix A. Summary of survey areas and types of surveys conducted for long-term monitoring of Snow Geese and Brant in northern Alaska, 1991–2010.

Year	Ikpikpuk River Delta Snow Goose Colony			Kukpowruk River Delta Snow Goose Colony			Regional Aerial Surveys <sup>a</sup>	
	Aerial Nesting Survey	Ground-based Nest Search	Banding	Aerial Nest Survey	Ground-based Nest Search	NSB Ground Search <sup>b</sup>	Nesting	Brood-rearing
1991	no	no	no	yes	no	no	none	none
1992	yes	yes	no	yes	yes	no	Area A <sup>a, c</sup>	none
1993	yes	yes	no	yes	yes	no	Area A <sup>c</sup>	none
1994	yes	no	no	yes	no	no	Area A	Area A <sup>d</sup>
1995	yes	no	no	yes	no	yes	Area A	Area A
1996	yes	no	no	no	no	yes	45 colonies <sup>e, f</sup>	Area B <sup>a</sup>
1997	yes	no	no	no	no	yes	45 colonies <sup>f</sup>	Area B
1998	yes	no	no	no	no	yes	45 colonies <sup>f</sup>	none
1999	yes	no	no	yes <sup>g</sup>	no	yes	45 colonies	Area A
2000	yes	no	yes	no	no	yes	45 colonies	Area B
2001	yes	yes	yes	no	no	yes	45 colonies	Area B
2002	yes	yes	yes	yes <sup>h</sup>	no	no	45 colonies	Area B
2003	yes	yes	yes	no	no	yes	45 colonies	Area B
2004	yes	yes	no	no	no	no	45 colonies	Area B
2005	yes	yes	yes	no	no	no	45 colonies	Area B
2006	yes	yes	yes	no	no	no	45 colonies	Area B
2007	yes	yes	yes	no	no	yes	45 colonies	Area B
2008	yes	yes	yes	no	no	yes	45 colonies	Area B
2009	yes	yes	no	no	no	yes	23 colonies	Area B
2010 <sup>i</sup>	yes <sup>i</sup>	yes <sup>i</sup>	no	no	no	no	23 colonies	Area B

<sup>a</sup> Area A comprised parts of both the Chukchi and Beaufort Sea coasts between the southern end of Kasegaluk Lagoon in the west and the western edge of the Colville River delta; Area B comprised the western Beaufort Sea coast between Barrow in the west and the western edge of the Colville River delta.

<sup>b</sup> North Slope Borough (NSB) survey data provided by R. Suydam, NSB Dept. of Wildlife Management. Surveys were conducted only on the Kukpowruk River delta and did not include searches of the Epizetka River delta, where Snow Geese have been recorded nesting in some years.

<sup>c</sup> In 1992 and 1993, regional aerial surveys did not record Brant, only Snow Geese.

<sup>d</sup> In 1994, weather conditions prevented a complete brood-rearing survey and excluded that part of the Chukchi Sea coast between Franklin and Barrow.

<sup>e</sup> In 1996–2008, the nesting surveys focused on 45 known Brant colonies between Barrow and the western edge of the Colville River delta. Snow Goose nests/colonies observed in transit between Brant colonies also were recorded.

<sup>f</sup> In 1996–1998, in addition to the 45 known Brant colonies, additional inland areas were surveyed intensively for Brant and Snow Goose nests. In 1996, 3 inland areas were surveyed: an area south of Dease Inlet and west of the Chipp River, the area between the Ikpiukpuk River and east to Teshekpuk Lake, and the Fish Creek delta (see Ritchie and Rose 1996). In 1997, the area east of Teshekpuk Lake and to Harrison Bay and south to Fish Creek was surveyed (see Ritchie 1998a). In 1998, the area north of Teshekpuk Lake (to the Beaufort Sea coast) and tundra immediately south of Teshekpuk Lake was surveyed (see Ritchie 1998b).

<sup>g</sup> In 1999, aerial surveys included nests located near the mouth of the Epizetka River in an area not included in previous surveys.

<sup>h</sup> In 2002, all nests were located near the mouth of the Epizetka River, none were found at the Kukpowruk River delta.

<sup>i</sup> In 2010, the aerial nest survey also included aerial photo-survey and the ground-based nest search was modified to improve colony-wide estimates of numbers.



#### STRATIFIED RANDOM NESTING PLOTS

- Plots are circular with a 50 meter radius. Mark the center of the plot with a piece of survey lath and hook a 50-m piece of p-cord on the stake (or another “survey” stake, if lath is too short). Walk the perimeter with 2 or three people holding onto the cord while zigzagging on the line (tough to describe but easy to do). If the plot’s center point is in water, use the GPS to determine your 50 m boundary from the center – place a plot marker on one of the cardinal directions indicating which direction TO the center point. Search the entirety of the plot on dry land.
- We will have 123 High density plots, 27 low density plots and 10 Zero density plots (zero plots are low priority; only do Zero density plots if you’ve completed at least 125 of the high/ low. High and low density plots have the same priority level). If you finish all 160 plots congratulations you can come home. If you don’t, start praying and don’t come home. If you can’t finish all of them, make sure they are well distributed across the entire delta (within logistical reason). As you mark-off clusters of plots, mark them on your maps so that you have a visual of where you’ve been and what you have left to do.
- Surveying High and Low plots: for logistical/fuel/time constraints plan to survey plots in clusters (e.g. south end of Island D). IMPORTANTLY, semirandomize when you do these clusters. We need to make sure that the plots are spread across the delta and not clumped on one side or the other or north or south. (in case you run out of time/weather, etc).
- Surveying “Zero” plots is low priority, so only do these if you have a good sample of high and low. These can be done quickly, scan from the helicopter before landing (sit on opposite sides). These probably could be done without having to shut down the helicopter – use your judgment based on habitat (if you think you could see nests well).

#### METHODS FROM THE REPORT:

- Ground searches are best conducted within a week or 2 of hatching in the colony and, in 2009, the ground search was conducted 8–11 July. We accessed the Ikpikpuk River delta via a helicopter and established a camp along the western side of the delta. During ground surveys, precise locations of nests were recorded using a handheld GPS. Nests were classified as *successful* if at least 1 eggshell fragment in the nest bowl was largely separated from a thickened shell membrane (Downing 1980), *unsuccessful* if eggshell fragments were firmly attached to papery shell membrane or if shell fragments were totally missing (Downing 1980). A few nests were classified as *unknown* when physical evidence seemed equivocal (and all unexamined nests also were classified as unknown fate). We will not count membranes for productivity nor habitat. Because nests typically were densely packed, we left a marker in each nest bowl (a small piece of cut-up tongue depressor) to prevent double-counting of nests. All locations later were entered into a geographic information system (GIS) database (ArcGIS software).

Appendix C. Brant colony locations and total numbers of nests recorded on aerial surveys, Barrow to Fish Creek, Alaska, 1994–2010.

Colony No.	Survey Section <sup>a</sup>	Latitude	Longitude	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
9	3	70.8951667	-157.0330000	10	15	24	34	15	24	16	19	13	25	10	27	8	13	25	19	24
52	3	71.0243333	-157.0098333	0	6	4	13	3	11	13	12	21	23	23	12	6	25	40	8	11
7	3	71.0401667	-156.8920000	6	10	7	13	12	8	16	22	13	30	10	8	14	4	23	7	17
53	3	70.9465000	-156.5598333	0	12	5	6	0	6	3	nd	0	4	4	6	3	0	3	12	4
19	3	70.8340000	-156.4595000	3	1	0	3	0	5	0	0	0	0	0	0	1	2	2	nd	nd
18	3	70.9331667	-156.4236667	1	5	4	0	6	5	6	0	4	8	3	4	0	4	13	nd	nd
20	3	70.7590000	-156.3801667	2	0	0	1	1	0	1	4	2	1	2	0	2	3	2	nd	nd
35	3	71.0910000	-156.3690000	0	7	0	4	0	4	5	8	10	0	11	6	8	8	12	7	95
60	3	70.7865000	-156.3615000	0	5	2	1	0	1	1	0	1	1	2	3	0	1	0	nd	nd
36	3	71.0341667	-156.3418333	0	8	0	0	3	0	0	3	2	5	5	5	7	3	4	nd	nd
54	3	70.7776667	-156.2921667	0	1	5	2	0	1	4	0	2	2	6	0	2	3	4	nd	nd
51	3	71.0910000	-156.2663333	0	6	0	5	3	7	2	1	3	6	2	4	2	0	10	2	3
50	3	71.0255000	-156.2205000	0	2	3	3	6	8	8	8	5	8	10	1	7	4	13	21	6
49	3	71.1006667	-156.2141667	0	5	8	4	6	7	4	5	7	2	5	6	5	3	8	nd	nd
12	3	70.7851667	-155.9788333	10	6	0	3	2	3	2	4	2	0	2	0	2	3	3	0	4
11	3	70.8448333	-155.9426667	25	20	20	10	30	29	35	25	30	45	40	0	52	40	98	96	58
10	3	71.1525000	-155.9331667	6	10	4	11	7	13	4	15	9	15	0	4	10	6	4	1	9
14	3	70.8073333	-155.8265000	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	nd	nd
15	3	70.8233333	-155.7531667	5	1	0	0	0	13	0	0	2	0	0	2	0	1	2	0	3
64	3	71.0126670	-155.7270000	0	5	0	0	0	0	3	nd	1	nd	0	1	4	1	0	nd	nd
48	3	70.8121667	-155.7145000	0	4	9	0	7	2	4	0	8	4	6	3	2	3	3	nd	nd
25	3	71.0801667	-155.6948333	4	2	0	2	1	0	2	2	0	0	1	1	0	0	0	nd	nd
65	3	70.8433330	-155.6895000	0	3	0	0	0	3	0	6	0	2	0	0	0	0	0	nd	nd
44	3	71.0613333	-155.6521667	0	1	2	3	6	2	2	4	8	5	3	2	1	3	1	nd	nd
26	3	71.1083333	-155.6186667	5	3	0	6	2	3	5	6	1	3	1	3	0	0	0	nd	nd
17	3	70.8991667	-155.4236667	3	3	6	7	3	2	7	5	1	3	3	0	0	3	4	nd	nd
16	3	70.8546667	-155.3955000	5	0	1	3	0	3	1	2	0	2	1	0	0	0	4	nd	nd
23	3	70.9818333	-155.3365000	6	5	10	17	20	27	21	28	8	22	3	19	19	22	19	14	13
45	3	70.8866667	-155.2783333	0	4	0	0	3	2	4	5	1	5	5	1	0	3	3	nd	nd
24	3	70.9888333	-155.2753333	10	10	12	25	28	30	23	32	10	25	40	34	51	20	13	34	35
22	3	70.8396667	-155.2008333	3	5	0	1	4	1	5	6	2	3	6	4	0	0	3	nd	nd

Appendix C. Continued.

Colony No.	Survey Section <sup>a</sup>	Latitude	Longitude	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
27	3	71.0893333	-155.1798333	3	8	0	7	2	9	15	16	5	0	6	8	2	4	3	9	19
46	3	70.9333333	-155.1166667	0	0	0	0	0	3	8	3	0	2	2	12	3	7	10	1	13
43	3	71.1335000	-155.0073333	0	2	0	nd	0	0	2	0	10	20	12	7	4	2	12	28	12
47	3	70.9111667	-154.9843333	0	15	14	16	11	17	16	33	15	15	12	14	17	7	18	3	6
28	3	71.0626667	-154.9468333	4	8	10	2	1	15	2	5	2	10	8	5	4	7	10	6	0
29	3	71.0736667	-154.7853333	5	6	0	6	7	11	7	6	3	3	2	3	3	2	9	0	0
30	4	70.9270000	-154.6625000	3	0	0	0	0	0	0	0	0	0	nd	0	2	0	3	nd	nd
31	4	70.8006667	-154.4586667	5	5	5	8	4	15	6	2	6	0	nd	4	0	nd	0	nd	nd
34	4	70.7998333	-154.3751667	0	2	0	0	0	1	0	0	0	0	0	0	0	nd	0	nd	nd
32	4	70.6395000	-154.2016667	40	35	35	30	30	15	40	10	20	30	63	85	50	60	40	70	34
33	4	70.8393333	-153.9236667	4	2	3	5	5	3	7	12	3	18	12	3	12	9	9	4	3
56	4	70.9133333	-153.2755000	0	6	2	0	3	1	1	6	1	0	nd	0	2	2	2	nd	nd
57	5	70.7408333	-152.4080000	nd	15	35	28	25	6	27	26	9	11	23	3	6	13	17	9	39
58	5	70.4308333	-151.6450000	nd	25	29	45	47	55	50	45	34	10	30	17	35	12	33	22	19

<sup>a</sup> 3 = Dease Inlet, 4 = Smith Bay, 5 = Harrison Bay

Appendix D. Location and numbers of Brant (visual estimates and photo counts) during brood-rearing surveys, Barrow to Fish Creek, Alaska, 2010.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults	No. Young	Total
3	Brant Point South	71.30958	-156.56247	2	4	6	na	na	
3	Ikpik Slough	71.29493	-156.53796	4	7	11	na	na	
3	Scott Point West	71.24321	-156.21715	8	12	20	8	12	20
3	Iko Bay	71.18537	-155.96133	60	60	120	76	69	145
3	Tulageak Point	71.19150	-155.77245	34	15	49	34	18	52
3	West Admiralty Bay	71.06600	-155.58419	36	24	60	40	22	62
3	Inaru River Mouth	70.84541	-155.93940	24	24	48	25	26	51
3	Chipp River Mouth	70.82532	-155.66779	18	20	38	na	na	
3	Chipp River Mouth	70.85804	-155.60056	40	10	50	44	6	50
3	Chipp River Mouth	70.84853	-155.59429	6	10	16	na	na	
3	Tangent Point	71.12240	-155.10602	8	0	8	na	na	
3	Tangent Point	71.13116	-155.10691	15	0	15	na	na	
4	Smith River	70.84645	-153.25572	400	0	400	na	na	
4	Smith River	70.89719	-153.27933	30	0	30	na	na	
4	Smith River	70.88928	-153.28242	6	0	6	na	na	
4	Smith River	70.87867	-153.31116	80	0	80	na	na	
4	Smith River	70.87946	-153.32333	40	0	40	na	na	
4	Smith River	70.87426	-153.32597	100	0	100	na	na	
4	Smith River	70.86809	-153.32959	100	0	100	na	na	
4	Smith River	70.86926	-153.35904	40	15	55	39	10	49
4	Smith River	70.87242	-153.38033	20	0	20	na	na	
4	Smith River	70.89248	-153.30781	15	0	15	na	na	
4	McLeod Point East	70.88582	-153.63218	20	0	20	na	na	
4	Ikpikpuk River East	70.80919	-153.93431	20	30	50	29	27	56
4	Ikpikpuk River East	70.78903	-154.06862	16	0	16	na	na	
4	Mckay Inlet	71.09438	-155.03709	150	0	150	na	na	
4	Mckay Inlet	71.11027	-155.01847	380	0	380	na	na	
4	Mckay Inlet	71.09640	-155.04386	110	0	110	na	na	
4	Mckay Inlet	71.08107	-155.04988	5	0	5	na	na	
4	Mckay Inlet	71.07412	-155.04833	90	0	90	na	na	
4	Mckay Inlet	71.04115	-155.03245	120	0	120	na	na	
4	Mckay Inlet	71.03660	-155.03036	350	0	350	na	na	
4	Mckay Inlet	71.04342	-155.06477	270	0	270	na	na	
4	Mckay Inlet	71.03943	-155.06244	300	0	300	na	na	
4	Mckay Inlet	71.05161	-154.94955	130	0	130	na	na	
4	Mckay Inlet	71.05078	-154.97913	75	0	75	na	na	
4	Mckay Inlet	71.08147	-154.94330	45	0	45	na	na	
4	Mckay Inlet	71.08626	-154.95105	200	0	200	na	na	
4	Mckay Inlet	71.09412	-154.95618	65	0	65	na	na	
4	SE Sinclair Lake	70.95325	-154.71085	30	0	30	na	na	
4	SE Sinclair Lake	70.94393	-154.68607	90	0	90	na	na	
4	Piasuk River Delta	70.89764	-154.71358	10	0	10	na	na	

## Appendix D. Continued.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults	No. Young	Total
4	Piasuk River Delta	70.89151	-154.72953	10	0	10	na	na	
4	Piasuk River Delta	70.88214	-154.63992	100	0	100	na	na	
4	Piasuk River Delta	70.86448	-154.62115	350	0	350	na	na	
4	Piasuk River Delta	70.86669	-154.66836	300	0	300	na	na	
4	Piasuk River Delta	70.86851	-154.71809	50	0	50	na	na	
4	Piasuk River Delta	70.85594	-154.70430	100	0	100	na	na	
4	Piasuk River Delta	70.85180	-154.64614	90	0	90	na	na	
4	Piasuk River Delta	70.83964	-154.60524	20	0	20	na	na	
4	Piasuk River Delta	70.83865	-154.63653	50	0	50	na	na	
4	Piasuk River Delta	70.84385	-154.77958	230	0	230	na	na	
4	Ikpikpuk River Delta	70.82182	-154.59281	600	0	600	na	na	
4	Ikpikpuk River Delta	70.81773	-154.54121	340	0	340	na	na	
4	Ikpikpuk River Delta	70.81959	-154.49978	180	0	180	na	na	
4	Piasuk River Delta	70.80194	-154.77090	50	0	50	na	na	
4	Piasuk River Delta	70.79868	-154.71411	12	18	30	na	na	
4	Piasuk River Delta	70.79866	-154.71857	100	30	130	90	34	124
5	Fish Creek Delta	70.38454	-151.27461	80	100	180	141	114	255
5	Fish Creek Delta	70.39812	-151.29117	130	100	230	163	136	299
5	Fish Creek Delta	70.39425	-151.36854	50	70	120	90	55	145
5	Fish Creek Delta	70.39271	-151.38382	80	70	150	120	37	157
5	Fish Creek Delta	70.39011	-151.38771	100	50	150	152	77	229
5	Fish Creek Delta	70.41711	-151.39895	30	0	30	na	na	
5	Fish Creek Delta	70.40173	-151.48742	20	20	40	28	13	41
5	Fish Creek Delta	70.41673	-151.52624	300	75	375	349	60	409
5	Fish Creek North	70.48802	-151.80753	35	10	45	43	10	53
5	Fish Creek North	70.51098	-151.84990	220	0	220	na	na	
5	Fish Creek North	70.51408	-151.77837	290	0	290	na	na	
5	Atigaru Point	70.54900	-151.72267	17	0	17	na	na	
5	Atigaru Point	70.54110	-151.75010	16	7	23	na	na	
5	Atigaru Point	70.55161	-151.76131	18	0	18	na	na	
5	Kogru River	70.55922	-151.99920	6	5	11	na	na	
5	Kogru River	70.54455	-152.14856	5	1	6	na	na	
5	Kogru River	70.54446	-152.63649	110	70	180	115	62	177
5	Kogru River	70.54911	-152.63548	170	15	185	236	10	246
5	Kogru River	70.55307	-152.61469	120	0	120	na	na	
5	Kogru River	70.55371	-152.62095	110	0	110	122	0	122
5	Saktuina Point	70.56886	-152.11721	80	0	80	na	na	
5	Saktuina Point	70.56949	-152.10251	12	0	12	na	na	
5	Saktuina Point	70.57947	-152.05485	12	0	12	na	na	
5	Saktuina Point	70.58278	-152.06365	30	0	30	na	na	
5	Garry Creek South	70.60645	-152.30857	225	0	225	na	na	
5	Garry Creek South	70.60707	-152.32774	14	0	14	na	na	
5	Garry Creek South	70.60125	-152.34221	60	0	60	na	na	

## Appendix D. Continued.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults	No. Young	Total
5	Garry Creek South	70.60380	-152.33273	105	0	105	na	na	
5	Garry Creek South	70.60647	-152.33418	20	0	20	na	na	
5	Garry Creek South	70.60751	-152.41838	12	0	12	na	na	
5	Garry Creek South	70.60885	-152.41538	24	0	24	na	na	
5	Garry Creek South	70.61219	-152.42503	25	0	25	na	na	
5	Garry Creek South	70.61746	-152.43271	30	0	30	na	na	
5	Garry Creek	70.62923	-152.47578	1600	0	1600	na	na	
5	Garry Creek	70.62657	-152.45885	60	0	60	na	na	
5	Garry Creek	70.62461	-152.48008	200	0	200	na	na	
5	Garry Creek	70.61857	-152.49603	70	0	70	na	na	
5	Garry Creek	70.62646	-152.50579	100	0	100	na	na	
5	Garry Creek	70.62864	-152.51874	500	0	500	na	na	
5	Garry Creek	70.61874	-152.53429	22	10	32	na	na	
5	Garry Creek	70.62544	-152.53114	50	0	50	na	na	
5	Garry Creek	70.62544	-152.53114	70	30	100	56	36	92
5	Garry Creek	70.62985	-152.53369	150	0	150	na	na	
5	Garry Creek	70.63035	-152.51916	550	0	550	na	na	
5	Garry Creek	70.63495	-152.51548	5	0	5	na	na	
5	Garry Creek	70.63803	-152.51683	10	0	10	na	na	
5	Garry Creek	70.63579	-152.53448	20	0	20	na	na	
5	Garry Creek	70.61793	-152.62827	50	0	50	na	na	
5	Garry Creek	70.63155	-152.50508	20	0	20	na	na	
5	Garry Creek	70.64581	-152.46025	170	20	190	na	na	
5	Garry Creek	70.66065	-152.46348	300	0	300	na	na	
5	Garry Creek	70.66772	-152.46793	275	0	275	na	na	
5	Garry Creek	70.67483	-152.47106	150	0	150	na	na	
5	Garry Creek	70.67929	-152.48270	250	0	250	na	na	
5	Garry Creek	70.67075	-152.47672	200	0	200	na	na	
5	Garry Creek	70.66968	-152.48862	25	0	25	na	na	
5	Garry Creek	70.67122	-152.49836	600	0	600	na	na	
5	Garry Creek	70.65119	-152.51754	500	50	550	na	na	
5	Garry Creek	70.65892	-152.52927	300	0	300	na	na	
5	Garry Creek	70.65676	-152.52820	1500	0	1500	na	na	
5	Garry Creek	70.64486	-152.52258	750	0	750	na	na	
5	Garry Creek	70.64508	-152.55661	50	0	50	na	na	
5	Garry Creek	70.66626	-152.56446	12	0	12	na	na	
5	Garry Creek	70.67064	-152.56844	45	0	45	na	na	
5	Garry Creek	70.64569	-152.56401	150	0	150	na	na	
5	Garry Creek	70.66978	-152.57415	50	0	50	na	na	
5	Garry Creek North	70.69698	-152.41970	100	0	100	na	na	
5	Abraham BM	70.71633	-152.38006	30	0	30	na	na	
5	Abraham BM	70.73617	-152.48574	120	0	120	na	na	
5	Abraham BM	70.74401	-152.49851	180	0	180	na	na	

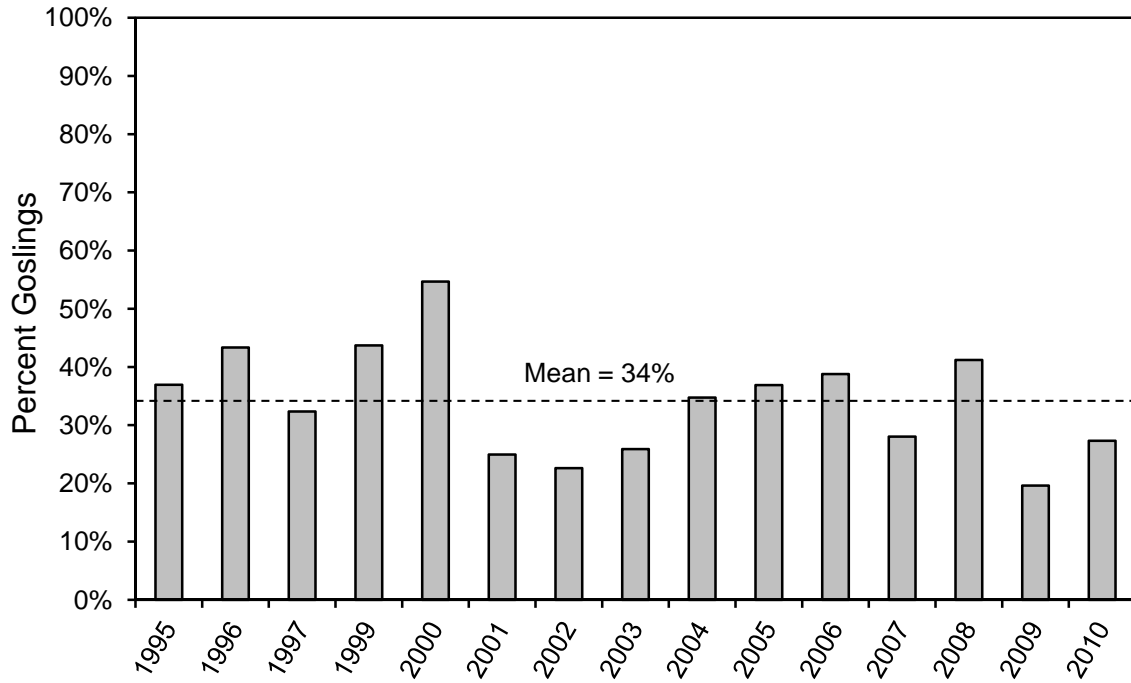
## Appendix D. Continued.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults	No. Young	Total
5	Abraham BM	70.75255	-152.50304	25	0	25	na	na	
5	Abraham BM	70.75571	-152.52625	130	0	130	na	na	
5	Abraham BM	70.74591	-152.47704	170	0	170	na	na	
5	Abraham BM	70.74964	-152.41819	30	15	45	na	na	
5	Abraham BM	70.74929	-152.38596	80	0	80	na	na	
5	Abraham BM	70.75927	-152.37702	25	0	25	na	na	
5	Abraham BM	70.74953	-152.38398	90	0	90	na	na	
5	Cape Halkett	70.77680	-152.33114	450	0	450	na	na	
5	Cape Halkett	70.78025	-152.32594	10	6	16	na	na	
5	Cape Halkett	70.79892	-152.24741	60	0	60	na	na	
5	Cape Halkett	70.82068	-152.20958	75	0	75	na	na	
5	Cape Halkett	70.82758	-152.23797	20	0	20	na	na	
5	Cameron Point	70.87551	-152.63985	16	0	16	na	na	
5	Cameron Point	70.87356	-152.64811	70	0	70	na	na	
5	Cameron Point	70.85077	-152.63765	180	0	180	na	na	
5	Cameron Point	70.87753	-152.67970	18	0	18	na	na	
5	Pogik Bay	70.84596	-152.82761	70	0	70	na	na	
5	Kokruagarok	70.90307	-153.08949	6	0	6	na	na	
5	Smith River	70.91297	-153.18078	400	0	400	na	na	
5	Smith River	70.89908	-153.18774	65	0	65	na	na	
5	Smith River	70.88540	-153.18024	450	0	450	na	na	
5	Smith River	70.87146	-153.24024	20	0	20	na	na	
5	Smith River	70.86369	-153.23386	130	0	130	na	na	
5	Smith River	70.86254	-153.21931	160	0	160	na	na	
5	Smith River	70.85721	-153.20318	170	0	170	na	na	
5	Smith River	70.85078	-153.22676	250	0	250	na	na	

Appendix E. Distribution and composition of Brant groups during brood-rearing surveys, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010. (See Table 2 for overall totals.)

Section	Total Groups	Brood Groups	Adults Without Broods	Adults With Broods	Total Adults	Goslings	Total Birds in Brood Groups	Total Birds
Year								
Dease Inlet								
1995	15	11	170	373	543	278	651	821
1996	17	12	786	236	1,022	227	463	1,249
1997	24	6	1,288	110	1,398	100	210	1,498
1999	21	14	172	302	474	366	668	840
2000	17	13	646	340	986	266	606	1,252
2001	16	9	1,165	739	1,904	148	887	2,052
2002	24	8	1,098	468	1,566	68	536	1,634
2003	38	13	4,427	567	4,994	258	825	5,252
2004	54	19	3,112	741	3,853	474	1,215	4,327
2005	16	4	1,338	270	1,608	97	367	1,705
2006	18	18	0	806	806	511	1,317	1,317
2007	22	10	414	418	832	267	685	1,099
2008	25	15	536	487	1,023	298	785	1,321
2009	14	2	1,115	57	1,172	21	78	1,193
2010	12	10	23	257	280	194	451	474
Mean	22	11	1,086	411	1,497	238	650	1,736
SD	11	5	1,207	226	1,286	141	334	1,309
Smith Bay								
1995	8	5	340	210	550	65	275	615
1996	5	4	225	80	305	38	118	343
1997	5	3	530	120	650	39	159	689
1999	30	13	1,680	286	1,966	203	489	2,169
2000	2	1	130	120	250	200	320	450
2001	22	7	3,219	201	3,420	243	444	3,663
2002	14	6	2,546	382	2,928	131	513	3,059
2003	20	7	2,581	522	3,103	130	652	3,233
2004	21	10	1,940	574	2,514	227	801	2,741
2005	41	12	2,018	581	2,599	399	980	2,998
2006	54	29	3,412	1,585	4,997	903	2,488	5,900
2007	49	11	3,210	346	3,556	186	532	3,742
2008	23	3	2,043	98	2,141	58	156	2,199
2009	52	6	6,342	286	6,628	81	367	6,709
2010	46	4	5,717	170	5,887	89	259	5,976
Mean	26	8	2,396	371	2,766	199	570	2,966
SD	18	7	1,843	376	1,959	218	583	2,036
Harrison Bay								
1995	16	9	670	969	1,639	566	1,535	2,205
1996	16	10	119	512	631	368	880	999
1997	43	21	1,048	655	1,703	284	939	1,987
1999	45	19	1,753	790	2,543	501	1,291	3,044
2000	6	5	14	210	224	342	552	566
2001	38	4	5,718	368	6,086	44	412	6,130
2002	46	8	4,358	594	4,952	223	817	5,175
2003	60	9	11,062	391	11,453	129	520	11,582
2004	91	18	7,490	1,525	9,015	810	2,335	9,825
2005	49	20	2,391	1,597	3,988	935	2,532	4,923
2006	53	25	2,758	1,532	4,290	1,070	2,602	5,360
2007	68	15	4,723	1,501	6,224	429	1,930	6,653
2008	99	29	6,410	2,005	8,415	1,458	3,463	9,873
2009	95	13	10,947	2,037	12,984	479	2,516	13,463
2010	96	19	13,068	2,252	15,320	724	2,976	16,044
Mean	55	15	4,835	1,129	5,964	557	1,687	6,522
SD	30	7	4,238	683	4,629	383	998	4,704





Appendix F. Percent goslings in Brant brood-rearing groups, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010.

Appendix G. Number of adults, nests, and estimated nesting success of Snow Geese at the Kukpowruk River delta and Ikpikpuk River delta colonies, 1991–2010.

Year	Kukpowruk			Ikpikpuk		
	Adults <sup>a</sup>	Nests <sup>b</sup>	Nesting Success	Adults <sup>a</sup>	Nests <sup>c</sup>	Nesting Success
1991	185	55	nd	nd	nd	nd
1992	130	26	8%	200	60	7%
1993	135	44	89%	140	42	21%
1994	10	0	nd	20	5	nd
1995	68	36	11%	200	55	nd
1996	nd	57	65%	0	0	nd
1997	nd	35	0%	160	50	nd
1998	nd	46	4%	195	nd	nd
1999	45	5 <sup>d</sup>	nd	552	176	nd
2000	nd	13	0%	1,500	250	nd
2001	nd	9 <sup>d</sup>	nd	1,230	335	48%
2002	147	41 <sup>d</sup>	nd	1,232	918	63%
2003	nd	18	≥44%	1,364	1,149	97%
2004	nd	nd	nd	2,900	1,436	90%
2005	nd	nd	nd	2,390	1,116	70%
2006	nd	nd	nd	4,421	2,386	86%
2007	nd	204	61%	9,300	2,505	85%
2008	nd	320	nd	14,398	4,641	89%
2009	nd	315	<50%	9,374	4,479	1%
2010	nd	nd	nd	11,868	4,769	8.5%

<sup>a</sup> Total number of adults equals all adults in flight plus those associated with nest sites; all estimates of adults are from aerial visual surveys exclusively, except in 2010 when nests were enumerated from aerial photo survey, and flying adults were estimated visually during the photo survey flight

<sup>b</sup> Number of nests at Kukpowruk were determined from aerial surveys, except in 1996–1998, 2000–2001, 2003, and 2007–2009 when nests were enumerated during North Slope Borough ground searches (R. Suydam, NSB, pers. comm.)

<sup>c</sup> Number of nests at Ikpikpuk were determined from aerial surveys in 1992–2000, ground searches in 2001–2003, combined aerial and ground counts in 2004–2009, and an aerial photo survey in 2010

<sup>d</sup> Aerial surveys in 1999, 2001, and 2002 included the Epizetka River mouth, 2 miles north of Kukpowruk River—in 1999, all nests were located near the Epizetka River mouth and none were found at the Kukpowruk River

Appendix H. Locations and numbers of Snow Geese (visual estimates and photo counts) during brood-rearing surveys, Barrow to Fish Creek, Alaska, 2010.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults <sup>a</sup>	No. Young	Total
3	West Admiralty Bay	71.12822	-155.58310	2	0	2			
3	West Admiralty Bay	70.95796	-156.08289	5	0	5			
3	Kurgorak Bay	71.03989	-155.20082	30	0	30			
3	Kurgorak Bay	71.04671	-155.17595	70	0	70			
4	Smith River	70.88169	-153.42426	8	9	17			
4	McLeod Point East	70.88582	-153.63218	6	9	15			
4	McLeod Point East	70.88582	-153.63218	20	0	20			
4	Naluakruk Lake	70.86065	-153.62684	26	0	26			
4	Naluakruk Lake	70.86350	-153.59675	175	0	175			
4	Naluakruk Lake	70.86220	-153.57817	110	0	110			
4	McLeod Point	70.88764	-153.77357	30	0	30			
4	McLeod Point	70.88502	-153.79175	15	0	15			
4	Ikpikpuk River East	70.80766	-153.97347	20	25	45	30 (2)	32	62
4	Ikpikpuk River East	70.80919	-153.93431	40	0	40			
4	Ikpikpuk River East	70.78903	-154.06862	100	0	100			
4	Mckay Inlet	71.11027	-155.01847	20	0	20			
4	Sinclair Lake	70.94986	-154.94717	25	0	25			
4	Sinclair Lake	70.96172	-154.95388	150	0	150			
4	Sinclair Lake	70.96588	-154.96646	120	0	120			
4	Sinclair Lake	70.96433	-154.97842	250	0	250			
4	Sinclair Lake	70.97912	-154.95821	30	0	30			
4	Sinclair Lake	70.98786	-154.95752	50	0	50			
4	Sinclair Lake	70.99353	-154.96337	500	0	500			
4	Mckay Inlet	71.02646	-155.00001	200	2	202			
4	Mckay Inlet	71.03104	-154.96678	20	0	20			
4	Mckay Inlet	71.07707	-154.93078	175	0	175			
4	SE Sinclair Lake	70.94708	-154.69304	450	0	450			
4	SE Sinclair Lake	70.94393	-154.68607	25	0	25			
4	Piasuk River Delta	70.91640	-154.62952	350	0	350			
4	Piasuk River Delta	70.91757	-154.61649	70	25	95	67 (4)	19	86
4	Piasuk River Delta	70.90706	-154.66796	65	0	65			
4	Piasuk River Delta	70.89446	-154.70420	7	0	7			
4	Piasuk River Delta	70.89107	-154.75277	12	0	12			
4	Piasuk River Delta	70.89036	-154.76042	50	0	50			
4	Piasuk River Delta	70.88122	-154.71913	60	0	60			
4	Piasuk River Delta	70.86672	-154.68471	12	0	12			
4	Piasuk River Delta	70.87322	-154.76804	7	0	7			
4	Piasuk River Delta	70.87596	-154.79403	30	0	30			
4	Piasuk River Delta	70.87990	-154.83500	40	0	40			
4	Piasuk River Delta	70.87692	-154.83887	10	0	10			
4	Piasuk River Delta	70.87400	-154.83779	55	0	55			
4	Piasuk River Delta	70.87071	-154.83565	90	0	90			

## Appendix H. Continued.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults <sup>a</sup>	No. Young	Total
4	Piasuk River Delta	70.86530	-154.82966	75	0	75			
4	Piasuk River Delta	70.86155	-154.83724	50	0	50			
4	Piasuk River Delta	70.86467	-154.84545	60	0	60			
4	Piasuk River Delta	70.86819	-154.86507	100	0	100			
4	Piasuk River Delta	70.86895	-154.86756	150	0	150			
4	Piasuk River Delta	70.87615	-154.87775	60	0	60			
4	Piasuk River Delta	70.87715	-154.87860	50	0	50			
4	Piasuk River Delta	70.88509	-154.88216	220	0	220			
4	Piasuk River Delta	70.86114	-154.83594	25	0	25			
4	Piasuk River Delta	70.86090	-154.82063	15	0	15			
4	Piasuk River Delta	70.85873	-154.77932	40	0	40			
4	Piasuk River Delta	70.83925	-154.64815	20	0	20			
4	Piasuk River Delta	70.83944	-154.66431	20	0	20			
4	Piasuk River Delta	70.84080	-154.68759	50	0	50			
4	Piasuk River Delta	70.84106	-154.70650	4	0	4			
4	Piasuk River Delta	70.84169	-154.73678	35	0	35			
4	Piasuk River Delta	70.84178	-154.74015	30	0	30			
4	Piasuk River Delta	70.84403	-154.78548	26	4	30			
4	Piasuk River Delta	70.83165	-154.78313	150	0	150			
4	Piasuk River Delta	70.83123	-154.71180	30	0	30			
4	Piasuk River Delta	70.83147	-154.69019	50	0	50			
4	Piasuk River Delta	70.83739	-154.66886	30	3	33			
4	Ikpikpuk River Delta	70.81672	-154.59346	40	20	60	61 (2)	19	80
4	Ikpikpuk River Delta	70.80331	-154.44296	50	20	70	49	16	65
4	Ikpikpuk River Delta	70.78749	-154.32650	70	0	70			
4	Ikpikpuk River Delta	70.80680	-154.32973	30	0	30			
4	Ikpikpuk River Delta	70.81587	-154.55372	40	25	65	58 (3)	30	88
4	Piasuk River Delta	70.81351	-154.76585	18	0	18			
4	Piasuk River Delta	70.81271	-154.83656	120	0	120			
4	Piasuk River Delta	70.80237	-154.73992	110	0	110			
4	Ikpikpuk River Delta	70.77346	-154.40170	375	0	375			
4	Piasuk River Delta	70.78939	-154.60451	180	0	180			
4	Piasuk River Delta	70.78938	-154.64790	150	0	150			
4	Piasuk River Delta	70.78950	-154.65324	195	0	195			
4	Piasuk River Delta	70.78958	-154.65875	60	0	60			
4	Piasuk River Delta	70.78937	-154.70346	160	0	160			
4	Piasuk River Delta	70.78791	-154.73972	80	0	80			
4	Piasuk River Delta	70.78801	-154.75284	270	0	270			
4	Piasuk River Delta	70.78561	-154.83665	32	0	32			
4	Piasuk River Delta	70.77921	-154.84748	400	0	400			
4	Piasuk River Delta	70.77239	-154.79634	4	0	4			
4	Piasuk River Delta	70.78196	-154.72788	125	0	125			
4	Piasuk River Delta	70.77722	-154.69371	30	0	30			

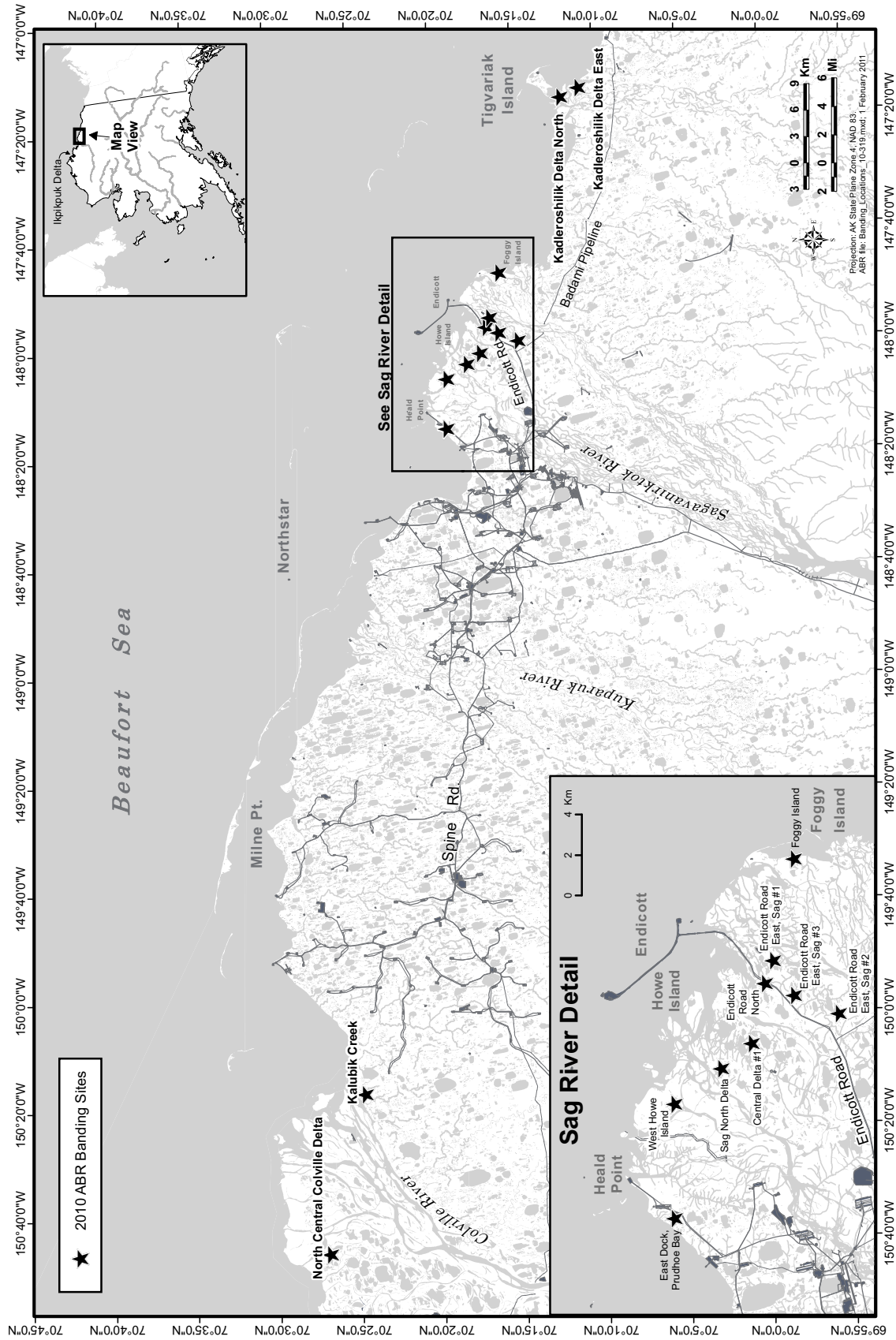
## Appendix H. Continued.

Section	Location	Latitude	Longitude	Visual Estimate			Photo Count		
				No. Adults	No. Young	Total	No. Adults <sup>a</sup>	No. Young	Total
5	Fish Creek Delta	70.37122	-151.23854	12	20	32			
5	Fish Creek Delta	70.39271	-151.38382	30	0	30	47	(2)	0
5	Fish Creek Delta	70.42368	-151.41281	26	0	26			
5	Kogru River	70.54280	-152.52520	6	0	6			
5	Kogru River	70.56484	-152.59108	14	12	26			
5	Saktuina Point	70.58824	-152.09577	8	13	21			
5	Garry Creek South	70.60673	-152.38704	15	0	15			
5	Garry Creek	70.62923	-152.47578	160	0	160			
5	Garry Creek	70.63803	-152.51683	15	0	15			
5	Garry Creek	70.62612	-152.58873	30	0	30			
5	Garry Creek	70.62741	-152.60094	350	0	350			
5	Garry Creek	70.62299	-152.62714	130	0	130			
5	Garry Creek	70.61793	-152.62827	3	0	3			
5	Garry Creek	70.62218	-152.64161	300	0	300			
5	Garry Creek	70.63234	-152.63025	4	0	4			
5	Garry Creek	70.62531	-152.63989	190	0	190			
5	Garry Creek	70.62907	-152.67261	75	0	75			
5	Garry Creek	70.62826	-152.69630	55	0	55			
5	Garry Creek	70.62495	-152.70917	150	0	150			
5	Garry Creek	70.63282	-152.50107	44	0	44			
5	Garry Creek	70.64581	-152.46025	33	0	33			
5	Garry Creek	70.65964	-152.46433	120	0	120			
5	Garry Creek	70.67483	-152.47106	7	0	7			
5	Garry Creek	70.65676	-152.52820	110	0	110			
5	Garry Creek	70.64508	-152.55661	150	0	150			
5	Garry Creek	70.65529	-152.56043	300	0	300			
5	Garry Creek	70.64569	-152.56401	150	0	150			
5	Garry Creek	70.63503	-152.67610	100	0	100			
5	Garry Creek	70.64408	-152.67119	80	0	80			
5	Garry Creek	70.64792	-152.65856	20	0	20			
5	Garry Creek	70.65025	-152.62880	120	0	120			
5	Garry Creek	70.65937	-152.61119	150	0	150			
5	Garry Creek	70.66517	-152.61145	75	0	75			
5	Garry Creek	70.68034	-152.62851	140	0	140			
5	Garry Creek	70.68269	-152.54740	575	0	575			
5	Garry Creek	70.68243	-152.52483	4	6	10			
5	Garry Creek North	70.68956	-152.43150	7	0	7			
5	Garry Creek North	70.69200	-152.42446	8	0	8			

<sup>a</sup> Blue phase adult Snow Geese listed in parentheses

Appendix I. Distribution and composition of Snow Goose groups based on visual estimates during brood-rearing surveys, Barrow to Fish Creek, Alaska, 1995–1997 and 1999–2010. (See Table 6 for overall totals.)

Section	Total Groups	Brood Groups	Adults Without Broods	Adults With Broods	Total Adults	Goslings	Total Birds in Brood Groups	Total Birds
Year								
<b>Dease Inlet</b>								
1995	3	3	0	23	23	39	62	62
1996	1	1	0	3	3	6	9	9
1997	2	2	0	5	5	8	13	13
1999	1	1	0	2	2	3	5	5
2000	1	0	1	0	1	0	0	1
2001	1	1	0	4	4	7	11	11
2002	2	1	22	12	34	9	21	43
2003	4	4	0	44	44	53	97	97
2004	4	3	3	67	70	91	158	161
2005	5	2	27	16	43	16	32	59
2006	2	2	0	106	106	145	251	251
2007	6	5	19	48	67	71	119	138
2008	4	2	2	36	38	10	46	48
2009	7	2	35	18	53	17	35	70
2010	4	0	107	0	107	0	0	107
Mean	3	2	14	26	40	32	57	72
SD	2	1	28	30	36	42	71	70
<b>Smith Bay</b>								
1995	6	6	0	154	154	164	318	318
1996	3	1	57	10	67	6	16	73
1997	8	6	21	87	108	127	214	235
1999	21	16	88	467	555	560	1,027	1,115
2000	22	19	102	513	615	753	1,266	1,368
2001	17	10	379	234	613	145	379	758
2002	23	20	76	1,437	1,513	1,063	2,500	2,576
2003	33	32	20	1,736	1,756	2,003	3,739	3,759
2004	46	43	156	2,470	2,626	3,234	5,704	5,860
2005	54	34	2,418	1,413	3,831	1,139	2,552	4,970
2006	113	111	13	6,861	6,874	7,688	14,549	14,562
2007	88	73	1,091	3,939	5,030	3,287	7,226	8,317
2008	247	194	2,423	9,056	11,479	8,051	17,107	19,530
2009	118	13	11,526	506	12,032	76	582	12,108
2010	81	10	6,762	535	7,297	143	678	7,440
Mean	59	39	1,675	1,961	3,637	1,896	3,857	5,533
SD	65	52	3,269	2,688	4,071	2,655	5,321	5,911
<b>Harrison Bay</b>								
1995	4	4	0	21	21	29	50	50
1996	3	2	50	50	100	73	123	173
1997	12	2	363	6	369	3	9	372
1999	9	6	190	46	236	61	107	297
2000	19	10	382	110	492	157	267	649
2001	13	8	43	114	157	89	203	246
2002	12	6	17	142	159	78	220	237
2003	11	8	18	172	190	154	326	344
2004	19	4	903	107	1,010	131	238	1,141
2005	15	7	550	84	634	176	260	810
2006	37	30	198	623	821	911	1,534	1,732
2007	25	5	985	102	1,087	96	198	1,183
2008	28	10	1,166	263	1,429	245	508	1,674
2009	37	5	2,948	83	3,031	62	145	3,093
2010	38	4	3,745	38	3,783	51	89	3,834
Mean	19	7	771	131	901	154	285	1,056
SD	12	7	1,122	151	1,107	219	366	1,122



Appendix J. Locations on the Colville River delta and on the Sagavanirktok River delta at which Snow Geese were banded in 2010.

Appendix K. Band histories of Snow Geese recaptured at the Ikpikpuk, Piasuk, Colville, and Sagavanirktok banding sites, 2000–2008 and 2010. Histories are excluded for birds banded and recaptured at the same site. No birds were banded on the Ikpikpuk River delta in 2010.

Band Number	Banding Site				Recapture Site						
	Age <sup>a</sup>	Sex <sup>b</sup>	Color	Location	Lat	Long	Date	Location	Lat	Long	Date <sup>c</sup>
1367–96306	L	M	White	Howe Island, AK	70.16667	-147.66667	7/29/1993	Piasuk River delta	70.85028	-154.73139	8/5/2000
4007–59960 <sup>d</sup>	L	F	White	Banks Island, NT	72.33333	-125.33333	7/14/1996	Ikpikpuk River delta	70.80306	-154.50083	8/4/2001
4007–90572	L	M	White	Atkinson Point, NU	67.66667	-102.83333	7/13/1998	Ikpikpuk River delta	70.80306	-154.50083	8/4/2001
4007–59960 <sup>d</sup>	L	F	White	Banks Island, NT	72.33333	-125.33333	7/14/1996	Ikpikpuk River delta	70.80306	-154.50083	7/31/2002
1277–05671	ASY	M	White	Banks Island, NT	72.33333	-125.00000	7/19/1994	Ikpikpuk River delta	70.80306	-154.50083	8/1/2002
1557–09503	L	F	White	MacKenzie Delta, NT	69.33333	-135.16667	8/2/1999	Ikpikpuk River delta	70.80306	-154.50083	8/2/2002
1557–09583 <sup>d</sup>	L	F	White	MacKenzie Delta, NT	69.33333	-135.16667	8/2/1999	Ikpikpuk River delta	70.80306	-154.50083	8/2/2002
1557–64441	AHY	M	White	Banks Island, NT	72.83333	-124.00000	7/18/2001	Ikpikpuk River delta	70.80306	-154.50083	8/2/2003
1587–48941	AHY	M	White	Banks Island, NT	72.33333	-125.16667	7/16/2002	Ikpikpuk River delta	70.80306	-154.50083	8/2/2003
1557–09583 <sup>d</sup>	L	F	White	MacKenzie Delta, NT	69.33333	-135.16667	8/2/1999	Ikpikpuk River delta	70.80306	-154.50083	8/3/2003
4007–47492	AHY	U	White	Wrangel Island, Russia	71.50000	-179.50000	8/4/2002	Ikpikpuk River delta	70.79667	-154.35750	8/3/2003
4007–47318	HY	M	White	Wrangel Island, Russia	71.50000	-179.50000	8/3/2002	Ikpikpuk River delta	70.80306	-154.50083	8/2/2005
1587–12548	L	M	White	Wapusk National Park, MB	58.50000	-93.33333	7/23/2001	Ikpikpuk River delta	70.80306	-154.50083	8/3/2005
1707–34532	AHY	M	White	Banks Island, NT	72.83333	-123.66667	7/13/2004	Ikpikpuk River delta	70.80306	-154.50083	8/3/2005
1707–35147	AHY	F	White	Banks Island, NT	72.33333	-123.16667	7/15/2004	Ikpikpuk River delta	70.80306	-154.50083	8/3/2005
1557–12367	AHY	M	White	Banks Island, NT	72.66667	-123.16667	7/16/2000	Piasuk River delta	70.82402	-154.68031	8/4/2005
1587–48943	AHY	F	White	Banks Island, NT	72.33333	-125.16667	7/16/2002	Piasuk River delta	70.82402	-154.68031	8/4/2005
1367–96343	L	M	White	Howe Island, AK	70.16667	-147.66667	7/30/1993	Piasuk River delta	70.94277	-154.63463	8/5/2005
1707–36303	AHY	M	White	Banks Island, NT	72.83333	-124.16667	7/15/2005	Ikpikpuk River delta	70.80306	-154.50083	8/2/2006
1557–07792	AHY	M	White	Banks Island, NT	72.33333	-125.33333	7/18/1998	Ikpikpuk River delta	70.80306	-154.50083	8/3/2006
1587–47339 <sup>d</sup>	L	F	White	MacKenzie Delta, NT	69.33333	-135.16667	7/31/2001	Ikpikpuk River delta	70.80306	-154.50083	8/3/2006
4007–48092	HY	M	White	Wrangel Island, Russia	71.50000	-179.50000	8/4/2002	Ikpikpuk River delta	70.80306	-154.50083	8/3/2006
1707–34127	SY	M	White	Banks Island, NT	72.83333	-124.16667	7/12/2004	Ikpikpuk River delta	70.80306	-154.50083	8/3/2006
1707–34821	SY	F	White	Banks Island, NT	72.33333	-123.16667	7/14/2004	Ikpikpuk River delta	70.80306	-154.50083	8/3/2006
1557–10015	SY	M	White	Banks Island, NT	72.83333	-124.83333	7/10/2000	Ikpikpuk River delta	70.80306	-154.50083	8/4/2006
1707–34119	SY	F	White	Banks Island, NT	72.83333	-124.16667	7/12/2004	Ikpikpuk River delta	70.80306	-154.50083	8/4/2006
4007–49657	HY	M	White	Wrangel Island, Russia	71.50000	-179.50000	8/6/2004	Ikpikpuk River delta	70.80306	-154.50083	8/4/2006
4007–49901	AHY	M	White	Wrangel Island, Russia	71.50000	-179.50000	8/6/2004	Ikpikpuk River delta	70.80306	-154.50083	8/4/2006
1727–55532 <sup>d</sup>	L	F	White	Wrangel Island, Russia	71.50000	-179.50000	7/23/2005	Ikpikpuk River delta	70.79139	-154.38778	8/3/2007
1847–11195	AHY	M	White	Wrangel Island, Russia	71.50000	-179.50000	7/15/2006	Ikpikpuk River delta	70.80306	-154.50083	8/4/2007
1707–71015	L	M	White	Ikpikpuk River delta, AK	70.80306	-154.50083	8/4/2005	Colville River delta	70.79139	-154.38778	8/4/2007
1587–47339 <sup>d</sup>	L	F	White	Richard Island, NT	69.33333	-135.16667	7/31/2001	Ikpikpuk River delta	70.80306	-154.50083	8/2/2008



Appendix K. Continued.

Band Number	Banding Site			Recapture Site							
	Age <sup>a</sup>	Sex <sup>b</sup>	Color	Location	Lat	Long	Date	Location	Lat	Long	Date <sup>c</sup>
1727-55532 <sup>d</sup>	L	F	White	Wrangel Island, Russia	71.50000	-179.50000	7/23/2005	Ikpikpuk River delta	70.80306	-154.50083	8/2/2008
1847-12407	AHY	F	White	Banks Island, NT	72.83333	-124.16667	7/15/2007	Ikpikpuk River delta	70.80306	-154.50083	8/2/2008
1847-50672	AHY	M	White	Johnson Point, NU	67.83333	-100.66667	8/2/2007	Ikpikpuk River delta	70.80306	-154.50083	8/2/2008
1707-71975	L	M	White	Ikpikpuk River delta, AK	70.80306	-154.50083	8/4/2006	Sagavanirktok River delta	70.32667	-148.10528	8/4/2008
1587-47889 <sup>d</sup>	AHY	F	White	Banks Island, NT	72.33333	-125.16667	7/12/2002	Sagavanirktok River delta	70.27250	-147.96833	8/5/2008
1847-07721	AHY	F	White	Wrangel Island, Russia	71.50000	-179.50000	7/28/2007	Sagavanirktok River delta	70.30556	-148.06139	8/6/2008
4007-31559 <sup>e</sup>	-	-	White	Alaska	-	-	7/28/2001	Colville River delta	70.41806	-150.26389	7/31/2010
1707-36717	AHY	M	White	Banks Island, NT	72.91667	-124.08333	7/15/2005	Colville River delta	70.41806	-150.26389	7/31/2010
1707-36786	AHY	M	White	Egg River, NT	72.41667	-124.41667	7/16/2005	Colville River delta	70.41806	-150.26389	7/31/2010
1937-13503	AHY	F	White	Sagavanirktok River delta, AK	70.32667	-148.10528	8/4/2008	Colville River delta	70.41806	-150.26389	7/31/2010
1937-13587	AHY	M	White	Sagavanirktok River delta, AK	70.32667	-148.10528	8/4/2008	Colville River delta	70.41806	-150.26389	7/31/2010
1937-13929	AHY	F	White	Sagavanirktok River delta, AK	70.30556	-148.06139	8/6/2008	Colville River delta	70.41806	-150.26389	7/31/2010
4007-18251	AHY	M	White	Banks Island, NT	72.41667	-124.91667	7/16/1995	Colville River delta	70.45167	-150.75000	8/1/2010
1557-63578 <sup>e</sup>	-	-	White	Northwest Territories	-	-	7/16/2001	Sagavanirktok River delta	70.32667	-148.10528	8/1/2010
0867-24342	AHY	F	White	Ikpikpuk River delta, AK	70.80306	-154.50083	8/1/2002	Sagavanirktok River delta	70.32667	-148.10528	8/1/2010
1847-02008	AHY	M	White	Ikpikpuk River delta, AK	70.80306	-154.50083	8/1/2007	Sagavanirktok River delta	70.32667	-148.10528	8/1/2010
1847-03273	AHY	F	White	Ikpikpuk River delta, AK	70.79139	-154.38778	8/4/2007	Sagavanirktok River delta	70.32667	-148.10528	8/1/2010
1847-03293	AHY	M	White	Ikpikpuk River delta, AK	70.79139	-154.38778	8/4/2007	Sagavanirktok River delta	70.32667	-148.10528	8/1/2010
1937-12866	L	M	White	Sagavanirktok River delta, AK	70.32667	-148.10528	8/4/2008	Colville River delta	70.45167	-150.75000	8/1/2010
1587-47889 <sup>d</sup>	AHY	F	White	Banks Island, NT	72.91667	-124.25000	7/12/2002	Sagavanirktok River delta	70.27250	-147.96833	8/2/2010
1587-49538	AHY	M	White	Banks Island, NT	72.91667	-123.75000	7/17/2003	Sagavanirktok River delta	70.27250	-147.96833	8/2/2010
1587-53532	L	F	White	Ikpikpuk River delta, AK	70.80306	-154.50083	8/1/2003	Sagavanirktok River delta	70.27250	-147.96833	8/2/2010
1847-01857	L	M	White	Ikpikpuk River delta, AK	70.80306	-154.50083	8/4/2006	Sagavanirktok River delta	70.27250	-147.96833	8/2/2010
1937-13300	AHY	F	White	Kalubik Creek, AK	70.42361	-150.21389	8/1/2008	Sagavanirktok River delta	70.25306	-147.99417	8/2/2010
0977-86569 <sup>e</sup>	-	-	White	Alaska	-	-	8/1/1993	Sagavanirktok River delta	70.30556	-148.06139	8/3/2010
1727-52708	AHY	M	Blue	Coral Harbor, NU	63.75000	-85.58333	7/25/2007	Sagavanirktok River delta	70.30556	-148.06139	8/3/2010
1557-07190	AHY	M	White	Banks Island, NT	72.41667	-125.25000	7/15/1998	Sagavanirktok River delta	70.18278	-147.24278	8/4/2010
1587-48067	AHY	M	White	Banks Island, NT	72.91667	-124.25000	7/11/2002	Sagavanirktok River delta	70.20167	-147.26917	8/4/2010
0977-24139	AHY	F	White	Ikpikpuk River delta, AK	70.80306	-154.50083	7/31/2002	Sagavanirktok River delta	70.20167	-147.26917	8/4/2010
1847-10341	AHY	M	White	Banks Island, NT	72.91667	-124.08333	7/12/2006	Sagavanirktok River delta	70.18278	-147.24278	8/4/2010
1847-03024	AHY	F	White	Ikpikpuk River delta, AK	70.79139	-154.38778	8/4/2007	Sagavanirktok River delta	70.20167	-147.26917	8/4/2010

<sup>a</sup> Age: Refers to age at time of banding. L = local, not flight-capable gosling; HY = flight-capable hatch-year bird; AHY = after-hatch year; ASY = after second year

<sup>b</sup> Sex: Refers to sex at time of banding. F = female, M = male

<sup>c</sup> Data are current through 31 December 2010.

<sup>d</sup> Bird recaptured on multiple occasions at the same banding site.

<sup>e</sup> At the time of this report, only preliminary banding information is available from the Bird Banding Lab.

Appendix L. Number of Snow Geese of each sex banded and number recaptured at each colony location on the Arctic Coastal Plain. Total banded birds excludes the current year (2010), because those birds could not have been recaptured.

Colony	Capture Type	Year(s)	Female	Male
Colville River Delta	Banded	2008	359 (51.2)	342 (48.8)
	Recaptured	2010	39 (62.9)	23 (37.1)
Ikpikpak River Delta	Banded	2000–2007	3602 (51.7)	3368 (48.3)
	Recaptured	2001–2010	514 (67.8)	244 (32.2)
Sagavanirktok River Delta	Banded	2008	431 (50.5)	423 (49.5)
	Recaptured	2010	80 (63.5)	46 (36.5)

Appendix M. Band returns of Arctic Coastal Plain Snow Geese that may be considered peripheral to or east of the main loci for wintering and spring use areas of the earlier Sagavanirktok River delta birds and the Western Arctic Snow Goose population. Numbers are reported by age of birds at the time of banding.

Location	Adults		Goslings	
	Females	Males	Females	Males
Arkansas	4	2	10	10
Illinois		1	1	
Kansas	5	3	5	3
Kentucky	1		1	
Louisiana	1	1	2	2
Mississippi				1
Manitoba			1	2
Nunavut			1	
Total	11	7	21	18