TECHNICAL REPORT

BREEDING BIOLOGY OF STELLER'S EIDERS NESTING NEAR BARROW, ALASKA, 2007

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INTRODUCTION

Background

Most of the world's Steller's eiders (*Polysticta stelleri*) nest in Arctic Russia and winter in waters adjacent to the Alaska Peninsula. A much smaller group, the Alaska-breeding population, nests on the arctic slope of Alaska (Pitelka 1974) and, to a lesser extent, on the Yukon-Kuskokwim Delta (Kertell 1991, Flint and Herzog 1999). The Alaska-breeding population was listed as threatened under the Endangered Species Act in 1997 due to concerns over apparent declines in numbers inferred from a reduction of nesting range in Alaska.

Steller's eiders are sparsely distributed across the Arctic Coastal Plain of northern Alaska (USFWS, Migratory Bird Management, unpublished data from aerial waterfowl breeding pair surveys). Breeding pair density based on aerial surveys is greatest near Barrow. Steller's eiders can be among the most abundant of the waterfowl species in the Barrow area (Pitelka 1974), but abundance and breeding effort vary widely from year to year (Quakenbush and Suydam 1999). Periodic non-breeding of Steller's eiders near Barrow may be related to the response of predators to fluctuations in abundance of brown lemmings (*Lemmus trimucronatus*) (Quakenbush and Suydam 1999).

The proximity of Steller's eider breeding to Barrow creates a unique opportunity to engage in research that might otherwise be logistically and economically unfeasible on the Arctic Coastal Plain, but also gives rise to potential conflicts between a threatened species and an active, expanding village. Barrow is an important study site for Steller's eiders for two reasons: it is an opportune location to address general biological questions, and because site-specific information is necessary for conservation planning and to fulfill the Service's consultation responsibilities under section 7 of the Endangered Species Act.

In 1991, the U.S. Fish and Wildlife Service (USFWS), Ecological Services Fairbanks Field Office and the North Slope Borough's Department of Wildlife Management initiated a study of the breeding biology of Steller's eiders near Barrow (Figure 1). The study focused on nest success, productivity, habitat use, nesting chronology, and among-year variation in breeding effort.

Knowledge of Steller's eider density and breeding distribution on the arctic slope of Alaska is limited. In addition, aerial breeding pair surveys conducted by USFWS, Migratory Bird Management, across the Arctic Coastal Plain are conducted at an intensity (2-4% area coverage) too low to detect trends in Steller's eider numbers (Larned et al. 2005, Mallek et al. 2005). To estimate density and to examine annual breeding-season distribution of Steller's eiders in the Barrow area, more intensive surveys were initiated in 1999. Annual surveys are conducted on three spatial scales using the following methods: 1) ground-based surveys to census breeding pairs within 4 km of the Barrow road system, 2) intensive aerial surveys to obtain an index of population size and assess distribution of Steller's eiders within approximately 60 km of Barrow [conducted by ABR, Inc., see annual report for details (Obritschkewitsch et al. 2008)] , and 3) intensive ground-based nest searches within 4 km of the Barrow road system. A stratified

adaptive cluster sampling nest search design was introduced in 2004 and conducted from 2004 to 2006 to estimate nesting density in the study area.

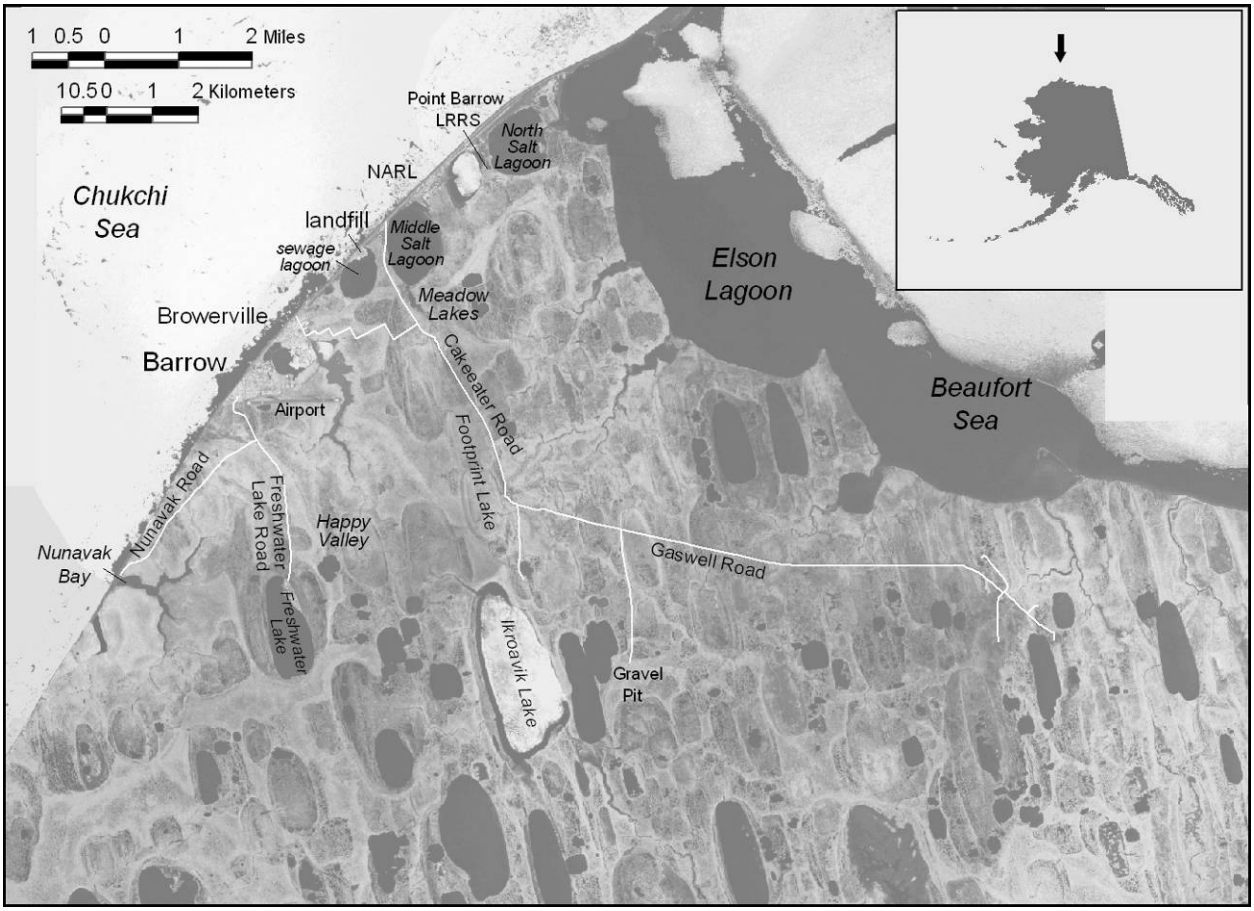


Figure 1. Barrow Study Area

Objectives

Survey and monitoring of Steller's eiders near Barrow directly contributes to the development, implementation, and evaluation of management and conservation actions. Habitat protection, including section 7 consultations and the development of a Barrow Steller's Eider Conservation Plan to protect important nesting habitat, relies on up-to-date information on the distribution and abundance of eiders and their nests. Monitoring of breeding propensity and success allows us to measure effects of management actions aimed at maintaining and increasing production in the area. Without these efforts, we would have no direct measure of the efficacy of actions or knowledge to implement changes for improvement.

An approved Recovery Plan for this species was completed in 2002. Based on the plan, recovery priorities are periodically (usually annually) revised, and recovery efforts at Barrow directly or indirectly address 15 high priority tasks identified on the most current (May 2007) recovery task

list. They are:

- Continue standardized ground-based breeding pair surveys at Barrow,
- Continue intensive aerial surveys in the Barrow triangle,
- Continue nest and brood monitoring at Barrow,
- Determine post hatch-fledgling survival,
- Monitor changes in distribution and abundance of predators at Barrow,
- Confirm identity of predator species causing egg/young loss,
- Opportunistically collect eggs on the Yukon-Kuskokwim Delta and North Slope to establish a flock of known-geographic origin Steller's eiders at the Alaska SeaLife Center,
- Determine female breeding area fidelity by capturing, marking and re-sighting hens at Barrow,
- Further analyze breeding female fidelity at Barrow,
- Screen/monitor for lead exposure throughout the range of the listed population,
- Determine the number and causes of infertile and inviable eggs in the Barrow breeding population,
- Acquire more genetic samples opportunistically from Russia and Alaska,
- Continue raven control near Barrow,
- Continue fox control near Barrow, and
- Continue education for Barrow residents to reduce disturbance of nests and ducklings.

In order to implement these recovery tasks and to complement on-going conservation efforts, we continued our long-term monitoring efforts, as well as continued new research and management projects that were initiated in 2005, with the goal of increasing production of the Alaska-breeding population. Specific objectives for research and monitoring of Steller's eiders at Barrow in 2007 were:

1. Continue systematic study of the abundance and distribution of Steller's eiders and their nests near Barrow using ground-based and aerial breeding pair surveys, and ground-based nest searches;
2. Monitor nest success by monitoring nests during incubation;
3. Evaluate the relative importance of nest predator species by monitoring a subset of nests with digital cameras;
4. In partnership with the Alaska SeaLife Center, collect infertile and inviable eggs and fecal samples from hens to evaluate causes of non-hatchability;
5. Band nesting hens to determine breeding area fidelity;
6. Collect tissue (blood) samples from nesting hens for contaminants analysis, primarily focusing on exposure to lead;
7. Collect cloacal swaps from nesting hens for avian influenza screening;
8. Involve local community members in Steller's eider conservation efforts by employing Barrow high school students for ground-based breeding pair surveys.

Results of camera nest-monitoring, fox control, and contaminants projects will be reported separately. ABR Inc. conducted the aerial survey and provided detailed methods and results in

their annual report (Obritschkewitsch et al. 2008). Fox control was conducted by Wildlife Services, USDA and raven nest control by the North Slope Borough, Department of Wildlife Management. Specific objectives and methods for all other components of this year's field work follow.

METHODS

Abundance and Distribution Surveys

Ground-based Breeding Pair Survey

We surveyed 136 km^2 of tundra (Figure 2) in 21 contiguous subunits between 12 and 18 June using methods established in 1999 (Obritschkewitsch et al. 2001, and described below) and using the data sheet modified in 2003 (described below). The survey area is defined as the total area within the survey boundary minus lake areas >150 m from shoreline (thus a 150 m perimeter from shoreline out into lakes is included within the survey boundary; see Figure 2). In 2007, the area surveyed was smaller than the past several years, but did encompass the "standard area," which is the common area completed in all years. Because the survey area has been modified through the years, densities of Steller's eiders within the area covered in all survey years (135 km^2), 1999-2007, (referred to as "standard area") are presented in the results to allow comparison of densities among years.

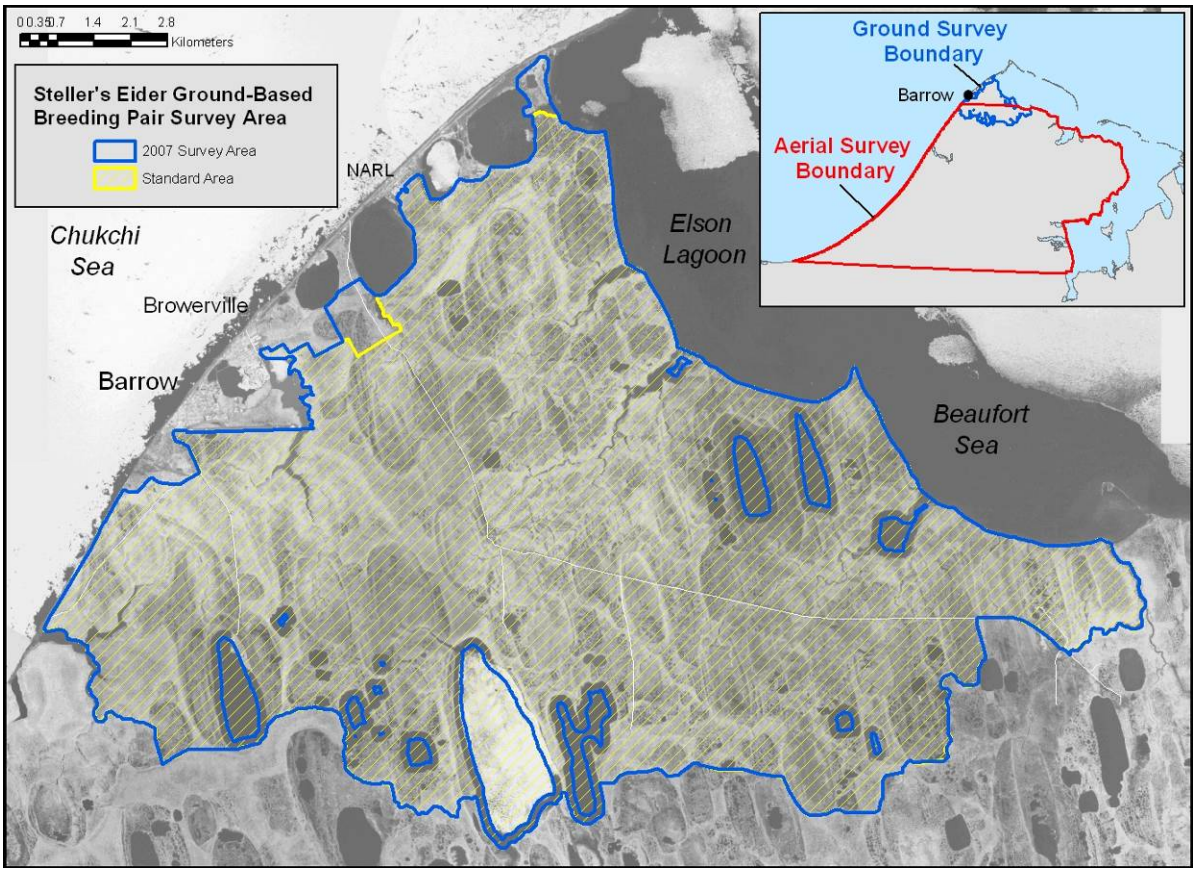


Figure 2. Area searched for Steller's eiders during ground-based breeding pair survey, 12-18 June 2007. The yellow cross-hatched area indicates the standard area that has been surveyed every year, 1999-2007. Inset shows boundary of aerial survey.

Surveys commenced immediately after pairs dispersed from Footprint Lake and other wetlands where Steller's eiders congregated after arriving in Barrow. The entire survey was completed in 7 days (all subunits covered once), with the majority conducted by 3-4 member teams. Search effort (person-hours per unit area) remained similar to previous years. Ground-based surveys are designed to provide 100% area coverage.

Searches were planned and conducted using GPS handheld units and high altitude infrared photography of the Barrow area enlarged to 1:12,000 scale, which allowed identification of features as small as two meters across. Search units were bounded by features that can be easily seen on photos and on the ground, such as streams, lakes, roads, and margins of drained lake basins. Searchers were instructed to spread out and walk in patterns that allowed them to view all water bodies in their units. In areas with little relief, distance between searchers was approximately 200-300 meters; in areas of greater relief, searchers spaced themselves closer together or walked in zigzag patterns to compensate for reduced visibility. Although it was impossible to see behind all of the mounds and ridges on the tundra using this protocol, the potential for sighting Steller's eiders was high given the low vegetation and relatively flat topography of the coastal plain near Barrow. When one or more Steller's eiders were observed, the location was plotted on an aerial photograph (and GPS, if possible) and detailed information was recorded on datasheets. While moving through the area, searchers kept track of eiders previously recorded to avoid double-counting birds that moved. Team members also communicated with each other via radios to avoid double-recording of sightings.

Other species counted during ground-based surveys include spectacled eider (*Somateria fischeri*) and the following potential or confirmed predators of eiders: pomarine jaeger (*Stercorarius pomarinus*), parasitic jaeger (*S. parasiticus*), long-tailed jaeger (*S. longicaudus*), glaucous gull (*Larus hyperboreus*), snowy owl (*Nyctea scandiaca*), common raven (*Corvus corax*) and Arctic fox (*Alopex lagopus*).

Nests and/or nesting behavior were noted for avian species and dens were noted for foxes. The data sheet was modified in 2003, with a behavior code (5 categories) assigned to each sighting as a measure of the observer's confidence in the breeding status of the species observed (Table 1). These categories varied from confirmed nesting (nest with eggs observed), probable/possible nesting (behavior indicates may be nesting but no nest found) to no indication of nesting activity (such as a bird that is foraging or that just flies through an area). For observations of multiple individuals, the lowest code appropriate for any individual was assigned to the group as a whole.

Table 1. Behavior codes for avian species counted in the ground-based survey area.

Code	Behavior	Description
1	Nest	Confirmed nest with eggs
2	Probable nest	Behavior strongly suggests nest presence, but no nest discovered
3	Possible nest	Behavior suggests possible presence of a nest
4	Present	No indication of nesting, but bird is doing something other than just flying through the area
5	Passing through	Bird moves through the area with no behavior other than flying

Behavior codes were standardized among observers by reference to descriptions of behaviors that would indicate probable or possible nesting for each species. For Steller's eiders, "probable nesting" was recorded if a female was observed to flush from the ground within 30 meters of an observer. "Possible nesting" was recorded if Steller's eiders were agitated by the observer's presence, yet were reluctant to leave; if an individual or pair flushed, circled, and returned; or if aggressive behavior by a male Steller's eider towards other birds was observed. If territorial or nesting behavior was observed, searchers briefly searched the area for possible nests.

Aerial Survey

ABR, Inc. conducted aerial surveys for Steller's eiders on the Arctic Coastal Plain from 17 to 18 June 2007. The surveyed area included the "Barrow Triangle," a 2725-km^2 area between Admiralty Bay and the Chukchi Sea coast from just south of Barrow to about the southern end of Admiralty Bay (see inset in Figure 2). Pre-survey estimates of eider abundance from ground surveys indicated Steller's eider numbers were low, thus east-west oriented 400-m wide strip transects were flown at 1600-m intervals, providing 25% coverage rather than 50% covered in known nesting years (see Obritschkewitsch et al. 2008 for further details on methods). For each Steller's eider observation, number, sex, and a brief description of habitat were recorded. Weather and visibility conditions were good throughout the surveys (Obritschkewitsch et al. 2008).

Chronology

Observations of Steller's eider flock size, sex composition and behavior was recorded during the pre-nesting period, ground-based surveys, and incidental to other activities and compiled to form an overview of wetland use. Data on weather conditions (spring temperatures and snow melt) were recorded at the National Oceanic and Atmospheric Administration (NOAA) weather station located at the Barrow airport (NOAA 2007).

Nest Search

Although few Steller's eiders were observed, and none were territorial, during the breeding pair survey, nest searching was conducted after the ground-based breeding pair survey from 19 June to 16 July. The adaptive cluster sampling method used from 2004 to 2006 (described in Rojek 2007) was not employed in 2007 due to budget constraints and smaller crew size. Thus, this year we did not obtain data to estimate nesting density in the study area. Most areas were searched by field crews of 2 to 4 biologists using methods established in 1999 (Obritschkewitsch et al. 2001). Each wetland area where Steller's eiders were observed during the breeding pair foot survey, as well as areas where the majority of nests had been found in previous years, was searched at least once. Observers walked slowly through selected areas, paying special attention to wetlands and adjacent tundra where Steller's eiders were observed and where they demonstrated signs of territoriality (e.g., showed reluctance to flush from a pond or returned to the same pond after flushing). Search effort was not standardized among areas and varied within and among search

areas. More intensive nest searching was conducted in areas where Steller's eiders were observed during these follow-up surveys, particularly if territorial or nesting behavior was observed, and in areas where Steller's eider and pomarine jaeger nests were found. A photographic field guide (Bowman 2004) was used to aid in identification of nests and eggs.

Areas searched were delineated on aerial photos and digitized on a scanned, geo-referenced aerial image of the study area. Nest locations were obtained with a GPS receiver (Garmin GPSMAP 60CS). Accuracy of handheld GPS units in the Barrow area is typically ± 5m.

Nest Success

Nest Monitoring

All Steller's eider nests found this season were monitored to determine nest success and causes of nest failure. The incubation period has been reported to last 24 days post-laying of the penultimate egg (Quakenbush et al. 2004). Due to concurrent projects this season, nests were visited at different intervals during the incubation period depending on whether or not they had a camera placed close to the nest. Camera nests were visited every 5 days after camera set-up to exchange memory cards and batteries. Servicing was done at the cameras, which were 10 - 23 m from nests, and did not cause incubating hens to flush from nests. Nests without cameras were visited at least every seven days until hatch, although the status of several nests within the vicinity of camera nests was determined during camera check visits. Nests may have been visited more frequently late in incubation due to timing of nest trapping activity.

All attempts were made to minimize impacts of nest visits. Flushing of hens was avoided on all visits to guard against causing abandonment or attracting predators. Some hens were flushed on the first visit, however, as that is how they were discovered. Nests were relocated with GPS coordinates and maps only. If the hen was absent from the nest or flushed when approached, the nest was visited briefly to count and cover the eggs. Latex gloves were worn when touching nests or eggs. Information on nest contents and status was recorded on each visit, including whether or not the nest was covered and eggs were warm, presence/absence of the female and male, nest status (laying, incubating, depredated, abandoned, or hatched), and in some cases, stage of incubation (by egg candling).

Consistent with past years, after nest failure or hatch we collected nest habitat information to characterize basic breeding requirements. Eggshell and contour feathers were collected for possible genetic analysis. The number of whole eggs and eggshells found at failed nests was recorded, along with condition of nest lining and appearance of depredated eggshells, and location of eggshells relative to the nest bowl.

Analysis of Nest Success

The fate of each nest was classified as successful or unsuccessful. Nests were considered successful if at least one young hatched and left the nest. Nest success was indicated by the

observation of ducklings in the nest or by the presence of at least one detached eggshell membrane in the nest (Klett et al. 1986). Cause of nest failure was determined whenever possible. Estimates of nest initiation and hatch dates were calculated using nest visit information and digital images for those nests monitored with digital cameras.

Both apparent and Mayfield (1961, 1975) nest success were calculated. Apparent nest success was computed including nests found post-termination. No nests appeared to have failed due to our research activities, so all were included in the analysis. For yearly Mayfield success estimates, we combine data from all sampled nests to compute a single daily mortality rate covering the period from the onset of laying through hatch, which averages 30 days for Steller's eider nests (Quakenbush et al. 2004). Confidence intervals were calculated following Johnson (1979). In the past several years, a Mayfield estimate was calculated that included only unmanipulated nests (i.e., nests included in camera studies were considered manipulated) for comparisons in nest success among years. After three years of camera monitoring, we do not believe cameras affect nesting behavior and all nests were included in the nest success calculation for 2007. Mayfield nest success estimates for 2005 and 2006 are adjusted from values previously reported (Rojek 2006, 2007) in the table comparing success among years in Appendix I.

In 2007, fox control was implemented for the third year in the study area. Control efforts were initiated one week prior to Steller's eider nest initiation dates and continued through the nesting period (end of July). As a result of this effort, nest success comparisons between 2005 -2007 and all other years are confounded because we believe fox predation has been a cause of nest failure in all years.

Habitat Use

Wetland habitat type was recorded for all Steller's eiders observations and nests using nine wetland class categories developed by Bergman et al. (1977), with four additional categories added (Table 2).

"Ditches" are man-made waterways with raised edges and emergent *Carex aquatilis* and pendant grass (*Arctophila fulva*) that formed when permafrost melted after the insulating vegetation mat was damaged by summer travel and/or removed by construction of winter roads. The "stream" category refers to deep or shallow, typically meandering streams containing emergent pendant grass and/or *Carex aquatilis.* The "dry tundra" category applies to Steller's eiders observed on tundra, not obviously associated with a water body.

Bergman et al. (1977) defined a class VI basin-complex as a large, partially drained lake basin that becomes partially dry by late July, exposing relatively dry upland-like areas and a mosaic of pools with *Carex aquatilis* and/or *Arctophila fulva*. A new category of partially drained basin, the "basin marsh," was created to describe a heavily vegetated basin that remains entirely aquatic throughout the summer. The primary example of this wetland type in Barrow is Footprint Lake,

a large (approximately 2 km^2) lake that was drained in 1950 (Britton 1957, Billings and Peterson 1980) and has since developed a dense stand of emergent *Arctophila fulva*.

The class VI basin-complex, although present in the Barrow area, is rarely identified as a habitat used by Steller's eiders in this study because it generally occurs as a composite of other, smaller-scale wetlands. For example, a basin complex may contain a mix of class II, III and IV ponds, a stream, and both classes of flooded tundra. A Steller's eider seen in a class II pond in a basin-complex would typically be assigned to the class II habitat and not to a basin-complex.

Table 2. Wetland habitat types used to categorize Steller's eider observations. Roman numerals correspond to wetland classifications described by Bergman et al. (1977).

Habitat Classification	**Description**
Ia	Flooded tundra (upland basins)
Ib	Flooded tundra (creek flats)
II	Shallow *Carex* ponds
III	Shallow *Arctophila* ponds
IV	Deep *Arctophila* ponds
V	Deep open lakes
VI	Basin complex
VIII	Coastal wetland
Ditch	Man-made channel with emergent vegetation
Stream	Any stream, excluding man-made channels
BM	Basin marsh
DT	Dry tundra

Additional habitat information was collected at nest locations, such as distances from nests to nearest permanent water bodies. Distances were calculated (in the field with a measuring tape for distances <120 m, or in ArcGIS for longer distances) between Steller's eider nests and nearest neighboring Steller's eider and pomarine jaeger nests and analyzed using Wilcoxon rank sum tests performed in R (version 2.6.0) to determine if average distance differed between successful and failed nests.

Hen Capture and Brood Monitoring

Hens were trapped late in incubation to band and collect samples. In the past several years, VHF radio-transmitters were attached to hens to monitor post-hatch to fledging success; however, due

to funding limitations this component of the project was not conducted this year. Hens were captured by lowering a horizontally-stretched mist net onto the nest. This was accomplished by two persons approaching the nest holding the mist net in a horizontal plane, with one panel of the net stretched fully between hands of outstretched arms (method similar to that described in Bacon and Evard 1990). After lowering the net, the two persons kneeled on either end of the net and crawled towards the nest. In most cases, the hen stayed tight on the nest until the trappers were in reaching distance.

USFWS metal tarsus bands (stainless steel, size 6) and plastic color bands (yellow with black alpha-numeric code) were applied to hens. Blood was drawn from the jugular vein for lead contaminants, DNA, and hormone analyses. A cloacal swab was taken for avian influenza screening and a fecal sample for bacterial screening. Body weight (to the nearest gram using a spring scale) and the following morphometric measurements were taken: culmen (from center of bill to highest point of bill tip), tarsus (diagonal and total), and wing (wing chord and flattened wing) lengths (to the nearest mm with calipers and metric rulers).

Limited ground surveys were conducted in late July in areas around successful nests to document broods.

RESULTS

Abundance and Distribution Surveys

Ground-based Breeding Pair Survey Area

The entire survey area was covered once during the ground-based survey period from 12-18 June 2007. A total of 23 (12 males and 11 females) Steller's eiders were counted (Figure 3, and see Appendix A for density map). Pair density in the standard area was 0.09 males/km^2, which is within the range typically calculated in non-nesting years (Table 3).

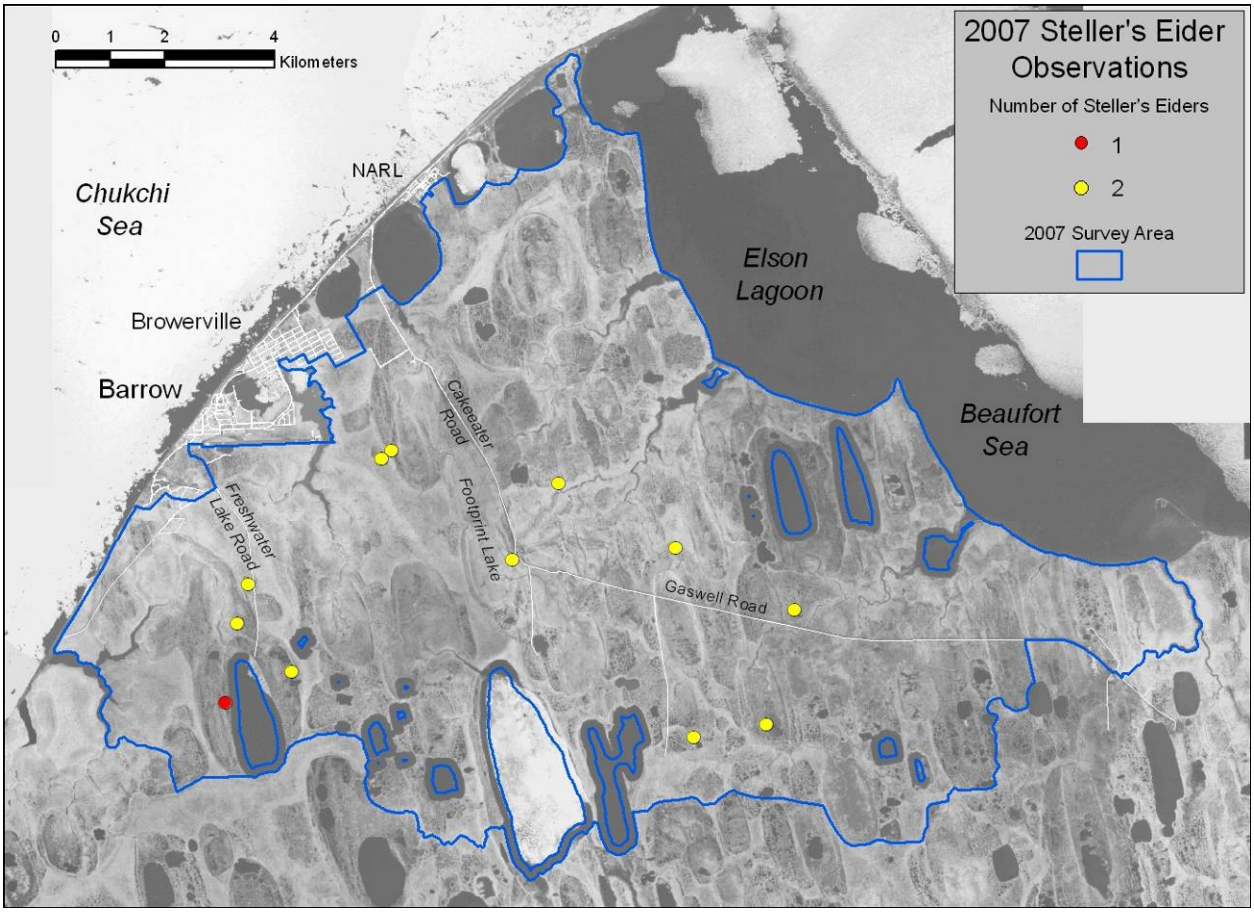


Figure 3. Steller's eider observations during ground-based breeding pair surveys, 12-18 June 2007. The survey area was covered once and all observations are displayed on the map.

Numbers of other avian species and Arctic foxes and number of nests/dens counted in the ground-based survey are presented in Appendix B. A figure showing the distribution of spectacled eider observations and nests is presented in Appendix C.

Table 3. Number of Steller's eider males and pair density during ground-based and aerial surveys, and nests found near Barrow, 1999-2007.

Year	Overall Ground-based Survey Area for Each Year			Standard Ground-based Survey Area[a]		Aerial Survey of Barrow Triangle		Nests found near Barrow
	Area (km^2)[b]	Males counted	Pair Density (males/km^2)	Males counted	Pair Density (males/km^2)	Males counted	Pair Density (males/km^2)[c]	
1999	172	135	0.78	132	0.98	56	0.04	36
2000	136	58	0.43	58	0.43	55	0.04	23
2001	178	22	0.12	22	0.16	22	0.02	0
2002	192	1	<0.01	0	0	2	<0.01	0
2003	192	10	0.05	9	0.07	4	<0.01	0
2004	192	10	0.05	9	0.07	6	<0.01	0
2005	192	91	0.47	84	0.62	31	0.02	21
2006	191	61	0.32	54	0.40	24	0.02	16
2007	136	12	0.09	12	0.09	12	0.02	12

[a]Standard area (the area covered in all years) is 135 km^2.
[b]Total survey area varied in the early years, but remained constant from 2002 -2006. In 2006, a 1 km^2 area surrounding the gravel pit southwest of the airport was deleted. Areas for years 1999-2003 are larger than values reported in earlier reports (Obritschkewitsch et al. 2001; Obritschkewitsch and Martin 2002a, 2002b; Rojek and Martin 2003) due to recalculation of area using criteria for lake area exclusions (see methods section).
[c]Actual area covered by aerial survey (50% coverage) was ~1408 km^2 in 1999, ~1363 km^2 in 2000 – 2006, and ~689 km^2 in 2007. Pair density calculations are half the bird density calculations reported in ABR, Inc.'s annual reports (Obritschkewitsch et al. 2008).

Aerial Survey: Density and Distribution in the Northern Arctic Coastal Plain

A total of 23 Steller's eiders (11 pairs and 1 single male) were observed on transect at 11 locations during aerial surveys (Figure 4). Estimated total for the aerial survey area was 96 birds (Obritschkewitsch et al. 2008). No eiders were observed during aerial surveys within the defined ground-based survey area. Pair density in the Barrow Triangle, estimated at 0.02 males/km^2, was the same as the last two years (nesting years) and about half that observed in earlier nesting years (1999 and 2000) (Table 3).

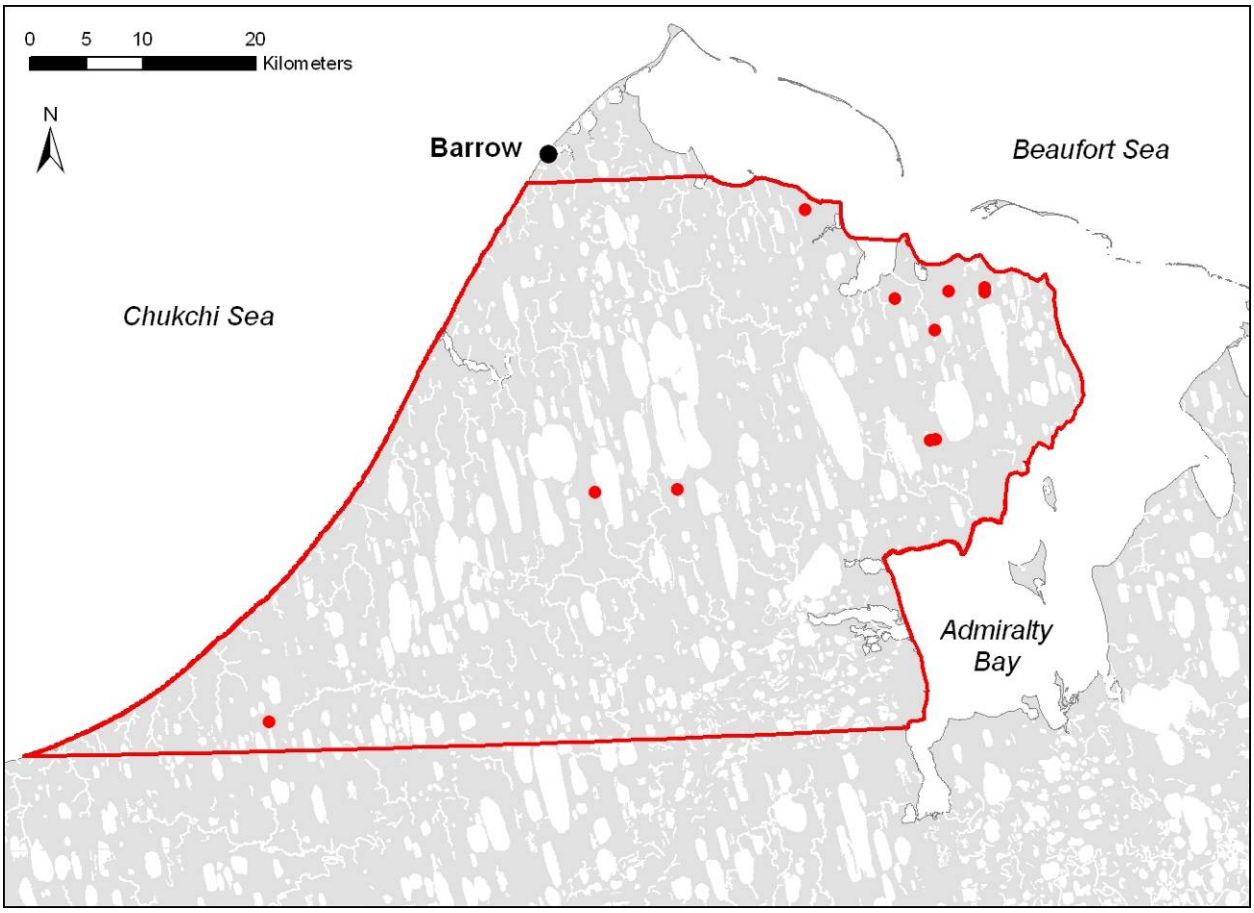


Figure 4. Steller's eider observations (red points) from the 2007 Barrow Triangle aerial survey (outlined in red) conducted by ABR, Inc.

Chronology

May and June temperatures and Snow Melt

The USFWS crew arrived in Barrow on 4 June 2007. Most of the tundra was snow-free close to town and about 50% of the Footprint Lake area was snow-free. Limited melted water was available along roadsides and the north end of Footprint Lake. Spring breakup occurred in the second and third weeks of June. Overall, June 2007 temperatures were average for Barrow and during the ground-based survey period from 12 – 18 June (Table 4).

Table 4. Average daily high temperatures, June 1999-2007, in Barrow for the month and for the ground-based survey period.

Year	June Survey dates	Average Maximum Daily Temperature, °F (std. dev. and n)	
		In June	During ground-based survey
1999	14-25	40 (5.3, 30)	41 (4.6, 12)
2000	14-29	45 (11.8, 30)	52 (10.1, 16)
2001	15-27	41 (7.9, 30)	44 (6.8, 13)
2002*	11-20	40 (6.6, 26)	41 (5.7, 7)
2003	12-20	40 (5.5, 30)	36 (3.8, 9)
2004*	14-23	44 (10.0, 29)	51 (8.4, 10)
2005	16-26	40 (6.9, 30)	42 (3.3, 11)
2006	12-21	44 (10.1, 30)	42 (5.4, 10)
2007	12-18	40 (5.6, 30)	43 (5.9, 7)

*No data available 18-21 June 2002, and 24 June 2004.

Steller's Eider Arrival, Nest Initiation, and Departure

A small number of Steller's eiders were observed in the Barrow area when the USFWS crew arrived on 4 June 2007. Small numbers were observed in Footprint Lake and other locations until surveys started on 12 June.

Nest initiation dates (defined as date of first egg laid) ranged from 17 to 23 June (n = 12; Figure 5).

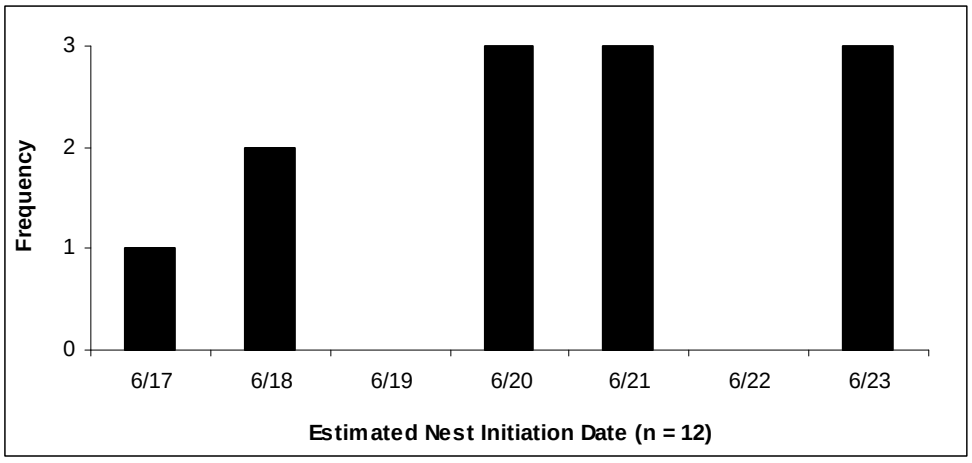


Figure 5. Estimated Steller's eider nest initiation dates near Barrow in June 2007.

Hatching occurred from 15 to 21 July (n = 7 nests). A few hens with broods (see Brood Observation section for more details), as well as lone hens, were observed on tundra ponds in the

second half of July. We had no reports of Steller's eider broods observed by other researchers after our crew departed Barrow at the end of July.

Nesting Effort

Due to funding limitations, intensive nest searching within randomly chosen plots was not conducted in 2007; thus we did not estimate number of nests or nesting density in the study area in 2007. No nests were found during the ground-based breeding pair survey. A total of 12 active nests were found during the nest search period (see Figure 6 for areas covered and Figure 7 for nest locations).

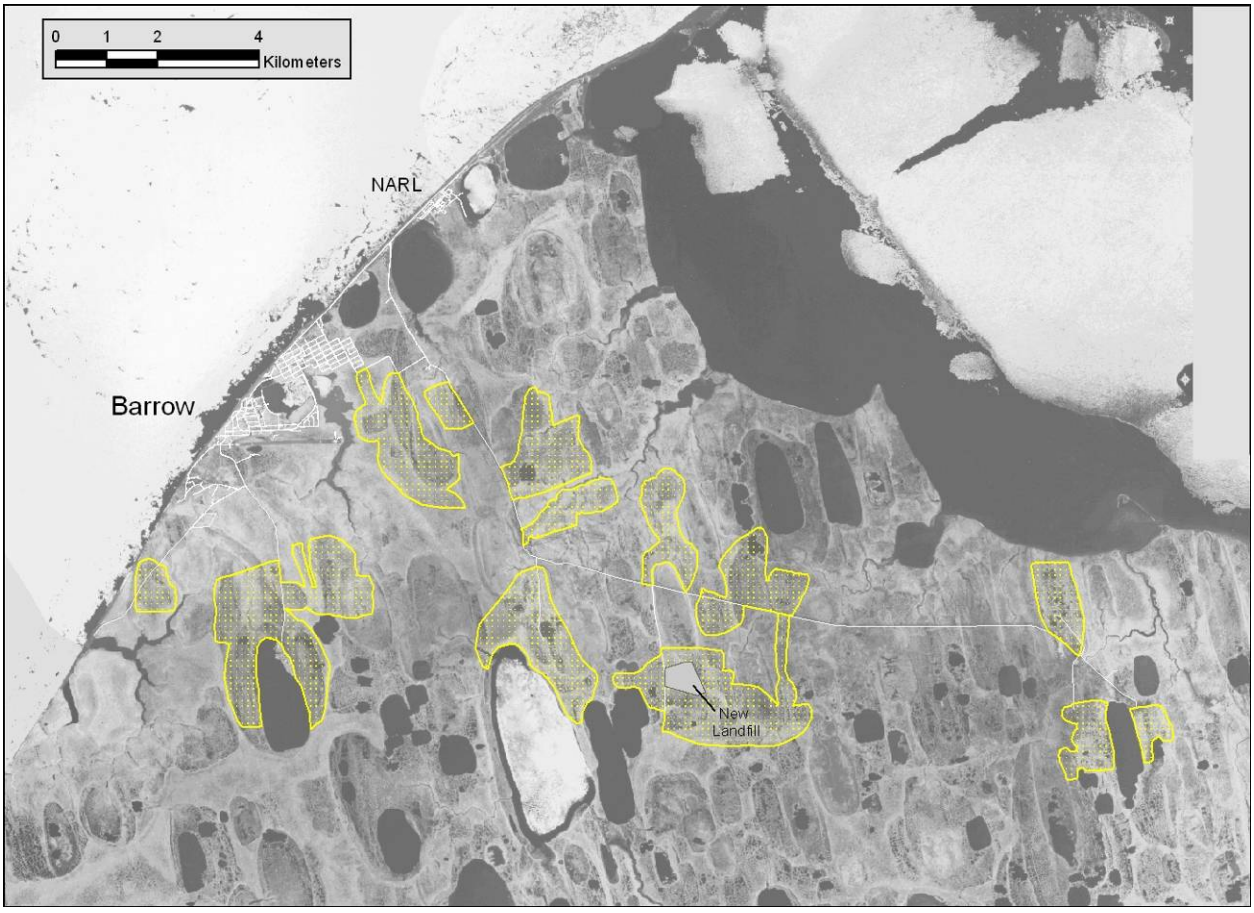


Figure 6. Areas searched for Steller's eider nests from 19 June – 16 July 2007.

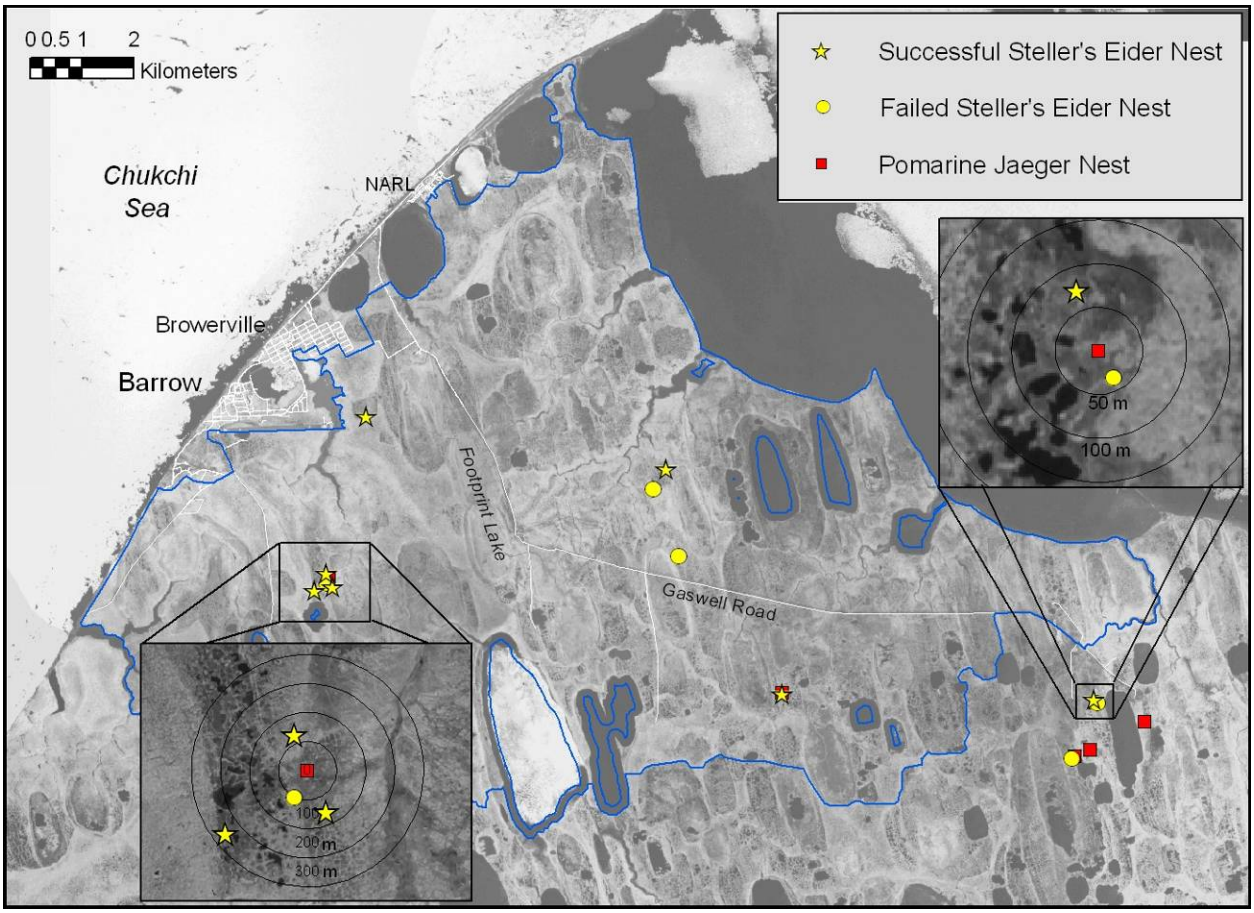


Figure 7. Locations of known Steller's eider and pomarine jaeger nests located within and near the study area in 2007.

Clutch Size and Nest Success

In 2007, effective clutch size (number of eggs in a nest after laying complete) ranged from 3 to 7 eggs (1 nest with 1 egg during early laying is not included as total clutch size not determined) and averaged 5.8 ± 1.1 eggs (Figure 8). One of 12 active nests (8%) contained 1 inviable egg.

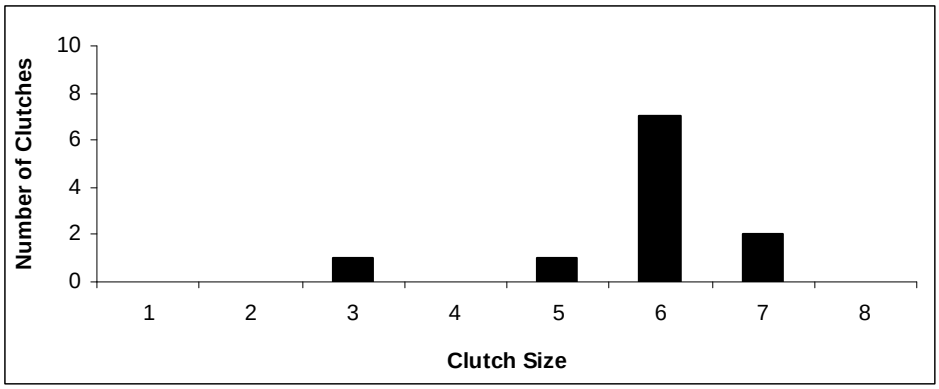


Figure 8. Effective clutch sizes for nests monitored near Barrow in 2007 (nest with 1 egg observed in early incubation but total clutch size not determined).

All 12 nests found in 2007 were active and monitored. Seven nests were known to hatch at least one duckling (Figure 9; see Appendix D for details). Average number of ducklings hatched was 5.7 ± 1.0 (range 4 to 7).

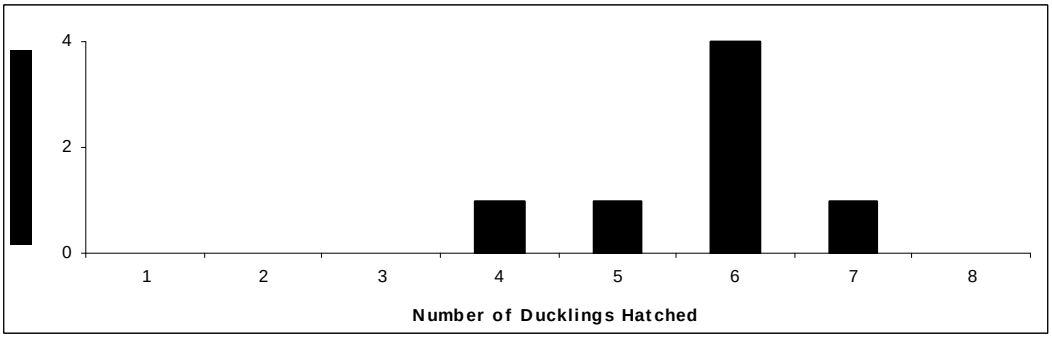


Figure 9. Number of ducklings hatched in nests monitored near Barrow in 2007.

Overall, apparent nest success was 58%. Mayfield nest success for active nests monitored (n = 12) was 46.5% (95% C.I.: 23 – 92%). See Appendix I for comparisons of nest success among years.

Five of 12 monitored nests failed, four of which were monitored with digital cameras. Camera images are still under review, but preliminary cause of failure for the four camera-monitored nests appeared to have been depredation by pomarine jaeger (1 nest and partial depredation at a second nest), common raven (1 nest), and arctic fox (2 nests, including the one partially depredated by pomarine jaeger, as noted above). At one successful nest, an arctic fox depredated the ducklings prior to the hen and brood departure from the nest bowl.

Habitat Use

Pre-Nesting Habitat Use

There were 12 sightings of single, pairs or groups of Steller's eiders during the ground-based survey (Table 5). More Steller's eiders were seen in deep *Arctophila* ponds than in any other habitat type during the pre-nesting period, followed by shallow *Arctophila* and *Carex* ponds.

Table 5. Habitat use by Steller's eiders during ground-based surveys near Barrow, 2007.

Habitat	Number of Sightings (%)	Number of Steller's eiders (%)
Ia - Flooded tundra (upland)	1 (8.3)	2 (8.7)
Ib - Flooded tundra (creek flats)	0 (0)	0 (0)
II - Shallow-Carex	2 (16.7)	4 (17.4)
III - Shallow-Arctophila	2 (16.7)	4 (17.4)
IV - Deep-Arctophila	5 (41.7)	9 (39.1)
V - Deep-open	1 (8.3)	2 (8.7)
VI - Basin-complex	0 (0)	0 (0)
VIII - Coastal	0 (0)	0 (0)
Ditch	0 (0)	0 (0)
Stream	0 (0)	0 (0)
BM - Basin marsh	1 (8.3)	2 (8.7)
DT - Dry tundra	0 (0)	0 (0)
In flight	0 (0)	0 (0)
Unknown (not recorded)	0 (0)	0 (0)
TOTAL	12	23

Nest Habitat

Most Steller's eider nests in 2007 had permanent water bodies nearby; primarily *Carex* and *Arctophila* ponds (Table 6). Mean distance to permanent water was 78 ± 78 m (range 9.6 – 260 m, n = 12; see Appendix E for more details).

Table 6. Nearest permanent water bodies to Steller's eider nests in 2007.

Nearest Permanent Water Body (basin type)	# of Nests	%
Shallow *Carex* pond	7	58
Shallow *Arctophila* pond	2	17
Deep *Carex* pond	2	17
Deep *Arctophila* pond	1	8
TOTAL	12	

In 2007, Steller's eider nests were located primarily in "Happy Valley" (northeast of Freshwater Lake, see Figure 1), at the end of Gaswell Road, and west of twin lakes (Figure 7). Five (42%) were found in areas used in previous years ("Happy Valley" and north of Footprint Lake), while the other seven were scattered in new locations in the eastern side of the study area (Figure 7). Distances between Steller's eider nests varied from 108 to 3330 m (Figure 10) and averaged 986 ± 1162 m. Unlike some previous nesting years, none of this year's nests were found <100 m from a conspecific neighbor and 42% were over 1000 m (See Appendix F for more details). Mean distance of successful nests from its nearest neighbor, 1093 ± 1466 (n = 7), was not significantly different (W = 17, p = 1.0) than mean distance of failed nests, 836 ± 665 (n = 5) (Figure 10).

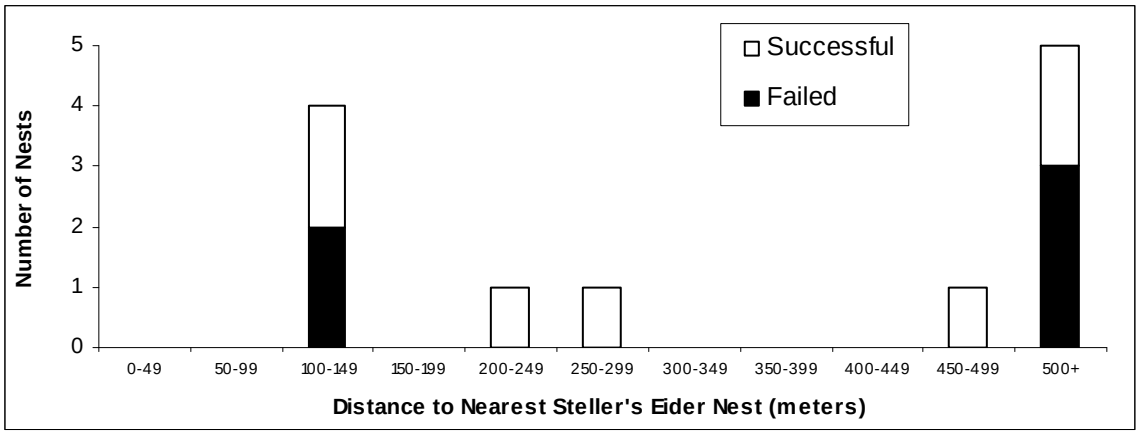


Figure 10. Nearest neighbor distances between Steller's eider nests in 2007 (n = 12).

Only 6 pomarine jaeger nests were located in study area in 2007 (Figure 7). Seven of the twelve Steller's eider nests (58%) were located within 156 m of a pomarine jaeger nest (Figure 11; see Appendix F for more details). Mean distance of successful Steller's eider nests from pomarine jaeger nests, 1268 ± 1978 m (n = 7; range 23 - 4913 m), was not significantly different (W = 17, p = 1.0) from mean distance of failed nests, 1646 ± 2197 m (n = 5; range 34 – 4670).

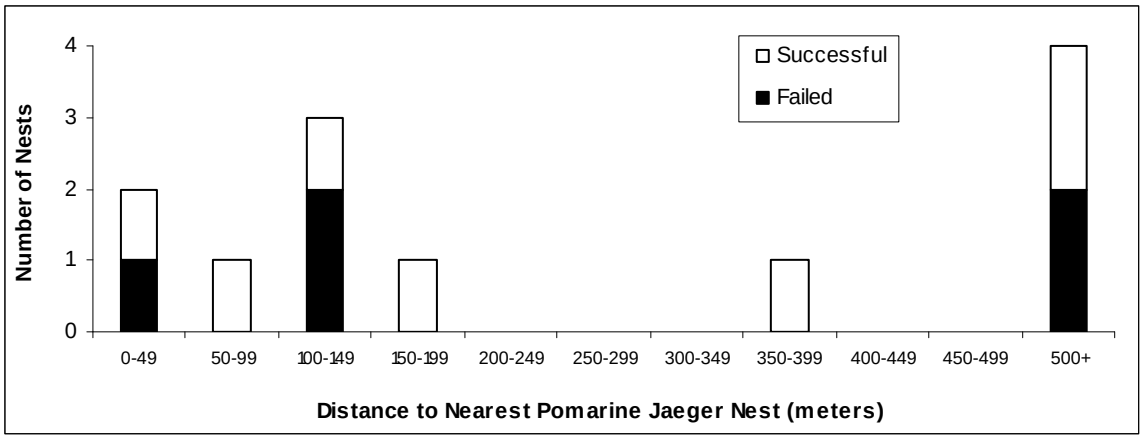


Figure 11. Distances between Steller's eider nests and nearest known pomarine jaeger nests in 2007 (n = 12).

No snowy owl nests were located within the eider study area in 2007.

Hen Capture

Five incubating hens were captured on nests close to hatch between 15 and 18 July. Some or all ducklings hatched in all nests where hens were captured. Cloacal swabs, fecal and feather samples were taken from all hens and blood was collected from four. None of the hens had been previously banded.

Brood Observations

Steller's eider hens with young broods of three to six ducklings were observed on four occasions in the second half of July. At least two of these sightings were likely the same brood (based on location and duckling size), but no bands were observed on the hens. All were observed swimming in or resting next to shallow *Arctophila* ponds. One observation was in "Happy Valley", near several nests that were monitored this year, and the other three observations were south of "Happy Valley" and east of Freshwater Lake, in wetlands where broods had been observed and radio tracked in the last two breeding years.

DISCUSSION

The 2007 season was the third consecutive Steller's eider nesting season documented near Barrow, which has only been previously recorded during one time interval (1995-1997) since breeding studies began in 1991. There were low numbers of birds observed on the tundra in mid-June during the ground-based breeding pair survey, which has indicated a non-breeding year in the past. Neither territorial nor nesting behavior was observed during the ground-based breeding pair survey, but because nesting was subsequently documented, in retrospect the survey was initiated too early to detect these behaviors.

As for chronology in 2007, arrival was similar to previous years. All nests located this year were initiated during one week in mid-June. While this was the typical time period to expect nest initiation, it has occurred over a long time period in other years with more nesting activity.

Mean clutch size (5.4) was about average in 2007 compared to other nesting years. Infertile eggs were documented in one nest (8%), which is less than the numbers observed in the past two years and averages 18% (8 of 44 nests) for the past three nesting years combined.

In previous years, the abundance of lemmings and breeding status of lemming avian predators, particularly pomarine jaegers, has been positively correlated with Steller's eider breeding activity (Appendix H; reports listed in Appendix J). Brown lemming density was lower in the Barrow area in 2007 after a high in 2006. No snowy owls and few pomarine jaegers nested within the study area. The pomarine jaegers that did nest were not aggressively defensive of their nests. The majority of the small numbers of Steller's eiders we found nesting this year were within a few hundred meters of a pomarine jaeger nest.

In 2007, ten of the twelve nests were monitored for some period of time with Reconyx digital cameras and six of the camera-monitored nests were successful. Camera images are still under review, but preliminary cause of failure for the four camera-monitored nests appeared to have been depredation by pomarine jaeger [1 nest and partial depredation (i.e., where some but not all eggs were depredated and hen resumed incubation) of a second nest], common raven (1 nest), and arctic fox (2 nests, including one partially depredated by pomarine jaeger). At one successful nest, an arctic fox depredated the ducklings prior to the brood's departure from the nest. All nests monitored with cameras in 2006 were successful, while in 2005 depredation of nests by pomarine jaegers was documented with video cameras at three of four camera-monitored nests.

Arctic fox control was conducted for the third consecutive year in the study area. Between early June and late July this year, 25 adult Arctic foxes (12 females and 13 males) and 24 juveniles were removed from the area (Corey Rossi, Wildlife Services, USDA, pers. comm.). As indicated above, preliminary review of camera images indicates two Steller's eider nest failures and one brood failure were caused by fox depredation. None of the nest failures in 2005 or 2006 were attributed to fox depredation. Foxes were sighted by FWS personnel in June and July of 2007, concurrent with fox control efforts, while fewer sighting occurred during this time period in 2005 and 2006. Fox numbers in the study area may have been higher in 2007 due to the lemming high

and associated good breeding conditions in 2006.

Low sample sizes and large confidence intervals in all years make it difficult to quantitatively assess nesting differences among years. Nest success in the past three years may have been enhanced by fox control, which confounds comparisons with earlier years. However, the relationship between fox control and Steller's eider reproduction is difficult to interpret, given large interannual differences in abundance of lemmings as well as eider predators, such as jaegers; weather; and possibly other factors that affect Steller's eider reproductive success. Although it cannot be determined with certainty, we believe that fox control in the last three years (2005-2007) contributed significantly to Steller's eider nesting success. Nest success (Mayfield estimates) averaged 16% in all years (1991-2004) before fox control was instituted, but averaged 52% 2005-2007 with fox control. Nest success was 21% in 2005, 88% in 2006 (the highest recorded since monitoring began in 1991), and 47% in 2007. Although we documented that a few nests failed due to fox predation in 2007, nest success for this year was higher than average for all years since monitoring began in 1991 (Appendix I) despite the fact that environmental conditions (lemming numbers down, no snowy owl nesting, small numbers of pomarine jaeger nesting) did not predict a good nesting year.

While sample size of monitored Steller's eider nests and broods is small due to their rarity, concurrent shorebird nesting studies were conducted since 2003 within our study area with much larger sample sizes. Shorebird nest success in 2003 and 2004 (no fox control) was 49% and 15% respectively, while success was 87%, 77%, and 84% in 2005-2007 (with fox control), respectively (Richard Lanctot, pers. comm.). These data provide further support that nest success of ground-nesting birds increases with fox control in this area.

Glaucous Gull Distribution and Abundance

Introduction

Food habits of glaucous gulls (*Larus hyperboreus*) in the Arctic vary considerably with food abundance, location, season, and individual (Day 1998). Glaucous gulls do not appear to prey heavily on lemmings, and are present near Barrow every year regardless of lemming density. Quakenbush et al. (2004) estimated local abundance as several hundred to several thousand gulls, noting that the majority appeared to be non-breeders. By far the greatest density of gulls occurs near the landfill and sewage lagoon (Figure 12). Barrow residents have expressed concerns over public health issues (gulls that presumably frequent the landfill and sewage lagoon also feed on harvested wildlife intended for human use) and a perceived increase in gull predation on waterfowl eggs and nestlings (letter from Charles D.N. Brower to U.S. Fish and Wildlife Service, September 2000).

Overall, gulls appear to have low to moderate effects on productivity for most waterfowl (Day 1998); however they can have considerable impacts on some waterfowl populations. Glaucous gulls were believed to be among the most important predators of goose and eider eggs on the Yukon-Kuskokwim Delta (Mickelson 1975). Glaucous gulls and mew gulls (*Larus canus*) were believed to exert major pressure on Yukon-Kuskokwim Delta goose populations by preying heavily on goslings of emperor (*Chen canagica*), cackling (*Branta hutchinsii minima*), and greater white-fronted (*Anser albifrons frontalis*) geese (Bowman et al. 1997). Birds nesting on islands and at high densities appear to be particularly susceptible to gull predation.

On the North Slope, glaucous gull numbers in the vicinity of oil fields vary with availability of anthropogenic food (Day 1998). Although variation in local abundance may reflect shifts in distribution rather than changes in overall population size, supplemental food likely increases juvenile gull survival and enhances body condition and fecundity of breeding gulls (reviewed in Day 1998). Thus, anthropogenic food sources may increase gull numbers on both local and regional scales.

It is unknown whether glaucous gull nest density has increased near Barrow, or whether gulls attracted to the Barrow Landfill also forage for natural foods on the adjacent tundra. As an initial assessment of the potential risk glaucous gulls pose to nesting Steller's eiders, starting in 2002 we documented gull abundance, distribution and breeding status throughout the Barrow study area.

Methods

We recorded all glaucous gulls and gull nests seen during ground-based surveys (12-18 June 2007). For each observation, location, flock size and behavior were recorded. Behavior was assigned one of five categories ("codes") as a measure of the observer's confidence in recording

the breeding status of the species observed (see Table 1), with the exception that "possible nesting" was undefined. For observations of multiple individuals, the lowest code appropriate for any individual was assigned to the group as a whole. "Probable nesting" was assigned if gulls gave alarm calls or if a pair was present and dived at the observer or called aggressively. Because the distinction between probable and possible nesting was not clearly defined for gulls, these two categories are combined in the results for a total number of sightings that may have included nesting gulls.

Gulls at the Barrow Landfill, sewage treatment lagoon, on the beach (directly across the road from the landfill), and a wetland ("North Pond") immediately northeast of the landfill (Figure 12) were also counted on two occasions (at ≈ 6 p.m.) during the 2007 ground-based survey period. Number of counts during the survey period has varied over the years. In 2002 and 2003, only one count was completed during the survey period; in 2004, landfill counts were done 1-3 times per day on multiple days of the survey; in 2005, landfill area counts were done twice per day, at ≈ 8 a.m. and ≈ 6 p.m.; in 2006, counts were done once every two to three days at ≈ 6 p.m. For comparison with ground-based survey results and previous years' data, the average of the two gull counts conducted in the landfill area during the ground-based survey period was used.

Observations were digitized on a scanned, geo-referenced aerial image of the study area using ArcView GIS software. Distribution patterns were estimated using a fixed-kernel density estimator (Hawth's Analysis tools, batched fixed kernel density estimator using kernel-bivariate normal parameter, scaling factor = 1,000,000, single smoothing factor = 1000; Beyer 2004) to calculate areas of high density (50% probability) and low-medium density (90% probability).

Additional counts of glaucous gulls at the Barrow Landfill, sewage treatment lagoon, and North Pond were collected every 2 to 3 days from 13 June to 25 July 2007 at ≈ 6 p.m. using binoculars, spotting scope (Pentax PF-80ED with 20X-60X zoom lens), and tally counter. Counts were also conducted at and in the vicinity of the new landfill (at pullouts along the road to new landfill) from 29 June to 25 July 2007 at ≈ 6:30 p.m. The new landfill started limited operation (but no organic material) in July 2007.

Results

Ground-based Survey Period

We counted 469 glaucous gulls in the 136-km^2 ground-based survey area, for an average density of roughly 3 bird/km^2 (Figure 12). An average of 100 ± 127 gulls (2 counts) were present at three sites in and around the old landfill during the survey period.

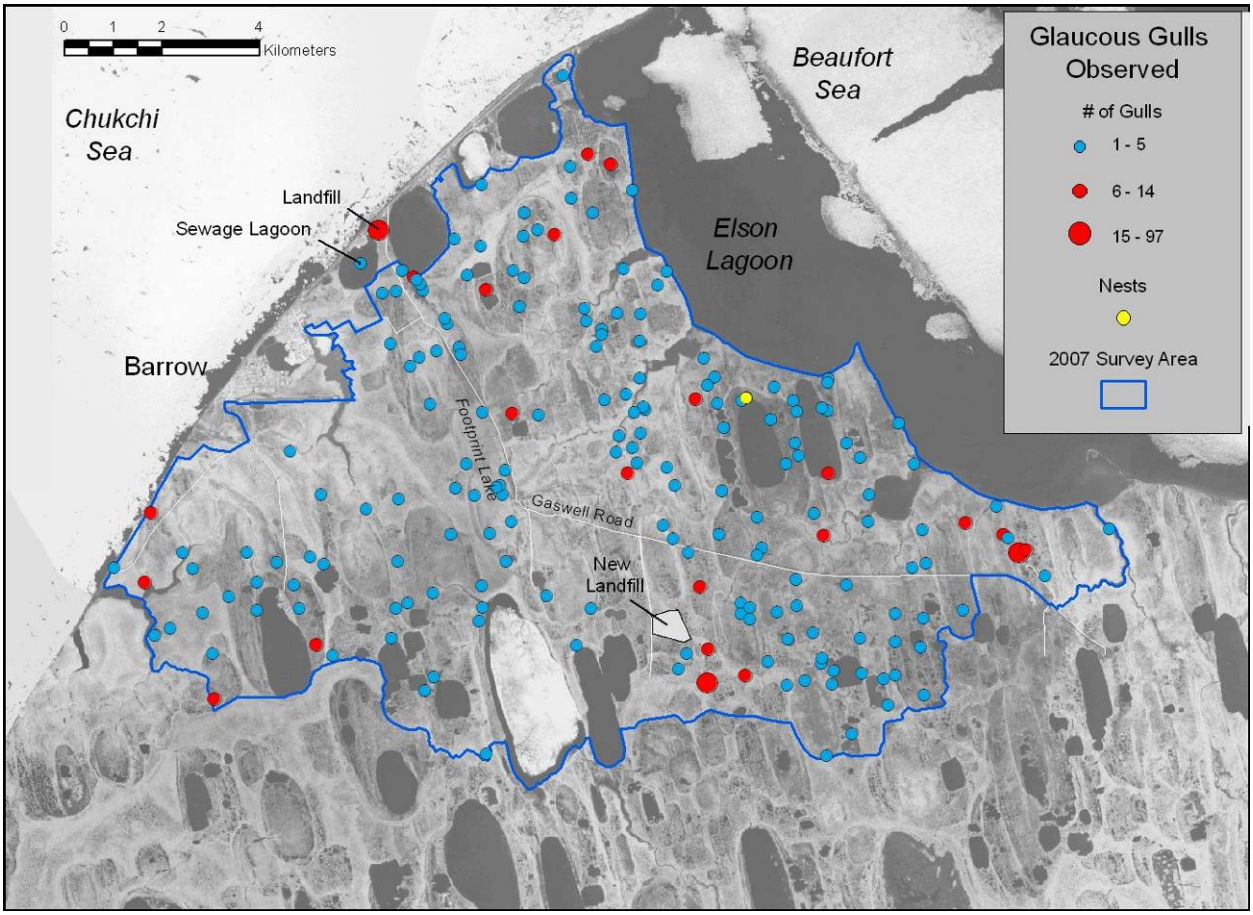


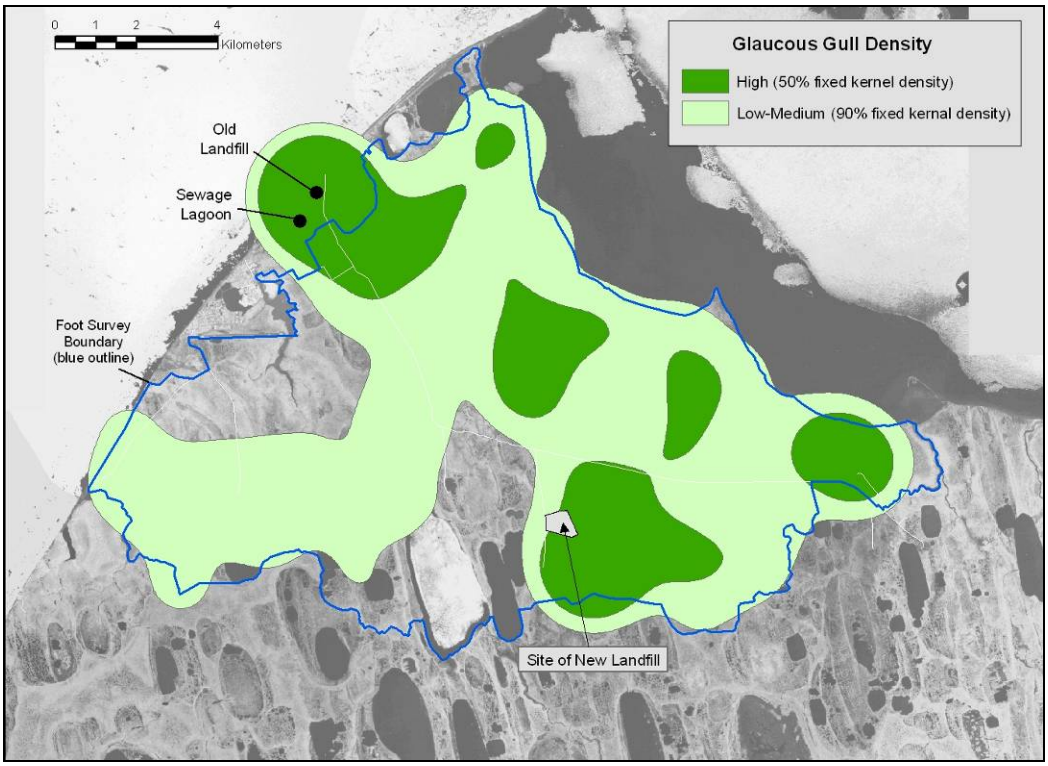
Figure 12. Glaucous gulls and gull nests observed during ground-based survey, and average counts of glaucous gulls at the Barrow landfill, sewage lagoon, and north pond, June 2007.

In the ground-based survey area, the majority of sightings were of individual (50% of sightings) and pairs of gulls (27%); 98% of sightings were of individuals, pairs, or groups of less than 10 birds (Figure 12). Small dispersed flocks or individual birds were present throughout the study area with more birds present in the eastern half of the area. The largest flock observed this year, 40 birds, was approximately 1 km southeast of the new landfill.

With landfill counts included, gull density was concentrated within a 3 km^2 area around the old landfill, as well as several areas in the eastern half of the study area, including a 4 km^2 area east of the new landfill (Figure 13A). Excluding landfill counts, gulls were distributed in very similar areas (Figure 13B).

Sightings of gulls in the ground-based survey area this year included primarily birds in flight passing through the area (68%). Gulls in low flight often seemed to alter their course to pass near ground-based surveyors.

A



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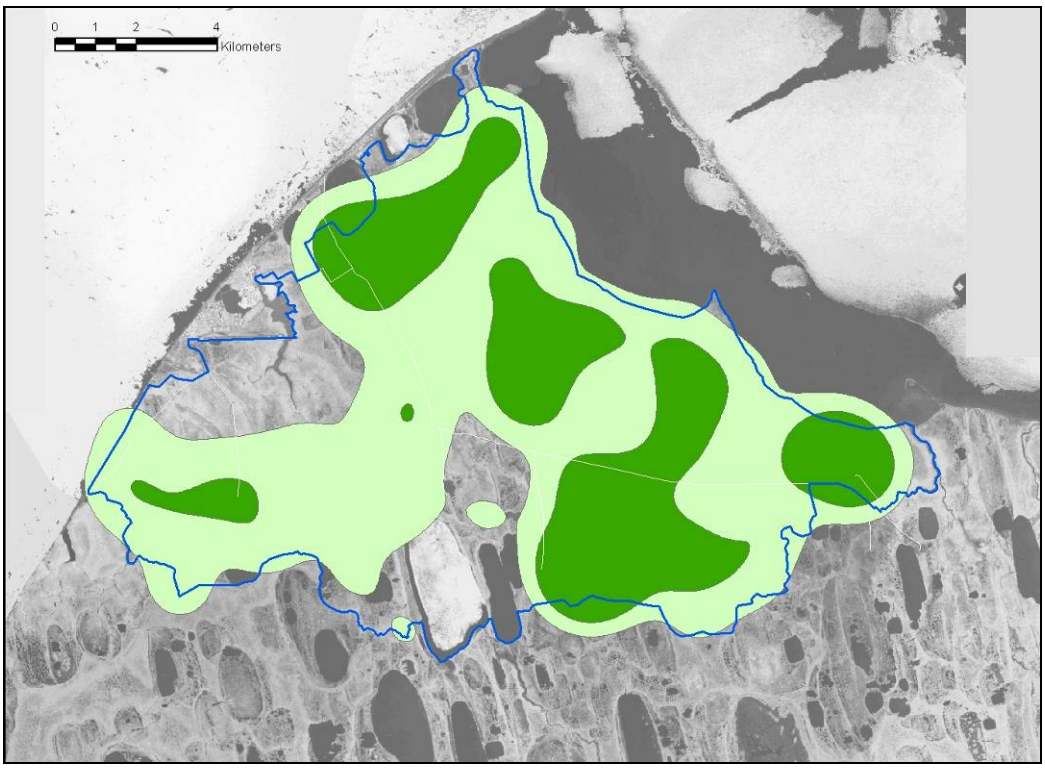

Figure 13. Glaucous gull distribution in the Barrow Area as estimated from fixed kernel analyses of gull observations during ground-based survey and in "A" including and in "B" excluding old landfill area counts, June 2007.

Only one glaucous gull nest was found within the survey area this year (Figure 12). The southeast area where an island colony of nests has been found in previous years was not included in the study area this year. In addition, 10 other sightings (5%) were of probable or possible nesting birds based on behavior (Table 7). Although some nests may have been missed during ground-based surveys, nesting glaucous gulls are typically aggressive and conspicuous on open tundra.

Table 7. Behavior of glaucous gulls counted in the ground-based survey area in 2007.

Behavior	Number of Sightings (%)	Number of Glaucous Gulls (%)
Nest	1 (0.5)	1 (0.2)
Probable/possible nest	10 (5.1)	21 (4.5)
Present	51 (26.0)	207 (44.1)
Passing through	134 (68.4)	240 (51.2)
Total	**196**	**469**

Additional Landfill Counts

Counts of glaucous gulls in the old landfill area from 13 June through 25 July averaged 256 ± 149 birds and ranged from 10 to 538 birds per count (n = 19 counts; Figure 14).

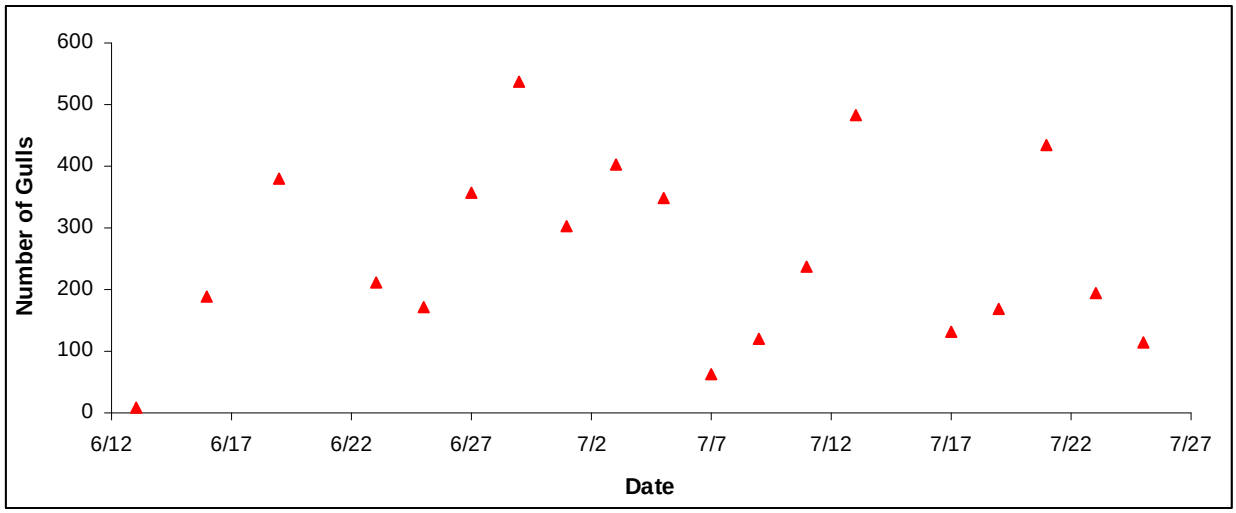

Figure 14. Evening counts of glaucous gulls in the old Barrow landfill area from 13 June through 25 July 2007.

Counts at and in the vicinity of the new landfill from 29 June through 25 July averaged 1 ± 2 birds and ranged from 0 to 8 birds per count (n = 13). Starting on the 13 July count, the landfill was in limited operation with metal objects being dumped within the fenced area. Gulls (1 to 5 individuals) were observed within the fenced landfill area on the last three counts of the season from 21 July to 25 July.

Discussion

In 2007, the number of glaucous gulls counted during ground-based surveys in the study area was similar to numbers observed in 2005 and higher than the low observed in 2006. Landfill numbers in the old landfill were the lowest observed (Table 8).

Table 8. Number of glaucous gulls and nests counted on the ground-based survey and in the landfill area, 2002-2007.

Year	Overall Ground-based Survey Area for Each Year			Common Ground-based Survey Area[a]		# Gulls in Landfill Area[a]	# Nests found near Barrow
	Area (km^2)[b]	# Gulls	Density (birds/km^2)	# Gulls	Density (birds/km^2)		
2002	192	552	2.88	404	2.97	262	12
2003	192	1424	7.42	1222	8.99	464	6
2004	192	773	4.03	624	4.59	443	1
2005	192	599	3.12	439	3.23	182	8
2006	191	257	1.35	225	1.65	292	8
2007	136	469	3.45	469	3.45	100	1

[a]Single counts in 2002 and 2003; average counts from 2004 to 2007. Landfill area refers to the old landfill located on Stevenson Street.

In all years, the majority of glaucous gulls observed in the Barrow area are suspected to be non-breeders or breeders with nests outside the study area. Few nests have been discovered in the study area (Table 8). Most nests observed over the years were found in the same location, an island within a wetland area in the southeast section of the study area. Nesting likely occurred in this wetland area in 2007, however, this area was not included in the study area. Only one nest was observed in the study area this year.

In all previous years (2002-2006), with the inclusion of old landfill counts, gull density was greatest in and near the old landfill. Gull density patterns were generally similar among those four years (see Obritschkewitsch and Martin 2002b; Rojek and Martin 2003; Rojek 2005, Rojek 2006, Rojek 2007). In 2007, high gull density was spread out in several areas, including near both old and new landfill areas and several other areas in the eastern half of the study area (Figures 17 & 18A). Excluding the landfill/sewage lagoon counts, the gull high density pattern in 2007 is similar to the pattern with those counts included (Figure 13B). This is the first year that high densities of gulls were observed within the vicinity of the new landfill. The new landfill was not in operation at the time of the survey, but preparation activities were occurring.

We did not observe any pattern in the additional counts at the old landfill through July. This year the highest count was 538 birds, which is similar to the high in 2006 (530 birds) but lower

than the high numbers observed in 2005 (1843 birds). There were few gulls observed directly within or near the new landfill during the counts conducted in July. Observations of gulls directly in the new landfill occurred one week after limited operation (no organic material) was noted. Gulls may have been attracted to the activity within the landfill area.

As noted in previous years, we still do not know the extent to which gulls attracted to the landfill also forage for natural foods in the Barrow area or their effects on local tundra-nesting birds. Similar to other years, most gulls were observed in flight and few were observed actively foraging. Possibly, gulls in flight were searching for foraging opportunities. With the closure of the old landfill and increased operation of the new landfill, it will be interesting to observe if glaucous gull numbers and distribution change in future years. More gulls were observed in the vicinity of the new landfill during the ground-based survey this year than observed in previous years. Regardless of the landfill's role, based on gull abundance throughout the study area, glaucous gulls are potential predators of Steller's eider nests near Barrow.

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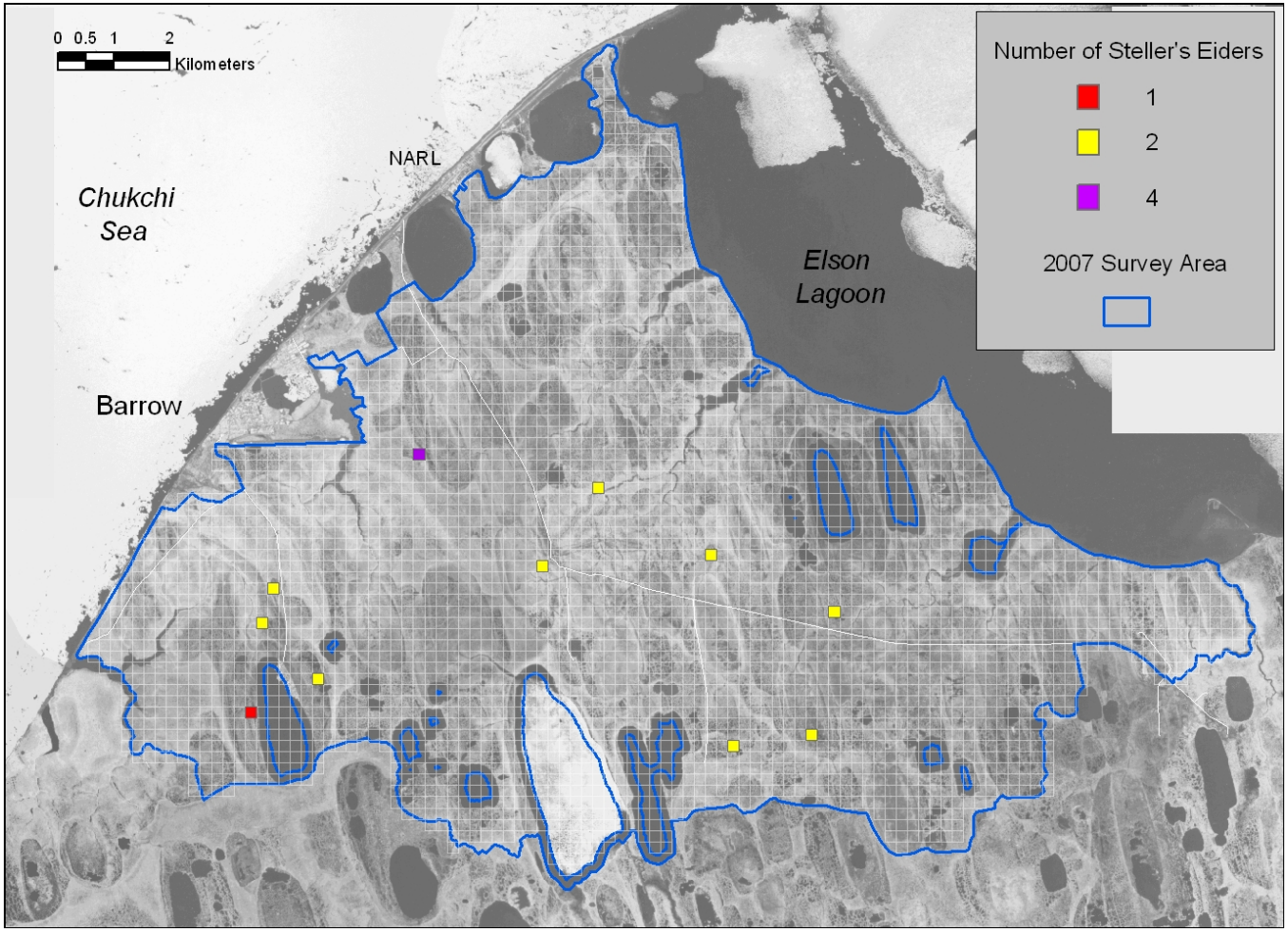


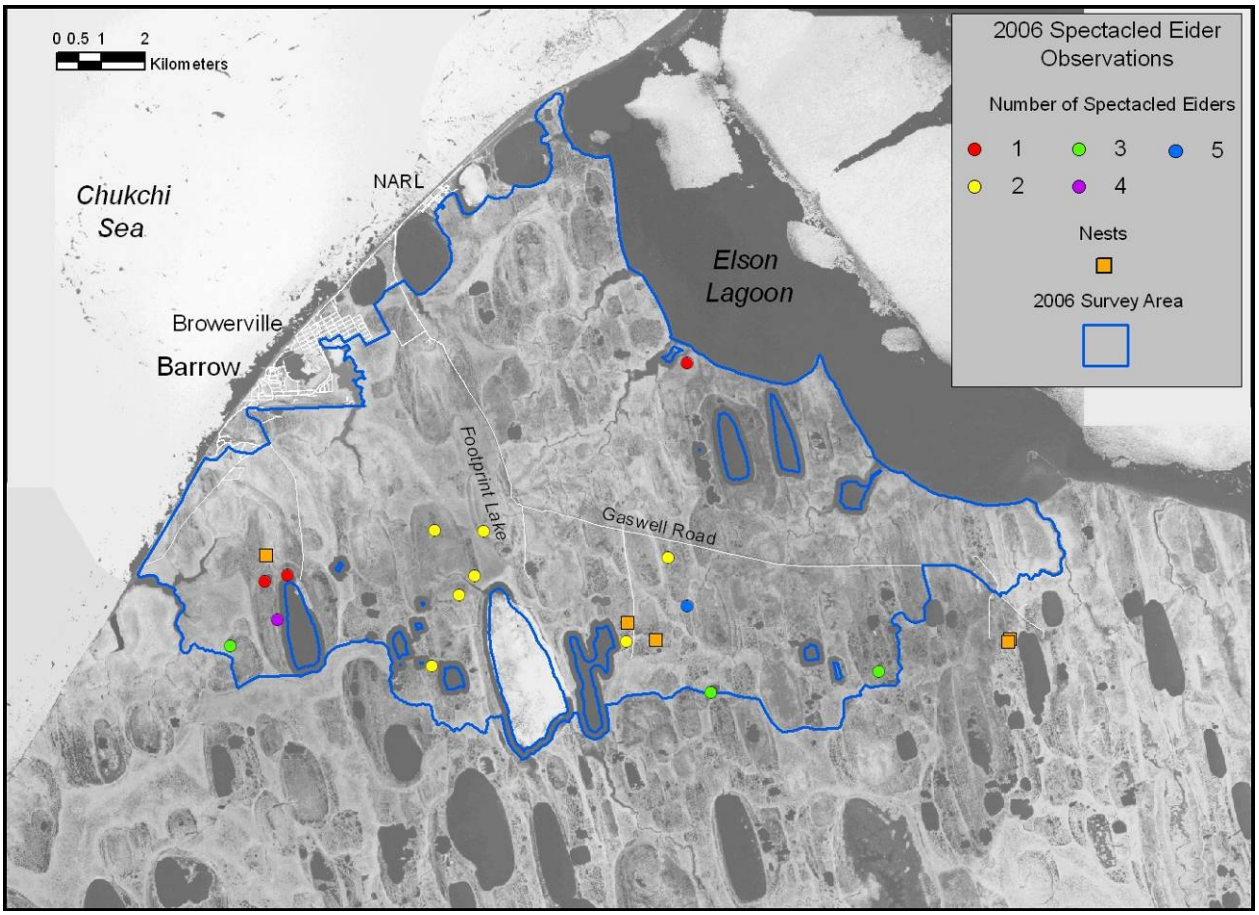
Appendix A. Density of Steller's eiders in the survey area from ground-based breeding pair survey observations, 12-18 June 2007. Eider density is displayed within 200 m^2.

Appendix B. 2007 Ground-based Survey results for all species counted. The number of confirmed nests is reported for survey results only; additional nests were found during nest searches or incidentally for Steller's eiders and other species.

Common Name	Species Name	Total number counted	Density (#/km^2)[a]	Number of confirmed nests/dens	Number of probable[b] nests	Number of possible[c] nests
Steller's Eider	*Polysticta stelleri*	23	0.17	0	0	0
Spectacled Eider	*Somateria fischeri*	35	0.26	0	0	6
Pomarine Jaeger	*Stercorarius pomarinus*	75	0.55	0	0	3
Parasitic Jaeger	*S. parasiticus*	158	1.16	1	2	6
Long-tailed Jaeger	*S. longicaudus*	66	0.49	0	0	1
Glaucous Gull	*Larus hyperboreus*	469	3.45	1	9	1
Snowy Owl	*Nyctea scandiaca*	56	0.41	0	0	0
Common Raven	*Corvus corax*	8	0.06	1[d]	0	0
Arctic Fox	*Alopex lagopus*	13	0.10	1[e]	N/A	N/A

[a] Survey area = 135 km^2. Density estimates in this table includes all birds observed (both males and females).
[b]Probable nest: behavior strongly suggests nest presence, but no nest was discovered.
[c]Possible nest: behavior suggests possible presence of a nest.
[d]A minimum of one pair resides in Barrow, with confirmed nesting on dewline towers north of NARL.
[e]Dens are generally not found during the survey but they are known to exist in the study area.

Appendix C. Spectacled eider observations during ground-based breeding pair surveys, 12 - 18 June 2007 and nests located in Barrow area in 2007.



Appendix D. Egg fates for Steller's eider nests, 2007.

Nest	Known Eggs Laid	Found Viable?	Egg Fates				
			Hatched	Inviable or died before hatch	Abandoned Whole	Vanished[a]	Depredated, shells present
1[b]	6	Y	6	0	0	0	0
2[b]	5	Y	5	0	0	0	0
3[b]	3	Y	0	1	0	2[c]	0
4[b]	1[d]	Y	0	0	0	1	0
5[b]	6	Y	6	0	0	0	0
6[b]	7	Y	0	0	0	5[e]	2
7[b]	6	Y	6	0	0	0	0
8[b]	6	Y	0	0	0	6	0
9[b]	7	Y	7	0	0	0	0
10[b]	6	Y	6	0	0	0	0
11	6	Y	0	0	0	6	0
12	6	Y	4	1	0	1	0
Total	**65**		**40**	**2**	**0**	**21**	**2**

[a]Vanished eggs are eggs unaccounted for at final nest visit. Either eggs did hatch and eggshell membranes were not recovered, or eggs disappeared due to partial nest depredation.
[b]Nest monitored with digital camera.
[c]Digital camera images revealed predation occurred at least 2 times at nest. No eggshells remained or at near nest.
[d]Digital camera images indicate more than one egg was laid, but total number not visually confirmed at nest.
[e]Digital camera images revealed predation occurred at least two times at nest. Not all eggshells recovered at nest.

Appendix E. Nearest water bodies to Steller's eider nests, 2007.

Nest	Nearest Permanent Water				Nearest Temp Water	
	Distance (m)	Type	Vegetation	Size (m x m)	Distance (m)	Type
01-07	10	LCP[a]	*Carex*	12 x 8	8	LCP
02-07	260	LCP	*Carex*	17 x 13	23	LCP
03-07	44	LCP	*Carex*	34 x 16	6	LCP
04-07	10	Pond	*Carex*	32 x 12	28	LCP
05-07	164	LCP	*Carex*	34 x 16	79	Trough
06-07	42	Pond	*Carex*	56 x 26	9	Lake Basin
07-07	46	Pond	*Carex*	56 x 27	8	LCP
08-07	22	Pond	*Arctophila*	29 x 16	5	LCP
09-07	129	LCP	*Carex*	15 x 8	45	LCP
10-07	24	Pond	*Arctophila*	32 x 20	1	Lake Basin
11-07	41	LCP	*Carex*	29 x 12	16	LCP
12-07	145	Pond	*Arctophila*	39 x 15	7	LCP

[a]Low-centered polygon

Appendix F. Distances from Steller's eider nests to nearest known Steller's eider, pomarine and parasitic jaeger nests in 2007 (no snowy owl nests located in 2007).

Nest ID	Successful Nest?	Distance to Nearest Nest (m)		
		Steller's Eider	Pomarine Jaeger	Parasitic Jaeger
01-07	Yes	3330	23	531
02-07	Yes	3130	3230	700
03-07	No	120	103	1330
04-07	No	1390	3320	698
05-07	Yes	120	156	1353
06-07	No	108	34	6630
07-07	Yes	108	74	6574
08-07	No	1390	4670	842
09-07	Yes	212	127	1512
10-07	Yes	268	356	1103
11-07	No	1170	104	6281
12-07	Yes	482	4913	1074

Appendix G. Steller's eider breeding biology study, 1991-2007: a brief review.

Steller's eider abundance and breeding effort vary widely near Barrow from year to year. Steller's eiders do not initiate nests near Barrow in some years, and can be absent from the tundra by mid-June. During this study, nesting by Steller's eiders was correlated with nesting by avian predators (Appendix H). Mayfield nest success has ranged from 0 to 88% (Appendix I). Following is a brief review of results from each year of this study. Details can be found in annual reports and other publications (Appendix J).

1991 Only six nests were found, but search effort was very low in the pilot year of this study. High success of nests monitored and presence of several broods from unknown nests (including four broods observed with mostly grown young in late August) suggest a relatively good breeding year.

1992 One pair was observed, on 15 June. No other Steller's eiders were seen in the study area in 1992. It was hypothesized that severe spring sea-ice conditions may have delayed spring migration and precluded nesting, however we cannot dismiss the possibility that Steller's eiders were present briefly and/or departed prior to initiation of ground surveys in the second week of June.

1993 Nests were initiated in mid- to late June. Most nests were found in a lake basin associated with Voth Creek, NW of Footprint Lake.

1994 Most Steller's eiders remained grouped on Footprint Lake until mid-July. Small groups and a few discrete pairs were observed away from Footprint Lake, but no nests were found or suspected.

1995 Steller's eiders arrived in early June. Nests were found in high numbers in various locations throughout the western half of the study area, including the Voth Creek basin, both sides of Freshwater Lake Road, and just east of Footprint Lake. Fledging success was low, but at least one brood was thought to have fledged.

1996 Warm May temperatures resulted in early snow melt. Steller's eiders dispersed to breeding areas almost immediately after arriving on 2 June. The main known nesting area was the Voth Creek basin, NW of Footprint Lake. Fledging success was low, but at least one brood was thought to have fledged.

1997 Steller's eiders arrived in early June and dispersed across the tundra in groups of 1-3 pairs after open water became available. Only four nests were found despite extensive search effort. None hatched. Groups began staging to depart in early July. No Steller's eiders were seen on the tundra after 10 July.

Appendix G continued

1998 Flocks occupied flooded wetlands in early June. A few discrete pairs were seen on tundra, but none remained for more than a few days. No nests were known or suspected. No Steller's eiders were observed on inland sites after 12 June.

1999 Steller's eiders arrived in early June. Nests were initiated throughout the latter half of June in various places in the western half of the study area, particularly in the Voth Creek basin.

2000 Steller's eiders arrived in early June. Nests were initiated primarily in the latter half of June. The greatest concentration of nests occurred near the SW corner of Footprint Lake.

2001 Mixed-sex flocks were observed in early June on flooded tundra and Footprint Lake. Pairs were observed briefly on the tundra during the latter half of June. No nests were initiated. No Steller's eiders were seen on the tundra past 25 June.

2002 A few flocks were seen in early June, but only a handful of discrete pairs were observed briefly on the tundra. Only one pair was seen at an inland site past 7 June (seen on 17 June) but was not present during a subsequent visit. For the first time during this study, snowy owls initiated nests in a year when Steller's eiders did not, however only 4 snowy owl nests were found (far fewer than in any other nesting year).

2003 Steller's eiders arrived in late May. Mixed-sex flocks were observed in Footprint Lake, Middle Salt Lagoon, and a few other flooded tundra areas and streams. Only 4 discrete pairs were observed on the tundra but they did not appear territorial. The last pair observed inland was on 19 June, which was the only pair observed after 14 June. Snowy owls initiated 6 nests.

2004 Phenology similar to 2003. Steller's eiders arrived in late May. Mixed-sex flocks were observed in Footprint Lake, Middle Salt Lagoon, and a few other flooded tundra areas and streams. Only 4 discrete pairs were observed on the tundra but they did not appear territorial. The last pair observations inland occurred on 21 June. On 7 July, one hen was observed on an inland pond and was reluctant to leave the area. Snowy owls did not nest and no pomarine jaeger nests were found during ground-based surveys.

2005 Steller's eiders present in early June. Nests were initiated throughout the latter half of June, mainly in the Voth Creek basin and west and east of Freshwater Lake Road. Two broods were known to have fledged. Four snowy owl and four pomarine jaeger nests were found in study area.

2006 Steller's eiders arrive in early June. Nests were initiated throughout the latter half of June in various locations throughout the study area. Four broods were known to have fledged. Snowy owls and pomarine jaegers nested in large numbers throughout the study area.

Appendix G continued

2007 Steller's eiders were present in small numbers in early June. Nests were initiated in the latter half of June in various locations but mainly found east of Freshwater Lake Road and at the end of Gaswell Road. Snowy owl nests did not nest and six pomarine jaegers nests were found in the study area.

Appendix H. Nesting by Steller's eiders and avian predators near Barrow, 1991-2007.

Year	Steller's eiders present past 15 June?	Nesting by			Steller's eider nests[a]		
		Steller's eiders	Snowy Owls (number of nests)[b]	Pomarine Jaegers	Found viable	Found post-failure	Total found
1991	Yes	Yes	Yes (33)	Yes	6	0	6[c]
1992	No	No	No (0)	No	0	0	0
1993	Yes	Yes	Yes (20)	Yes	13	7	20
1994	Yes	No	No (0)	No	0	0	0
1995	Yes	Yes	Yes (54)	Yes	25	53	78
1996	Yes	Yes	Yes (19)	Yes	12	10	22
1997	Yes	Yes[d]	No (0)	No	3	1	4
1998	No	No	No (0)	No	0	0	0
1999	Yes	Yes	Yes (26)	Yes	27	9	36
2000	Yes	Yes	Yes (17)	Yes	17	6	23
2001	Yes	No	No (0)	No	0	0	0
2002	Yes[e]	No	Yes (4)	No	0	0	0
2003	Yes[f]	No	Yes (6)	Yes[g]	0	0	0
2004	Yes	No	No (0)	No	0	0	0
2005	Yes	Yes	Yes (4)	Yes	16	5	21
2006	Yes	Yes	Yes (35)	Yes	16	0	16
2007	Yes	Yes	No (0)	Yes	12	0	12

[a]Number of nests found are not comparable among years due to inconsistent search effort.
[b]Data on number of owl nests from Owl Research Institute surveys (213 km^2 that encompasses the Steller's eider ground-based survey area) in the Barrow area (Petersen and Holt 1999; Denver Holt, Owl Research Institute, personal communication).
[c]Much lower search effort than in other years.
[d]Very few Steller's eider nests were found despite considerable search effort.
[e]One pair was observed on 17 June at a site not visited in earlier years. Otherwise, none were seen after 7 June.
[f]One pair observed on 19 June in a large stream. No other birds were observed after 14 June.
[g]Only one Pomarine Jaeger nest found during the survey, which was abandoned later in the season.

Appendix I. Steller's eider nest success, 1991-2007.

Year	Apparent Nest Success			Mayfield Success Estimate [a]				
	n	Nests hatched	Success (%)	Found viable	Number failed	Exposure days	Success (%)	Confidence limits (95%)[b]
1991	6	5	83	6	1	89	71	36-100
1992	0	0		0	0	0		
1993	20	4	20	13	9	161	18	5-55
1994	0	0		0	0	0		
1995	78	8	10	25	17	270	14	5-36
1996	22	6	27	11	5	147	35	14-88
1997	4	0	0	3	3	9	0	0-56
1998	0	0		0	0	0		
1999	36	7	19	27	20	256	9	3-25
2000	21[c]	4	19	17	11[c]	163.5 [d]	12	3-43
2001	0	0		0	0	0		
2002	0	0		0	0	0		
2003	0	0		0	0	0		
2004	0	0		0	0	0		
2005[e]	21	6	29	15	9	156	21	7-62[f]
2006[e]	16	15	94	16	1	226	88	67-100
2007[e]	12	7	58	12	5	198.5	47	23-92
Overall	236	62	26	145	81	1676	23	17-32

[a]Mayfield (1961, 1975)
[b]Johnson (1979)
[c]Excludes two nests that failed as a result of research activities.
[d]Includes pre-failure exposure intervals of two nests that failed due to research activities.
[e]Fox control occurred in study area. Mayfield success rates for 2005 and 2006 are recalculated from previously reported values (Rojek 2006, 2007) to include all nests in calculation (previously captured and camera monitored nests were excluded as manipulated), except those that may have failed due to research activities.
[f]Includes pre-failure exposure intervals (prior to manipulation) for two nests that may have failed due to research activities.

Appendix J. Reports of the Steller's eider breeding biology study for 1991-2007.

Publication	Years covered
Quakenbush et al. 1995	1991-1994
Quakenbush and Suydam 1999	1991-1995
Quakenbush et al. 2000	1991-1996
Quakenbush et al. 2004	1991-1999
Johnson and Korte 1997 (Appendix B in Obritschkewitsch et al. 2001)	1997
Obritschkewitsch et al. 2001	1998-2000
Obritschkewitsch and Martin 2002a	2001
Obritschkewitsch and Martin 2002b	2002
Rojek and Martin 2003	2003
Rojek 2005	2004
Rojek 2006	2005
Rojek 2007	2006
This report	2007