TECHNICAL REPORT

BREEDING ECOLOGY OF STELLER'S AND SPECTACLED EIDERS NESTING NEAR BARROW, ALASKA, 2012

Prepared by: David E. Safine

Endangered Species Branch
Fairbanks Fish and Wildlife Field Office
101 12th Ave., Room 110
Fairbanks, Alaska 99701

Fish and Wildlife Service
U.S. Department of the Interior

May 2013

This report may be cited as follows:

Safine, D. E. 2013. Breeding ecology of Steller's and spectacled eiders nesting near Barrow, Alaska, 2012. U. S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 64 pp.

TABLE OF CONTENTS

TABLES

FIGURES

ACKNOWLEDGMENTS

We greatly appreciate the help provided by the long list of individuals who assisted with field work on the eider project in 2012. We received tremendous assistance from the following U.S. Fish and Wildlife Service (USFWS) staff: Matthew Wilson, Megan Zarzycki, Neesha Stellrecht, Kaithryn Ott, Maria Berger, and Ernest Nageak. USFWS volunteers donate their time and energy to this project each year, and we would not be able to conduct a project of this scale without their valuable assistance. We extend our sincerest gratitude to following volunteers: Peter Winch, Emmett Wild, Michael Beck, Veronica Chaidez, Michelle Sopoliga, and Sarah MacLean. Eider Journey students are a very important and enthusiastic part of the team, thanks to the following Barrow High School students: Johnathon Nelson, Antonio Dunbar, Jared Nayakik, Ramey Gerke, Devan Amling, and Taylor Masterson. We thank Matthew Wilson and Megan Zarzycki for countless hours of nest camera data analysis. We appreciate the help of the USFWS Shorebird crew and Denver Holt of the Owl Research Institute for providing us with waterfowl and snowy owl nest locations. We value all the logistical assistance and support provided by staff at the North Slope Borough Department of Wildlife Management, particularly Taqulik Hepa, Robert Suydam, Todd Sformo, Brian Person, and Ryan Klimstra. Thanks to the North Slope Borough School District and Barrow Arctic Science Consortium (BASC) for their generous in-kind support and facilitating the participation of Barrow High School students in our work. Sincere thanks are due to Neesha Stellrecht for the countless ways she helps make our project run smoothly. We also thank Maria Berger for coordinating the Eider Journey Program. We appreciate the effort by Tuula Hollmen, Heidi Cline, and Ann Riddle of the Alaska SeaLife Center to help us assess and safely transport injured eiders. Thanks to Terry Smith and his trapping crew (USDA, Wildlife Services) for providing fox control in the study area each year. We benefited greatly from the expertise of the aerial survey team of Tim Obritschkewitsch and John Rose. Thanks to Glenn Sheehan of BASC for providing logistical support which was greatly appreciated. We thank the people of Barrow for making us feel welcome in their community, and Ukpeagvik Inupiat Corporation, Inc. (UIC) for providing housing and allowing us to study eiders on their land. Thanks to the National Oceanic and Atmospheric Administration and the Climate Monitoring and Diagnostic Laboratory (NOAA/CMDL) for access to NOAA/CMDL and U.S. Geological Survey land. We appreciate the generous support and guidance of Ted Swem, Sarah Conn, and Jimmy Fox of USFWS Fairbanks Fish and Wildlife Field Office. The National Fish and Wildlife Foundation, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, ConocoPhillips Alaska, Inc., and the North Slope Borough School District all provided critical project funding and in-kind support. Previous drafts of this report were greatly improved by the reviews of Stephen McDowell and Ted Swem.

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 and Aleutian Islands. A much smaller group, the Alaska-breeding population, nests primarily on the Arctic Coastal Plain of Alaska (North Slope; Pitelka 1974) and a handful of pairs may continue to nest on the Yukon-Kuskokwim Delta (Kertell 1991, Flint and Herzog 1999). Since the mid-1970s approximately 10 nests have been documented on the Yukon-Kuskokwim Delta (Flint and Herzog 1999, B. Lake/USFWS pers. comm.). 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), with the greatest breeding pair density 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 nesting Steller's eider to Barrow creates a unique opportunity to engage in research that might otherwise not be logistically and economically feasible on the Arctic Coastal Plain, but also gives rise to potential conflicts between a threatened species and an active, expanding community. Barrow is an important study site for Steller's eiders for two reasons. First, it is the most logistically feasible and only known location to consistently collect demographic data on the Alaska-breeding population. Secondly, site-specific information is necessary for conservation planning and to fulfill the Service's consultation responsibilities under Section 7 of the U.S. Endangered Species Act.

In 1991, the U.S. Fish and Wildlife Service (USFWS) Ecological Services Fairbanks Field Office and the North Slope Borough 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 annual variation in breeding effort of Steller's eiders and the avian predators (pomarine jaegers and snowy owls) related to their abundance and habitat use. Beginning in 1999, a breeding pair survey was added to the study to map distribution and relative abundance of Steller's and spectacled (*Somateria fischeri*) eiders and avian predators in the Barrow area. Demographic data (nest and brood survival) and nest locations have been collected on Steller's eiders since 1991, and in 2009 we began to record demographic data on spectacled eiders and other waterfowl. Understanding factors that limit reproductive output in Steller's eiders is critically important to species recovery, and comparing the nesting strategy of Steller's eiders to other waterfowl species in the same area may help understand these factors. The focus of this study is Steller's eiders, but effort is now also placed on spectacled eiders, and to a lesser extent on other nesting waterfowl.

Knowledge of Steller's eider density and breeding distribution on the North Slope is limited, mainly because this species is present in very low numbers and thus is difficult to survey. Aerial breeding pair surveys flown annually by USFWS Migratory Bird Management across the North Slope are conducted at a relatively low intensity (2-4% area coverage; Stehn and Platte 2009) given the vast area and limited available resources. Because this species is present in low and highly variable numbers on the Arctic Coastal Plain, and survey coverage is limited, estimates of abundance and population trends are imprecise (Stehn and Platte 2009). Using the best available information from the Arctic Coastal Plain aerial surveys conducted from 1993-2008, Steller's eiders are estimated to number about 576 (292-859, 90% CI) in Northern Alaska (Stehn and Platte 2009).

To estimate density and examine annual breeding-season distribution of Steller's eiders in the Barrow area, more intensive aerial surveys were initiated in 1999 (within approximately 60 km of Barrow; Figure 2). This more intensive and localized aerial survey flown by ABR, Inc. is referred to as the Barrow Triangle Survey, and coverage varies from 25-50% of the survey area (~700-1400 km^2) depending on breeding conditions. The Barrow Triangle Survey typically observes more Steller's eiders in a given year than the larger scale aerial surveys of the Arctic Coastal Plain (Stehn and Platte 2009, Obritschkewitsch and Ritchie 2010); however, inference from this survey is limited to the Barrow Triangle Region and cannot be extrapolated to the North Slope as a whole.

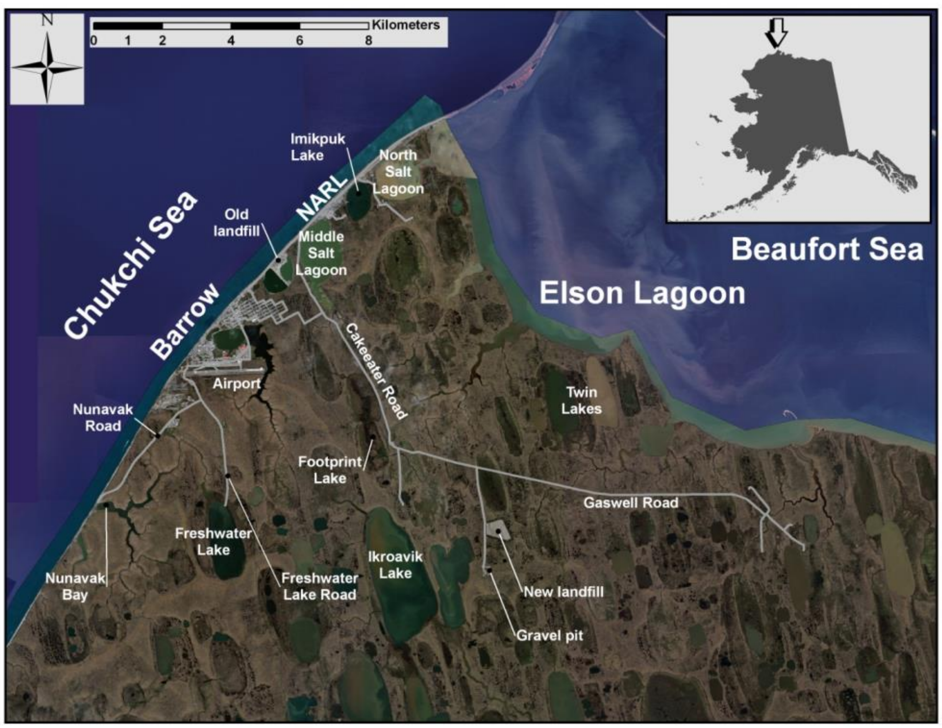


Figure 1. Location and features of the Steller's and spectacled eider study area near Barrow, Alaska.

Annual ground-based surveys covered in this report are the only efforts that collect demographic data on the Alaska-breeding population of Steller's eiders, but are conducted on a smaller spatial scale than the two previously mentioned aerial surveys. Ground-based surveys are conducted in a ~170 km^2 area, within approximately 6 km of the road system near Barrow, Alaska (Figure 2) and are used to locate and monitor breeding pairs, nests, and broods.

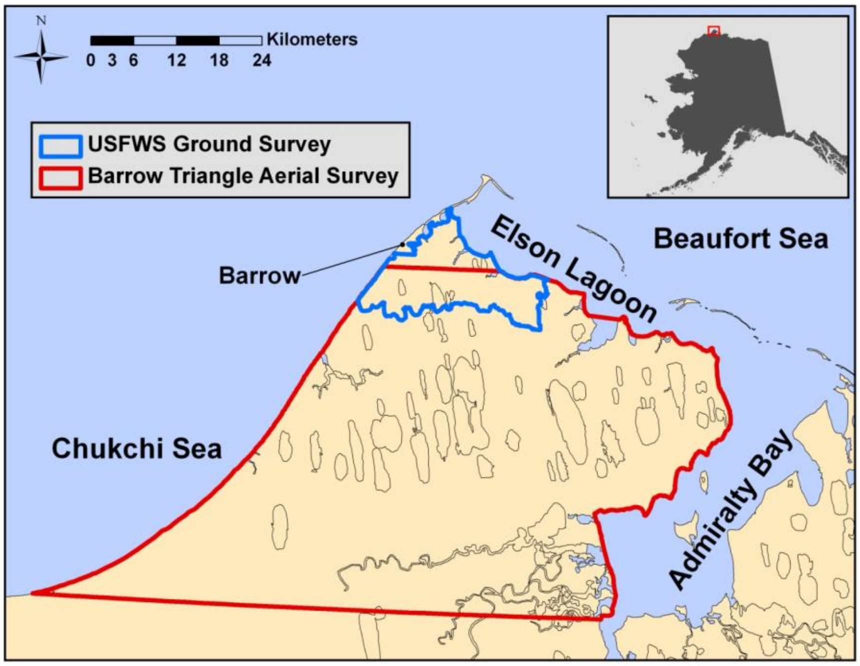


Figure 2. Location of the annual ground-based and aerial surveys conducted in the vicinity of Barrow, Alaska.

Objectives

Annual studies of Steller's and spectacled eiders near Barrow directly contribute 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 demographic parameters (mainly nest and brood survival) allows us to observe effects of management actions aimed at increasing reproductive success of birds nesting in the Barrow area. Without this monitoring, we would have no ability to assess the efficacy of actions or modify management actions in response.

A recovery plan for Steller's eiders was completed in 2002, and for spectacled eiders in 1996. Based on the plans, recovery priorities are periodically revised (annually or biannually), and recovery efforts at Barrow directly or indirectly address 21 high priority tasks identified on the most current recovery task lists (Steller's eider, February 2009; spectacled eider, December 2010). These tasks include:

Steller's eiders

- 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 brood survival (from hatch to fledging)
- 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 the number and causes of infertile and inviable eggs in the Barrow breeding population
- 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
- Acquire more genetic samples from birds breeding in known locations in Russia and Alaska
- Continue raven control near Barrow
- Continue fox control near Barrow
- Continue education and outreach (including Eider Journey) at Barrow to reduce disturbance of nests and ducklings
- Update and evaluate Population Viability Analysis with the most recent survey and demographic data

Spectacled eiders

- Improve education efforts across the range of the spectacled eider to eliminate take and the use of lead shot.
- Continue monitoring spectacled eider blood lead levels in areas where information is lacking, such as the North Slope and Russia, and monitor lead levels periodically throughout the range of the eider.
- Continue studies to increase understanding of the incidence and impact of diseases on eiders.
- Monitor for annual survival on the North Slope.
- Evaluate and predict effects of environmental change in breeding areas on spectacled eiders.

In order to implement these recovery tasks and to complement on-going conservation efforts, we continued our long-term monitoring efforts near Barrow, continued predator management projects that began in 2005, and implemented new research objectives all with the goal of increasing production of Alaska-breeding Steller's eiders. Specific objectives for research and monitoring of Steller's and spectacled eiders near Barrow in 2012 were:

1. Continue the systematic study of the abundance and distribution of Steller's and spectacled eiders and their nests near Barrow using ground-based and aerial breeding pair surveys, and ground-based nest searches.
2. Estimate nest and brood survival of threatened eiders by monitoring nests during incubation and

following hens with broods using VHF radio-telemetry.

3. Estimate nest survival of other species of nesting sea ducks and geese in the Barrow area to provide a comparison to threatened eiders, investigate sources of variation in nest survival, and provide nest survival estimates for sea ducks in years when Steller's eider nests are not discovered.
4. Evaluate the relative importance of nest predator species and describe incubation behavior by monitoring a subset of sea duck nests with digital cameras.
5. Collect blood samples from nesting sea ducks for contaminants analysis, primarily focusing on exposure to lead.
6. Collect cloacal swabs from nesting sea ducks to examine health and disease exposure.
7. Involve local community members in Steller's eider conservation efforts by employing Barrow high school students for ground-based breeding pair and nest surveys and fox control.

Results of the aerial survey, fox control, and contaminants and disease projects will be reported separately. ABR, Inc. conducted the Barrow Triangle aerial surveys in 2012 and provides detailed methods and results in their annual report (Obritschkewitsch and Ritchie 2013). Fox control was conducted by USDA Animal Plant Health Inspection Service, Wildlife Services and Barrow Arctic Science Consortium, and results are described in their annual report (Stevens and Smith 2012). Specific objectives and methods for other project components in 2012 follow.

METHODS

Abundance and Distribution Surveys

<u>Road-based survey</u>

Starting when the field crew arrived in Barrow in early June, and extending until the start of breeding pair surveys, daily counts of Steller's eiders along the road system were conducted. The area covered each day fluctuates as road conditions can be quite variable during break-up. In the days just prior to starting the pair survey, road based counts may no longer be feasible due to the dispersal of birds away from the road. Road-based surveys are intended to provide an index of arrival and dispersal dates, and relative abundance of Steller's eiders near Barrow.

<u>Ground-based breeding pair survey</u>

We surveyed the study area using methods established in 1999 (Obritschkewitsch et al. 2001, and described below) within the survey area boundaries defined in 2002 (Obritschkewitsch and Martin 2002b; excluding the 1 km^2 gravel pit area southwest of the airport, the 0.4 km^2 new landfill located south of Gaswell Road, and the airport expansion area south of the runway). The survey area was defined as the total area within the survey boundary minus lake areas >150 m from shoreline (thus waters up to 150 m from the shoreline of larger lakes were included within the boundary) and varies among years (Appendix A). There was a 134 km^2 area consistently surveyed in all years (1999-2012) and this is referred to as the "standard area." The standard area has decreased in area about 0.5 km^2 since the survey began in 1999 (Safine 2011). Because the total survey area has varied among years, numbers of eiders and avian predators within the minimally changed standard area are presented in the results to allow comparison among years.

Surveys commenced after pairs of Steller's eiders dispersed from Footprint Lake and other wetlands where they congregated after arriving in Barrow. The survey area was comprised of many sub-areas, each of which take a crew of 3-5 people approximately 4-6 hours to complete (Figure 3). Each crew searches one sub-area, and a total of ~3 sub-areas were completed each day. The entire survey takes about 10 days to complete, and surveys of sub-areas typically start near Barrow and continue eastward and southward following snow melt and road conditions. Sub-areas were originally designed using boundary features that could be easily seen on aerial photos and from the ground, such as streams, lakes, roads, and margins of drained lake basins. Search effort (person-hours per unit area) in 2012 remained similar to previous years. Ground-based surveys were designed to provide near 100% coverage of the area.

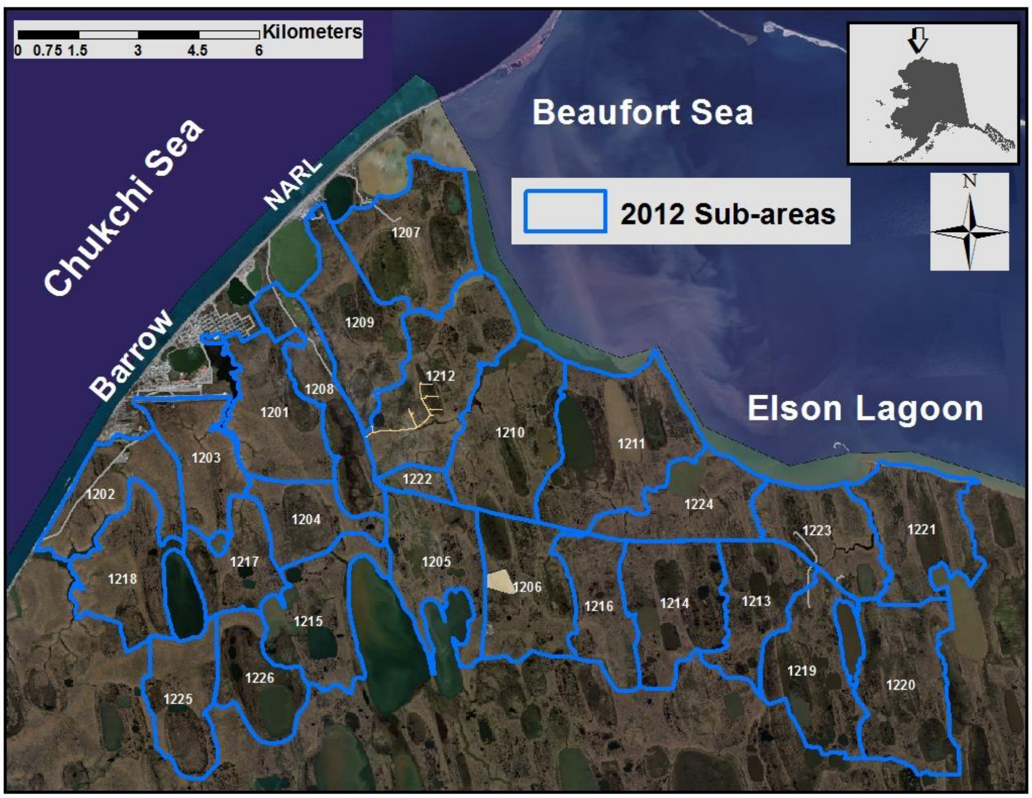


Figure 3. Size and location of sub-areas within the annual breeding pair survey conducted near Barrow, Alaska in 2012. Sub-areas were numbered by year and sub-area number (e.g., "1221" is survey year 2012 and sub-area #21).

To record bird and nest observations during the breeding pair survey we used handheld GPS/data collection devices (Juno SB, Trimble Navigation Limited, Colorado, USA). These units allowed us to accurately map both bird and nest observations, avoid data transcription errors, and eliminated the need for paper maps. We were able to use the Trimble units for data collection on all aspects of the project, although on some days we did not have enough Trimble units for all observers on the pair survey, so a few observers continued to use paper maps and GPS units (see Safine 2012).

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 and spectacled eiders was high given the low vegetation and relatively flat topography of the coastal plain near Barrow. Searchers kept track of birds previously recorded to reduce double-counting of birds, and team members used radios to communicate sightings.

Primary target species of the breeding pair-surveys were Steller's and spectacled eiders, but we also counted the following species of 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*). The data recorded for the pair survey includes: species, total observed, number male, number female, observation code, and habitat type. For nests found during the pair survey for the above species, we recorded location (latitude and longitude), number of eggs, and incubation stage (for waterfowl). For non-target waterfowl and loons incidentally found during pair surveys we recorded nest data (as above), but sightings of adults of these species were not recorded. Den sites were noted for foxes.

Observation code (5 categories) was a measure of the observer's confidence in the breeding status of the bird observed (Table 1). These categories varied from confirmed nesting to a bird flying through an area. For observations of multiple individuals, the lowest code appropriate for any individual was assigned to the group as a whole. Behavior codes were standardized among observers by reference to descriptions of behaviors that would indicate probable or possible nesting for each species. For example, the description for Steller's eiders behavior codes is as follows: "Probable nesting" was recorded if a female was observed to flush from the ground within 30 meters of an observer but no nest was found; "Possible nesting" was recorded if Steller's eiders were agitated by the observer's presence but reluctant to leave (male or pair flushed, circled, and returned or if aggressive behavior by a male towards other birds was observed). If territorial or nesting behavior was observed, searchers briefly searched the area for possible nests.

Table 1. Behavior codes for avian species counted during the breeding pair survey area near Barrow, Alaska.

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

Wetland habitat type was recorded for Steller's or spectacled eider observations using eight wetland class categories developed by Bergman et al. (1977), with four additional categories added (Table 2).

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

Habitat Classification	Description
I	Flooded tundra
II	Shallow *Carex* ponds
III	Shallow *Arctophila* ponds
IV	Deep *Arctophila* ponds
V	Deep open lakes
Ditch	Man-made channel with emergent vegetation
Stream	Any stream, excluding man-made channels
DT	Dry tundra

"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. "Streams" are deep or shallow, typically meandering and containing emergent pendant grass and/or *Carex aquatilis.* "Dry tundra" applies to observations 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*. The class VI basin-complex, although present in the Barrow area, is rarely identified as a habitat used by 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.

<u>Aerial survey</u>

ABR, Inc. conducted aerial surveys for Steller's and spectacled eiders in the Barrow Triangle area during the same time period as the ground-based breeding pair surveys. The survey covered a 2725 km^2

area between Admiralty Bay and the Chukchi Sea coast from just south of Barrow to the southern end of Admiralty Bay (Figure 2). East-west oriented, 400 m-wide strip transects were flown 800 m or 1600 m apart, providing 50% or 25% coverage, respectively (see Obritschkewitsch and Ritchie 2013 for further details on methods). In years when Steller's eiders were relatively abundant and likely nesting according to conditions observed near Barrow in June, the survey was flown at 50% coverage. If Steller's eiders were less abundant or likely not nesting near Barrow, the survey was flown at 25% coverage to save resources. For each Steller's eider observation, number, sex, and a brief description of habitat were recorded.

Chronology

Data on weather conditions (temperatures, precipitation, and snow melt) were recorded at the National Oceanic and Atmospheric Administration (NOAA) weather station located at the Barrow airport (NOAA 2011). Nesting chronology was calculated as described in the "Statistical analysis" section of the methods.

Nest Searching and Monitoring

<u>Nest searching</u>

Limited nest searching was conducted during the breeding pair survey if territorial or nesting behavior was observed, and targeted nest searching began after the pair survey was completed. We focused nest searching effort on Steller's and spectacled eiders, but all waterfowl nests found incidentally were recorded. Due to logistical constraints, after the breeding pair survey was completed we ceased collecting data on any additional nests of greater white-fronted geese (*Anser albifrons*). Nest searching was conducted using several main strategies, none of which were randomized or intended to generate estimates of density, or nesting effort. Nest searching was not conducted randomly because this method may limit sample size for nest survival estimates (especially in years when Steller's eider nesting effort was low). Primary search areas were delineated based on three criteria: 1) areas within ~400 m of lone males or pairs seen during the breeding pair survey, 2) areas with higher nest densities in past years, and 3) areas perceived to be likely nesting habitat, especially for spectacled eiders. Nests were also found incidentally during other efforts by our crew (e.g., nest monitoring) and reported to us by other researchers (e.g., USFWS shorebird crew).

Each day during nest searching a crew of 2-5 people would search one or more areas depending on their size (Figure 4). Some areas were searched more than once per year if we believed a nest may have been missed. We conducted searches from 0900-1700, Alaska Daylight Time. Searchers were spaced approximately 5-10 m abreast and visually searched to either side and ahead as they walked (Figure 5). A nest was defined as a scrape or depression that contained sufficient down, contour feathers, or eggs to positively identify species. Contour feather samples from known nests and a photographic field guide (Bowman 2004) were used to aid in identification of nests and eggs. When a nest was found or re-visited, we recorded the following information when possible: Date, time, species, observer, a unique nest number, latitude and longitude, nest status (active, abandoned, destroyed, hatched, unknown), number of eggs, shells, membranes, or ducklings, days of incubation (from egg candling or floating), amount of down (none, some, moderate, abundant), presence of male and female, and distance to flush.

Effective clutch size was calculated as described in the "Statistical analysis" section of the methods.

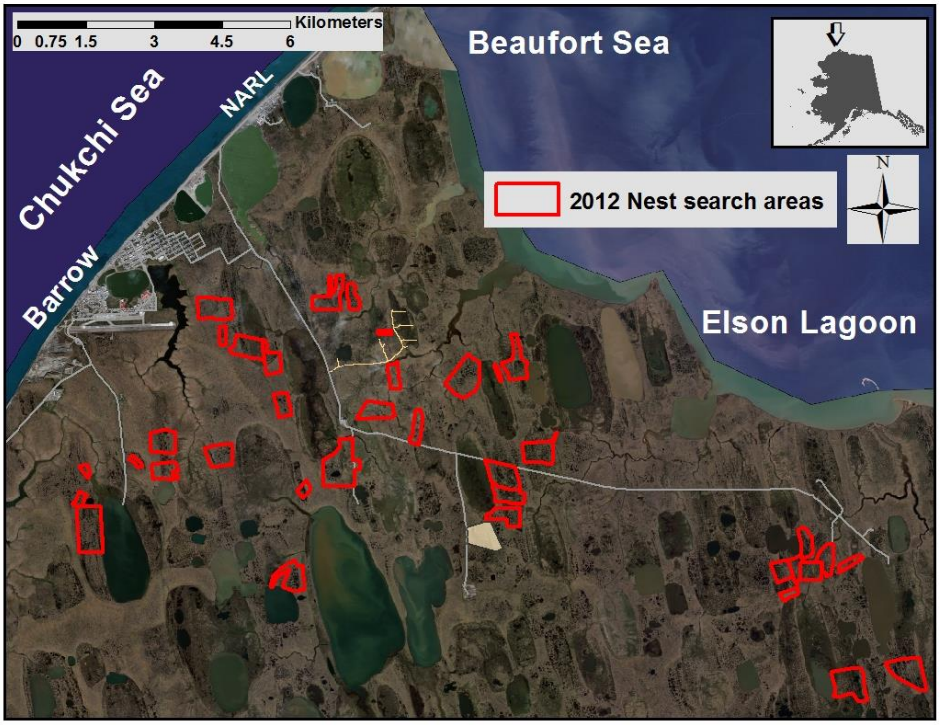


Figure 4. Nest survey areas for Steller's and spectacled eiders near Barrow, Alaska 2012.

Figure 5. Nest searching for eiders near Barrow, Alaska. Photo: D. Safine/USFWS.

Nest monitoring

All waterfowl nests found and recorded in 2012 were monitored to determine fate. Nests were visited approximately every 7 days until nest fate was determined (hatched, destroyed, or abandoned). Goose and swan nests were usually visited less frequently, especially greater-white fronted goose nests (~10 day intervals). All attempts were made to minimize effects of nest visits on nest survival. Nests were not physically marked, but were relocated using a GPS unit. Some hens were flushed when a nest was first encountered, however, during subsequent nest visits we avoided flushing females and confirmed their presence on a nest from 10-40 m away using binoculars. If the female was accidently flushed or not present, nests were visited to age eggs (if active) or determine the cause of failure (if inactive).

Nests may have been visited more frequently and females were occasionally flushed late in incubation to determine a hatch date for timing captures of females (for sea ducks only). For Steller's eiders, we did not intentionally flush females off nests, but instead wait for them to take nest breaks if eggs needed to be aged. After hatching or nest failure, egg membranes and/or contour feathers were collected for genetic analysis. Destroyed nests were examined for clues as to cause of predation, such as presence/absence, appearance, and location of eggshells.

Nest cameras

Digital time lapse cameras (15-second time intervals; Silent Image™ Camera, Reconyx, LLP) were placed at a subset of sea duck nests. The primary purpose was to positively identify nest predators and examine incubation behavior and potential sources of nest disturbance. Nest cameras were placed at nests of sea ducks (Steller's, spectacled, and king eiders and long-tailed ducks). In general, we placed cameras at nests that were >400 m but < 3 km from roads to reduce likelihood of discovery by humans, but facilitate camera maintenance. Nest cameras were placed on a tripod (Figure 6), ranging from 10-35 meters from the nest (depending on camera zoom and topography). Nests monitored with digital cameras were visited every 5 days to change batteries and memory cards. Cameras were placed far enough from nests that servicing them did not cause incubating hens to flush from nests. Nest camera images were reviewed and the following was recorded: start and end time of all images, start and end time of any period a female was not present on nest, cause of nest recess if known (human, nest predator, or other), means of leaving nest (fly or walk), predator and human presence, predation events, any events that occurred after hatch, and any missing camera time (due to battery and memory card changes, etc.).

Figure 6. A time lapse digital camera is positioned to monitor a sea duck nest near Barrow, Alaska. Photo: D. Safine/USFWS.

Habitat Use

Observations of Steller's and spectacled eider flock size, sex composition and behavior were recorded during breeding pair surveys to form an overview of wetland use during the pre-laying and early nesting period. Habitat use information during pair surveys was coarse scale, and involved assigning a habitat type to each eider observation (see Ground-based Breeding Pair Survey Section). After nest failure or hatch, we also collected nest and brood-rearing habitat information to characterize basic breeding requirements. In the field we recorded nest or brood site habitat type, nest bowl dimensions, distances to, and characteristics of, nearest permanent and temporary water bodies, and distance to ATV tracks and trails. Distances to nearest neighboring eider, jaeger, and snowy owl nests were calculated using the Geospatial Modeling Environment (Spatial Ecology, LLC) with ArcGIS.

For brood habitat use, we analyzed habitat data from all available brood observations up to 36 days of age (35 for spectacled eiders). We used habitat observations from broods that did and did not survive to fledging. To analyze brood movements, we used all locations of females and broods up to 36 days of age (35 for spectacled eiders), using the nest site as a starting point to calculate movements. We used 36 days of age for Steller's eiders as this approximates the age at fledging, and 35 days for spectacled eiders to be comparable to data collected for this species from other Alaska-breeding birds on the Yukon Delta. We calculated the following metrics using the Geospatial Modeling Environment (Spatial Ecology, LLC) and distance tools in ArcGIS: distance from hatch to first brood location, maximum distance moved from nest site, average distance moved between subsequent relocations, and total area used. For distance moved from hatch to first brood sighting, we used data from any broods that were seen at least once after hatch. To determine maximum distance moved from nest site, we used broods that survived to 36 (or 35) days of age, and measured the maximum straight line distance the brood was observed from the nest site. For average distance moved between relocations, we used data from any brood that was observed at least 5 times after hatch. To estimate total area used, we generated minimum convex polygons for all brood locations of each brood that survived to 36 (or 35) days of age. Minimum convex polygons are a coarse scale metric of area used during brood rearing, but are adequate given that each brood has only 8-10 locations by 36 days of age.

We recorded additional habitat data for broods in 2012 to further investigate differences in brood rearing habitat use between Steller's and spectacled eiders. We continued to record habitat type for all brood locations but added the following: pond (or lake) length and width (estimated by the observer to the nearest 5 m for small wetlands [<200 m] and measured from high resolution aerial photographs with ArcGIS for larger waterbodies); pond depth (measured with a weighted string to the nearest 5 cm); species of emergent vegetation present (*Arctophila* sp., *Carex* sp., both, or none); percent cover of emergent vegetation (estimated by the observer to the nearest 5%); and salinity (ppm) and water temperature (°C; both measured with an EXTECH® ExStik Salinity meter). If the adult female and ducklings were in a small wetland, we would return at a later date to record the habitat variables to avoid disturbing the brood. We returned to record habitat variables 1-16 days from the day the brood was originally recorded at a location.

Hen Capture and Brood Monitoring

A sample of adult female sea ducks were captured on nests during late incubation to monitor health and disease exposure, band females, and in some cases attach VHF radio-transmitters. Radio-marking was used to relocate adult females and ducklings to examine habitat use and estimate brood survival. Nest captures were targeted for 1-2 days before hatch (i.e., day 22-23 of incubation). Hens were captured by lowering a horizontally-stretched mist net onto the incubating female. 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 slowly crawled towards the hen. In most cases, the hen remained on the nest until the trappers were within 1 m.

USFWS metal bands (stainless steel, size 6 or 7A short) and plastic color tarsal bands (yellow with black alpha-numeric code for Steller's eider only) were applied to hens. Blood was drawn from the jugular vein for lead exposure, DNA, and hormone analyses. The tip of a secondary covert feather was collected for stable isotope analysis. A cloacal swab was taken for avian influenza or general viral screening, and a fecal swab was collected to examine bacterial exposure. We recorded body weight (± 1 g, using a digital scale), culmen, tarsus (diagonal and total), and 9^{th} primary length (juveniles only; ± 0.1 mm).

Prong-and-suture VHF transmitters (Advanced Telemetry Systems, Inc., Isanti, Minnesota, USA; model A4430, 9 g) modified with glue were attached to a sample of Steller's and spectacled eider hens (Mauser and Jarvis 1991, Rotella et al. 1993). A stainless steel prong (anchor) on the anterior of the transmitter was inserted sub-cutaneously between the scapulars through a 2-3 mm incision made with the tip of a scalpel blade. A few drops of veterinarian grade cyanoacrylate glue (Vet Bond™) were applied to seal the incision, and high quality hobby grade cyanoacrylate glue was used to anchor the transmitter to feathers. Transmitters were expected to be shed 2-6 months after attachment.

We attempted to locate radio-marked females with broods about once every three days (when duckling age was ~3-15 days), once every seven days (when duckling age was ~15-30 days), and then once every three days (ducklings >30 days) until repeated absence of a signal was recorded (assumed to indicate movement out of the study area). Females that lost their broods were confirmed to have failed by recording at least two visits when no ducklings were observed. These females were relocated opportunistically after confirmed failure. Females that fledged their broods were relocated post-fledging until they left the study area or we ceased tracking females on 12 September. We used a VHF receiver (Wildlife Track, WTI-1000) and 3-element hand-held Yagi antenna to track females. To minimize disturbance, we observed hens and broods from a distance, departed areas as quickly as possible after locating females, and tracking was not conducted on stormy or unusually cold days. Information was recorded on brood size, behavior, habitat, location, and time.

Latitude and longitude were recorded for each brood sighting at the location of the observer, and then offset in the Trimble unit by an estimated distance and direction to reflect the approximate location of the brood (i.e., recorded location). This allowed observers to minimize disturbance to females and broods by collecting data from a distance, and therefore recorded locations of broods may vary from actual locations by up to 50 m or more depending the observer's ability to estimate distance. Recorded locations in open water areas (e.g., Chukchi Sea, large lakes, etc.) were also offset by an estimated distance and direction, but likely differed from actual locations by a greater distance (50-400 m). If birds were farther offshore, in poor weather conditions, or only detected by their radio signal, their actual location may differ by up to 1 km or more from their recorded location. Because ducklings were not marked, marine locations represent adult females, and in most but not all cases, their fledged broods. Usually fledged juveniles were observed with or near adult females, and assumed to be that female's young (but identity of juveniles could not be known with certainty). In some cases, there was more than one brood together, or a mixture of adults and juveniles, and determining if a specific female was still accompanied by her young was difficult.

We attempted to capture all marked spectacled eider broods that survived to 35-40 days of age. When broods of this age class were located, we stretched a mist net out in the wetland, and attempted to drive the ducklings into the net. Ducklings that could not be captured in the net were pursued with a long-handled landing net if the wetland size was not too large. Females were not targeted, but were captured with the brood in some cases. Any birds not captured (adults or ducklings) were monitored while the brood was processed, so the entire brood could be reunited after banding. Ducklings and adult females were released simultaneously when possible to avoid brood fragmentation or abandonment by the hen, and researchers quickly left the area after release. Adults and juveniles were handled, banded, and sampled as listed above for nest captures. We did not attempt to capture Steller's eider broods.

Statistical Analyses

<u>Clutch size and nesting chronology</u>

We estimated effective clutch size from nests where eggs were observed at least once during incubation. This estimate may not reflect true clutch size (i.e., the number of eggs laid) as predation may reduce clutch size prior to nest visits. Sample size for clutch calculations were lower than number of nests found active as we avoided flushing females if possible, and some nests were destroyed before egg counts were obtained. Estimates of nest initiation and hatch dates were calculated using effective clutch size, incubation stage data from nest visits, and published information on length of incubation by species. Nests found in laying that failed before a count of the completed clutch was conducted, could only be used to estimate nest initiation date. Therefore, sample sizes for nest initiation and hatch dates may differ. Images from nests monitored with digital cameras were used when available to improve estimates of hatch date.

<u>Nest and brood survival</u>

The fate of each nest or brood was classified as successful or unsuccessful. A nest was considered successful if at least one duckling hatched, and was confirmed by observing at least one duckling or eggshell membrane in the nest (Klett et al. 1986). A brood was considered successful if at least one duckling was observed flying or reached fledging age. Causes of nest failures were determined whenever possible.

We estimated daily survival rate (DSR) of nests and broods using the nest survival model in Program MARK (White and Burnham 1999). Program MARK uses generalized linear models to generate maximum likelihood estimates of DSR. The nest survival model is a type of known fate analysis (White and Burnham 1999) and assumes the following about the nests or broods in the sample: fate is known with certainty, fate is independent, lack of heterogeneity in DSR within a grouping, and survival is not affected by the observer or markers (Williams et al. 2002, Dinsmore et al. 2002). These assumptions were violated in some cases. In the case of nests, a nest may become inactive after a visit due to the observer attracting a predator or causing abandonment. If we have data to indicate this was likely the case, data for that nest was censored after the last active visit to avoid a negative bias in DSR. We did not censor data after the last active visit for any nests in 2012. Our nest data likely violates the lack of heterogeneity within a group assumption when we combine multiple sea duck species in one group or multiple nests of the same species in the same group without spatial variables (e.g., distance to fox den). However, our limited sample size for sea ducks precludes the use of more complex models to reduce heterogeneity within groups.

For broods, our clearest violation of the assumptions was periodic failure to locate marked birds or their ducklings with telemetry (i.e., fate was not known with certainty in some cases). During brood monitoring, occasionally a female could be located, but the presence of a brood could not be confirmed without possibly disturbing (i.e., flushing) the hen. In these cases, the observer usually returned within a few days and confirmed the presence of ducklings. As some broods approached or exceeded fledging age, the telemetry signal for a female may have become undetectable or the female may have been located too far offshore in the ocean to confirm her status. When this occurred, fledging and subsequent movement of the adult female from the study area could not be distinguished from late brood loss and subsequent movement. For Steller’s eiders in 2012, we could confirm fledging with certainty in all cases by either observing flighted juveniles or juveniles ≥36 days of age. Steller’s eiders are known to fledge at ~32-36 days of age (Quakenbush et al. 2004 and Rojek 2007). For spectacled eiders, we confirmed fledging if members of a brood were observed flying, and we assumed fledging if ducklings were confirmed to survive to ≥35 days of age and subsequently the female could not be located in the study area. If a female’s radio signal was lost (and she could not be located) before ducklings reached

35 days of age, we censored the data after the last visual observation, and made no assumption on final fate. The literature reports spectacled eiders can fly at 45-52 days of age (Petersen et al. 2000).

In this report we analyzed nest survival for Steller's and spectacled eiders only. Given the limited sample sizes for these species, we only ran models that assumed daily survival rate of nests (DSR) was constant for each species.

To generate estimates of nest survival for each species, we extended DSR to the full exposure period (number of days a nest was exposed from onset of laying to hatch). The result is the probability a nest will survive the average exposure period required to hatch. For Steller's eiders, we used the exposure period reported in the literature (30 days; Quakenbush et al. 2004, Rojek 2008). For spectacled eiders, we calculated exposure period as clutch size + incubation period – 1 day. We used published estimates for the species from similar latitude for clutch size and incubation period, and assumed egg laying rates of one egg per 24 hours. For consistency we assumed incubation begins upon laying of the last egg, though some species likely begin incubation with the penultimate egg. We subtracted one day from the estimate as the exposure period does not begin until the first egg was laid. Exposure period was 27 days for spectacled eiders (estimate of 23 days of incubation and clutch size of 5; Flint and Grand 1999, Pearce et al. 1998, Safine 2011, Safine 2012).

Brood survival was analyzed for both Steller's and spectacled eiders. We estimated DSR of broods using the null model (assuming DSR was constant within a species). Like nest survival, a brood was considered successful if at least one brood member fledged. In brood survival, the survival of individuals in the brood will not affect the estimate if at least one duckling survives to fledging. To estimate brood survival, we extended DSR to the exposure period required to fledge a duckling of each species. As listed above, we used an exposure period of 36 days for Steller's and 50 days for spectacled eiders.

Nest survival comparisons between historical data (1991-2000) and more recent years (2005-2012) are compromised by the unknown effect of recent fox control. Fox control began in 2005, and was conducted in the study area each year from 2005-2012. Control efforts were initiated approximately late-May to early June of each year, a few weeks prior to expected Steller's eider nest initiation dates, and continued through middle or end of July to include most of the nesting period. In 2011 and 2012, we used snowmachines to conduct control earlier in the season, and in those years trapping began in early to mid-May. Changes in conditions on the study area in recent years that may have affected nest survival rates are confounded with fox control; however, we provide historical data on Steller's eiders as it is the only available comparison.

All error estimates presented in this report are standard errors unless otherwise noted.

RESULTS

Abundance and Distribution Surveys

Road-based survey

The USFWS crew arrived in Barrow on 2 June 2012. Road surveys were conducted from 2-10 June, and counts ranged from 0 to 22 Steller's eiders. One male Steller's eider was seen on 2 June, and there was not another Steller's seen until 6 June. The highest count occurred on 7 June, and numbers dropped thereafter. Numbers of birds seen from the road system were never very high during the road survey, and most birds seen from the road were located in the flooded basin just north of the new landfill.

Ground-based breeding pair survey

We conducted the ground-based breeding pair survey from 11 to 20 June, 2012. The annual survey area was covered once during the survey period, and the total number of Steller's and spectacled eiders recorded is in Table 3. The number of male Steller's eiders counted in both the ground-based standard survey area (consistent size in all years) and the Barrow Triangle aerial survey area from 1999-2012 is shown in Table 4 for comparison. This year we observed moderate numbers of Steller's eiders in the study area (0.41 males/km^2; standard survey area), and densities have ranged from 0-1 males/km^2 in past years. Steller's eider pair density was lowest in 2002 (0) and highest in 1999 (0.98), with densities similar to 2012 observed in 2000, 2006, and 2011. Since the survey began in 1999, spectacled eider numbers have ranged from 24 (in 2000) to 206 (in 2011) and averaged 99. This year's count was moderately high (154 birds).

Table 3. Counts of Steller's and spectacled eiders from the annual ground-based breeding pair survey near Barrow, Alaska, 2012.

Year	**Sub-areas**	**Total Steller's eiders Counted**				**Total spectacled eiders counted**			
		Male	Female	Unknown	Total	Male	Female	Unknown	Total
2012	26	61	52	0	113	102	52	0	154

Distribution maps of Steller's and spectacled eider observations and survey areas from the 2012 ground-based breeding pair surveys are shown in Appendix A. Numbers of other avian species, arctic fox, nests, and dens counted in the ground-based pair survey are presented in Appendix B.

Aerial survey

The following paragraph is a summary of the detailed information found in the annual aerial survey reports by Obritschkewitsch and Ritchie (2013).

ABR, Inc. conducted aerial surveys for Steller's eiders on the Arctic Coastal Plain from 18 to 23 June, 2012 (the USFWS ground-based survey was 11-20 June for comparison). The number of Steller's eiders estimated in the survey area was 156. The highest estimated total from the aerial survey was 224 in 1999, and the lowest estimate, and only year no Steller's eiders were observed, was in 2009. The estimated total from the 2012 aerial survey was moderately high compared to all years, and was the third highest count since the survey began in 1999. The numbers of birds counted during the USFWS ground-based survey was only moderate. This would suggest that there were relatively high numbers of Steller's eiders in the Barrow Triangle in 2012, but they were not concentrated immediately adjacent to Barrow. A similar situation occurred in 2000.

Table 4. Steller's eider males, nests, and pair densities recorded during ground-based and aerial surveys conducted near Barrow, Alaska 1999-2012.

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)	Males counted	Pair Density (males/km^2)	Males counted	Pair Density (males/km^2)	Males counted	Pair Density (males/km^2)[b]	
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
2008	166	114	0.69	105	0.78	24	0.02	28
2009	170	6	0.04	6	0.04	0	0	0
2010	176	18	0.10	17	0.13	4	0.01	2
2011	180	69	0.38	59	0.44	10	0.01	27
2012	176	61	0.35	55	0.41	37	0.03	19

[a]Standard area (the area covered in all years) was 134 km^2 (2008-2012) and ~134.5 km^2 in previous years.
[b]Actual area covered by aerial survey (50% coverage) was ~1408 km^2 in 1999 and ~1363 km^2 in 2000-2006 and 2008. Coverage was 25% in 2007, 2010, and 2011 (~682 km^2) and 27% in 2009 (~736 km^2) and 40% in 2012 (~1114 km^2). Pair density calculations are half the bird density calculations reported in ABR, Inc.'s annual reports (Obritschkewitsch and Ritchie 2013).

Chronology

Temperatures, precipitation, and snow melt
The first day the tundra was snow free (snow depth at Barrow weather station was 999.9 [i.e., no snow] not due to missing data) was 4 June 2012 (day of year 156). Mean first snow-free day at Barrow since the project began in 1991 was 31 May (± 2 SE), earliest was 10 May (130), and latest was 15 June (166; Figure 7). Snow melt in 2012 was slightly later than average.

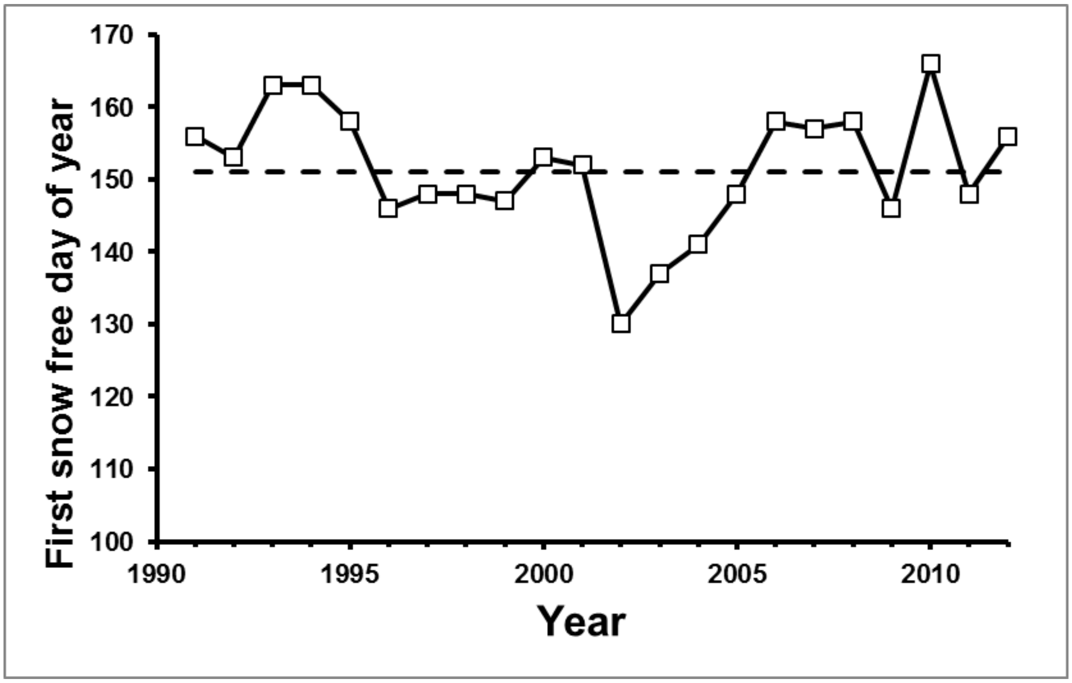


Figure 7. The first snow free day of the calendar year at the NOAA Barrow, Alaska airport weather station from 1991-2012. Dashed line is average first snow free day (May 31 or day of year 151) during this period.

Average monthly mean temperatures in May, June, July, and August were warmer than normal (1981-2010; Table 5). Late summer, July and August, were substantially warmer than normal (+3.1 and +6.3 °F, respectively). May had more precipitation, whereas June and July were drier than normal. August had normal precipitation.

Table 5. Mean monthly temperature and total precipitation at the NOAA weather station in Barrow, Alaska in 2012. Shaded columns are temperature and un-shaded are precipitation.

	May		June		July		August	
2012 mean temperature (°F) / total precipitation (inches)	21.6	0.50	37.3	0.09	44.0	0.54	45.3	1.09
change from normal (1981-2010)	+0.5	+0.32	+1.7	-0.23	+3.1	-0.44	+6.3	+0.04

The start of the ground-based breeding pair survey is timed to coincide with spring break up and the subsequent dispersal of Steller's eiders away from staging areas along the road system (e.g., Footprint Lake). Timing of the start of the pair survey has been fairly consistent among years, with the earliest start date 11 June (2002 and 2012) and latest 16 June (2005 and 2010; Table 6). Pair surveys began on the early end of the range in 2012 and the mean daily maximum temperature during the pair survey (46 °F) was above the average since 1999 (mean 43; Table 6).

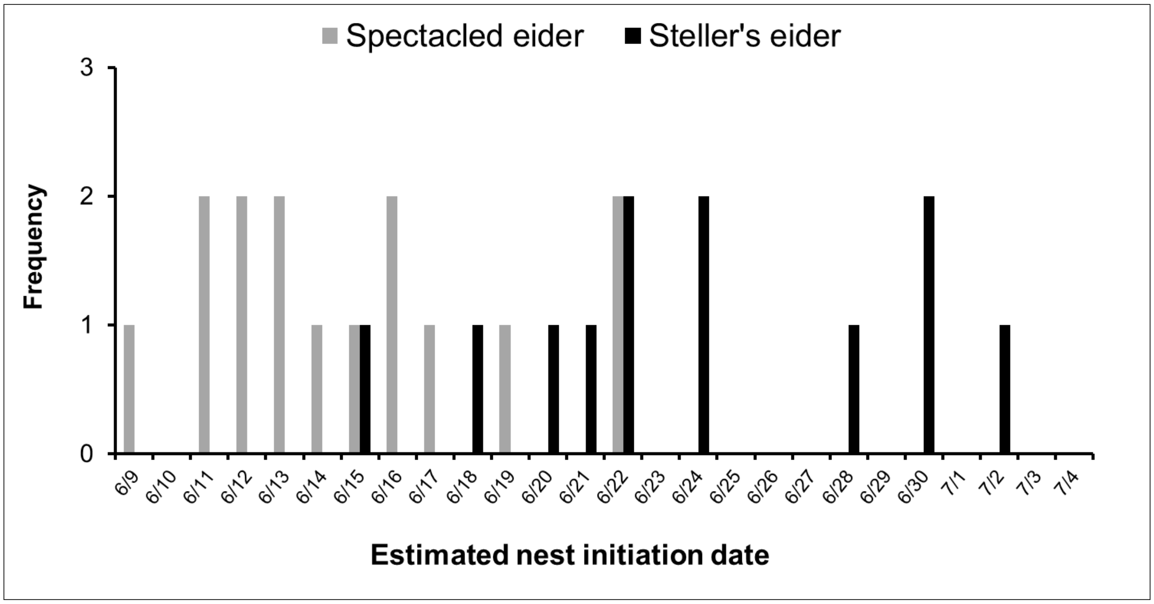
Table 6. Average daily high temperatures in Barrow for the month of June and during the ground-based breeding pair survey period, 1999-2012.

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)
2008	13-24	42 (8.4, 30)	46 (7.8, 12)
2009	12-20	40 (4.3, 30)	38 (2.6, 9)
2010	16-25	38 (4.7, 30)	38 (3.0, 10)
2011	12-21	39 (6.2, 30)	44 (6.4, 10)
2012	11-20	42 (6.8,30)	46 (9.0, 10)

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

Nest initiation and hatch dates

Nest initiation dates (defined as date the first egg was laid) for Steller's and spectacled eiders in 2012 ranged from 9 June to 2 July, and hatch dates ranged from 7 to 30 July (Figure 8; excludes nests without egg counts and age data). Mean nest initiation and hatch dates for Steller's and spectacled eiders are shown in Table 7.



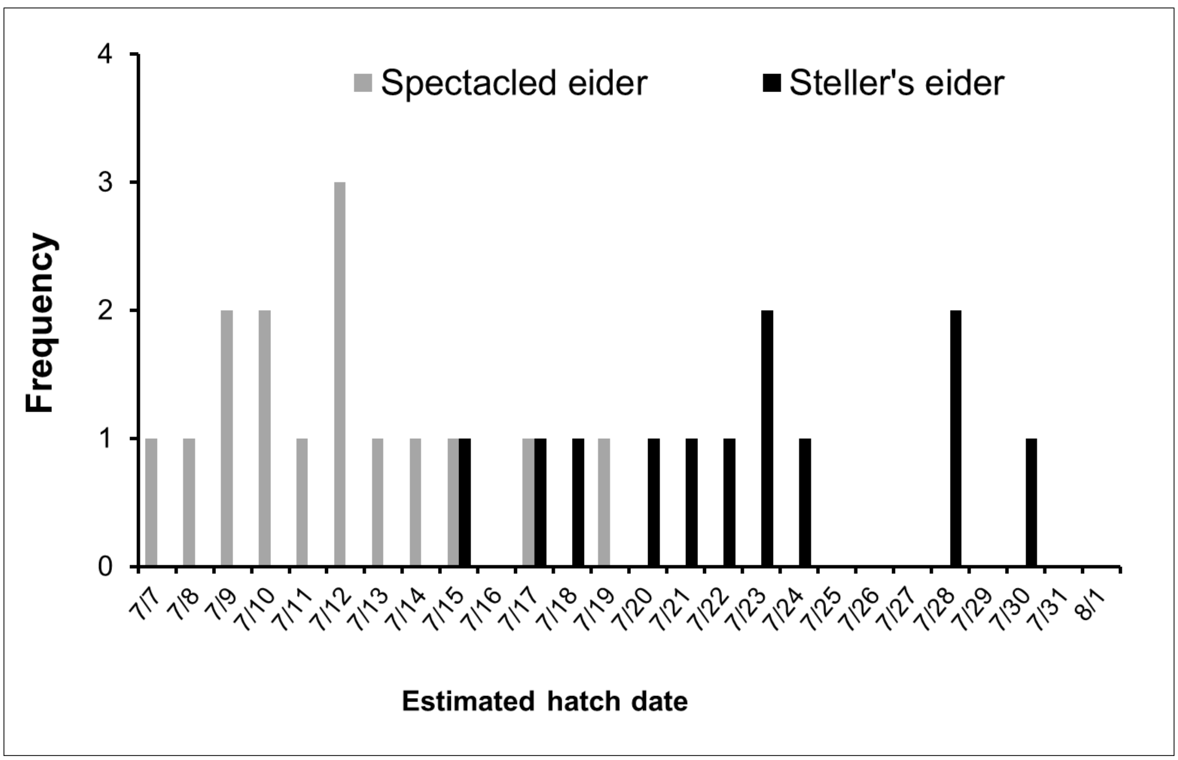


Figure 8. Frequency of known nest initiation and hatch dates for Steller’s and spectacled eiders near Barrow, Alaska in 2012.

Table 7. Mean nest initiation and hatch dates for Steller's and spectacled eiders near Barrow, Alaska 2012. Numbers in parentheses are standard errors.

	2012			
Species	Nest initiation	N	Hatch	N
Steller's eider	23 June (1.5)	12	22 July (1.3)	12
Spectacled eider	14 June (1.0)	15	11 July (0.9)	15

Nest Searching and Monitoring

Nest searching

Both active and inactive (already destroyed or abandoned) nests were found during breeding pair surveys, nest searching, incidentally, and by other researchers (Table 8). We conducted formalized nest searching from 23 June to 13 July, and the total area searched was 7.7 km^2 (however, some areas were searched more than once). Maps with locations of Steller's and spectacled eider nests from 2012 are in Appendix C. Average effective clutch size for Steller's and spectacled eiders for 2012 is found in Table 9.

Table 8. Waterfowl nests found near Barrow, Alaska 2012.

	Total nests	Found active
Species		
Dabblers (Tribe Anatini)		
Northern pintail	35	30
Pochards (Tribe Aythyini)		
Greater scaup	1	1
Sea ducks (Tribe Mergini)		
Steller's eider	19	12
Spectacled eider	26	17
King eider	24	15
Long-tailed duck	35	17
Geese and swans (Tribe Anserini)		
Greater-white fronted goose	104	104
Black brant	27	25
Tundra swan	5	5

Table 9. Average effective clutch size of Steller's and spectacled eider nests found near Barrow, Alaska 2012. Numbers in parenthesis are standard errors.

Species	# eggs	N
Steller's eider	5.6 (0.3)	12
Spectacled eider	5.1 (0.3)	14

<u>Nest monitoring</u>

Steller's eiders

All Steller's eider nests were monitored until hatch or failure, and 8 of 12 nests found while active hatched. Daily nest survival rate (DSR) was 0.966 (95% CI 0.913, 0.987) from the constant survival model (i.e., Mayfield survival; Mayfield 1961, 1975; Johnson 1979). Nest survival probability for Steller's eiders (30 day period; laying and incubation) was 0.36 (95% CI 0.07-0.68). An average of 4.4 (± 0.6) ducklings hatched per successful nest (from counts of egg membranes; Appendix D). For comparisons of Steller's eider nest success among years, see Appendix E. For details on egg fates, including egg depredation, inviability, and number of ducklings per nest, see Appendix D. Inviable eggs were detected in 8% of nests that were found while active in 2012 (1 of 12 nests). Egg candling was minimized for Steller's eiders to reduce disturbance on nests, and therefore some nests were never candled prior to hatch or depredation. Inviability rates presented here should be considered a minimum estimate.

Spectacled eiders

All spectacled eider nests found were monitored until hatch or failure, and 10 of 17 nests found while active hatched. Daily nest survival rate (DSR) was 0.969 (95% CI 0.936, 0.985) from the constant survival model (i.e., Mayfield survival; Mayfield 1961, 1975; Johnson 1979). Nest survival probability for spectacled eiders (27 day period; laying and incubation) was 0.43 (95% CI 0.17, 0.67). An average of 4.5 (± 0.3) ducklings hatched per successful nest (from counts of egg membranes). Inviable eggs were detected in 0% of nests that were found while active in 2012 (0 of 17 nests). As for Steller's eiders, inviability rates are a minimum estimate.

<u>Nest cameras</u>

Nest predators

We placed nest cameras on Steller's eider (N = 8), spectacled eider (N = 5), king eider (N = 4), and long-tailed duck nests (N = 3). Of 20 nests monitored with cameras, six were depredated and 14 hatched. In 2012, predators of camera-monitored sea duck nests were primarily avian (5 of 6 failures were caused by birds). Jaegers (two parasitic and one long-tailed jaeger) destroyed three nests, glaucous gulls destroyed one nest, and snowy owls destroyed one nest (by killing a hen king eider) and began to depredate another nest that was finished off by parasitic jaegers (included above). This was the first year of the study that we have had snowy owls depredate any of the nests we monitored with cameras. We suspected snowy owls of nest and hen depredation in a few instances in 2011, and we confirmed this with camera images in 2012. In one case, the snowy owl flushed a Steller's eider from the nest (presumably in an unsuccessful attempt to kill the female), began to peck or eat the eggs, then a pair of parasitic jaegers destroyed the rest of the nest (Figure 9). The Steller's eider is seen later visiting the nest, and did not appear to be injured. In the other instance, the snowy owl killed an adult female king eider. It is not known whether or not the snowy owl would have eaten the eggs as we made a routine nest check 40 minutes after the hen was killed, and collected the remains of the hen and nest. The king eider was found decapitated near the nest. We also found eider carcasses near other nests (not monitored by nest cameras), and suspect that snowy owls may have been the cause.

The sixth nest was destroyed by an arctic fox. Despite extensive fox control in 2012, there was still some level of fox predation in the study area, although we presume it was low.

Figure 9. These three pictures show a snowy owl beginning to depredate a Steller's eider nest, and then being chased away by an aggressive parasitic jaeger. Images were taken by a time lapse nest camera near Barrow, Alaska on 15 July, 2012.

Incubation behavior

Incubation behavior data, including recess length, number of recesses per day, and incubation constancy is not included in this report.

Habitat Use

<u>Ground-based breeding pair survey</u>

There were 58 sightings of single, paired, or grouped Steller's eiders during the ground-based breeding pair survey where habitat information was recorded (Table 10). Shallow *Arctophila* pond was the most common habitat type used by Steller's eider during mid-June (the pre-laying, laying, and early incubation period), followed by deep *Arctophila* pond.

Table 10. Habitat use by Steller's eiders during ground-based breeding pair surveys near Barrow, Alaska in June of 2012.

Habitat	Number of Sightings (%)	Number of Steller's eiders (%)
I - Flooded tundra	7%	7%
II - Shallow-Carex	9%	8%
III - Shallow-Arctophila	43%	44%
IV - Deep-Arctophila	28%	27%
V - Deep-open	0%	0%
Stream	2%	2%
Dry tundra	9%	9%
Ditch	3%	3%
TOTAL	**58**	**111**

Nests

Most Steller's eider nests in 2012 had permanent water bodies nearby; primarily *Carex* ponds (Table 11). Mean distance to permanent water was 35 ± 10 m (range 1-160 m, N = 19).

Table11. Nearest permanent water bodies to Steller's eider nests in 2012.

Nearest Permanent Water Body (basin type)	# of Nests	%
I - Flooded tundra	0	0
II - Shallow *Carex* pond	11	58
III - Shallow *Arctophila* pond	7	37
IV - Deep *Arctophila* pond	1	5
Ditch	0	0
Trough	0	0
Stream	0	0
TOTAL	19	

In 2012, we found Steller's eider nests dispersed throughout the study area, except near the end of Gaswell Road (Appendix C). Some Steller's eiders nested in areas that have been heavily used in past years (between Freshwater lake Road and Cakeeater Road, see Figure 1), whereas others nested along Cakeeater and Gaswell Roads in areas that have been used historically, but to a lesser extent. We found a cluster of 3 nests in an area previously not known to be used (near the southwestern end of Freshwater Lake). Most nests were located in the western half of the study area.

Nearest distances between Steller's eider nests varied from 60 to 2523 m and averaged 569 ± 144 m. Most nests (68%) were 100-1000 m from a conspecific neighbor; 16% of nests were <100 m, and 16% were >1000 m.

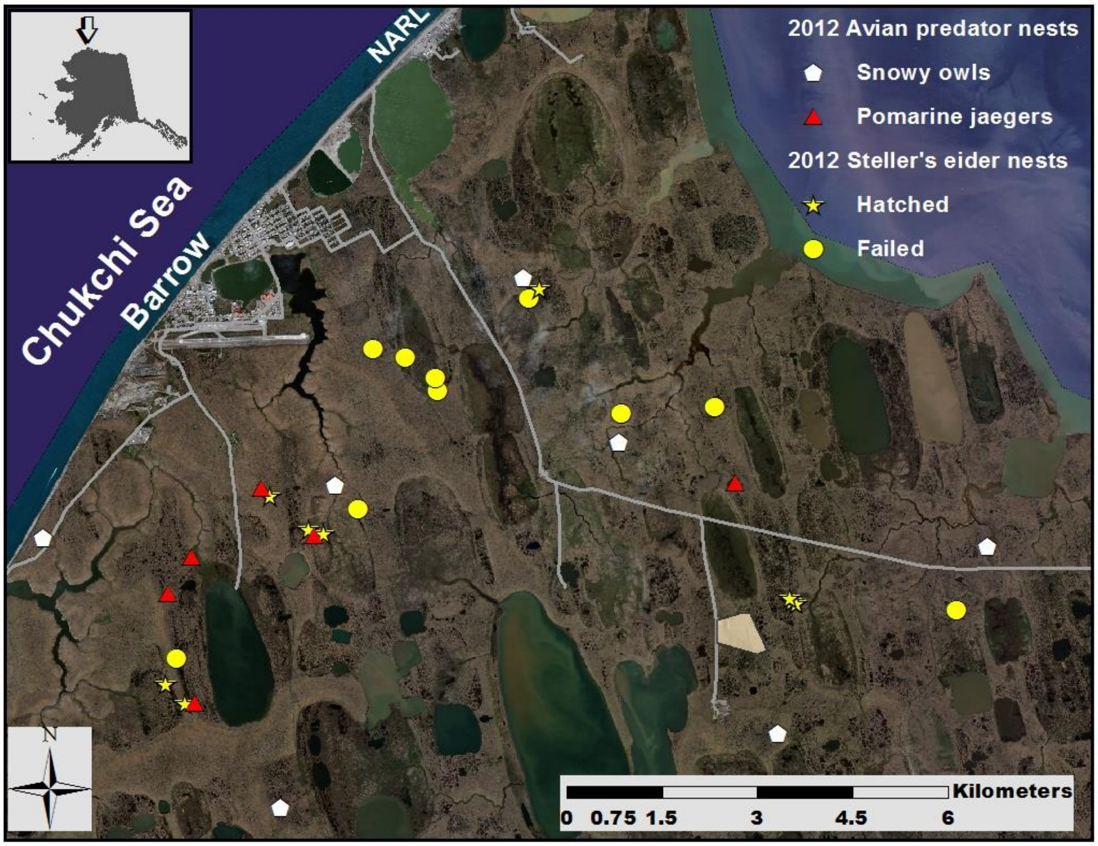


Figure 10. Known Steller's eider, pomarine jaeger, and snowy owl nests near Barrow, Alaska in 2012.

We found a small number of pomarine jaeger (6) and snowy owl (7) nests in the study area (Figure 10; See Appendix F for a comparison of number of Steller's eider and avian predator nests among years). There were additional pomarine jaeger and snowy owl nests in the study area that we did not find, but they likely did not nest in high numbers in our study area as in some past years (e.g., 2008).

Four (21%) Steller's eider nests were located within 300 m of a known pomarine jaeger nest, mean distance to a pomarine jaeger nest was 1951 ± 335 m. Successful Steller's eider nests averaged 1302 ± 481 m (n = 9) and failed nests average 2535 ± 400 m (n = 10) from pomarine jaeger nests (Figure 11). Distances between Steller's eider and snowy owl nests averaged 1566 ± 193 m. Successful Steller's eider nests were 1571 ± 277 m (n = 9) and failed nests were 1561 ± 283 m (n = 10; Figure 12) from snowy owl nests.

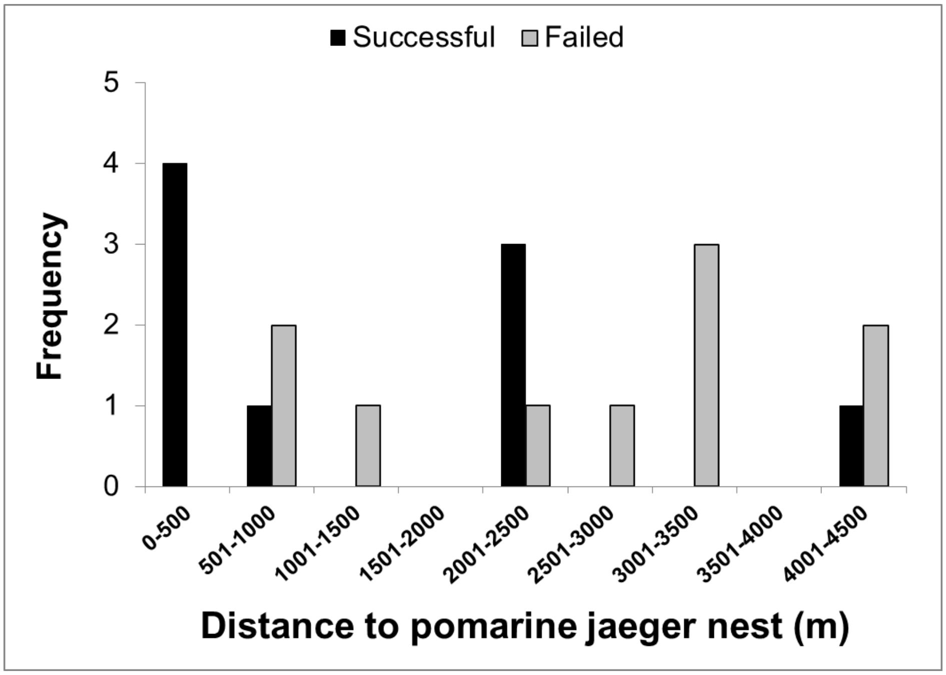


Figure 11. Distance from Steller's eider nests (successful and failed) to known pomarine jaeger nests near Barrow, Alaska in 2012.

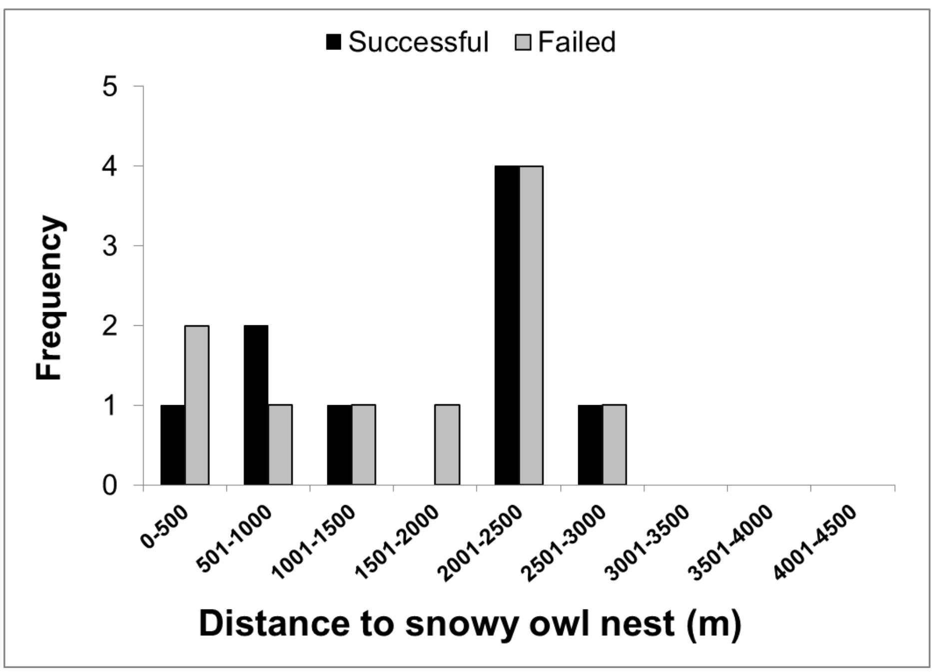


Figure 12. Distance from Steller's eider nests (successful and failed) to known snowy owl nests near Barrow, Alaska in 2012.

Hen Capture and Brood Monitoring

Nest captures

Steller's eiders

Eight Steller's eider hens were captured on the nest during late incubation from 15 to 29 July, 2012. Average body weight was 695 ±12 g, with a range of 652 to 756 g. We sampled females for viral and bacterial exposure, collected feather and blood samples, and attached VHF transmitters to track broods. All females that were captured successfully hatched ducklings. Of eight females captured, two were previously marked. One female was originally marked on the nest near Barrow in 2007, and in 2012 her nest was 3.0 km from the previous nest site. The other female was originally marked on the nest near Barrow in 2011, and in 2012 her nest was 3.2 km from the previous nest site (Figure 13; Table 12).

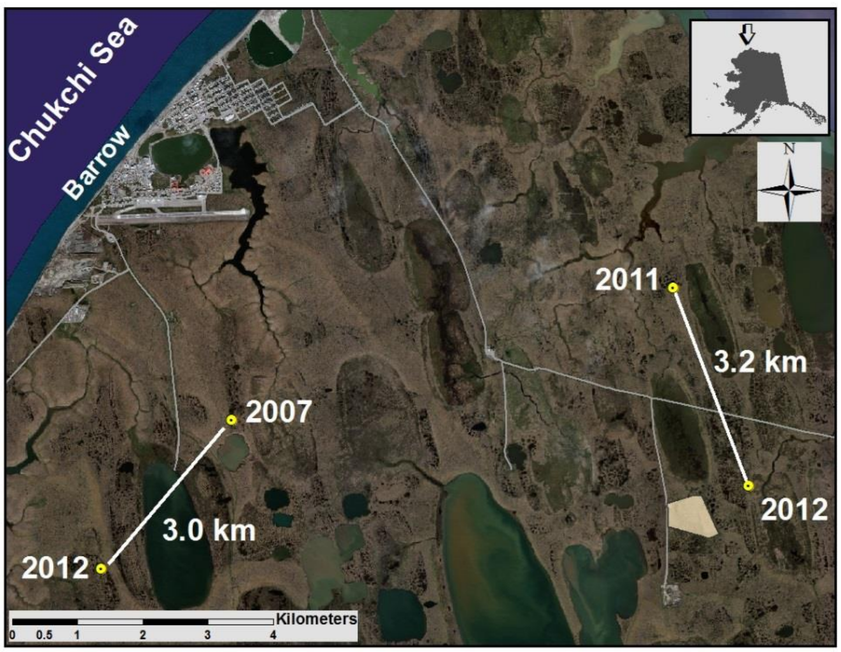


Figure 13. Locations of past and current nest sites for two female Steller's eiders recaptured in 2012 near Barrow, Alaska.

Table 12. Capture history for two previously marked Steller's eider females caught on nests near Barrow, Alaska in 2012.

2012 Nest #	Year of 1st Banding	Original Banding Location	Barrow 2012			Age in 2012	Comments
			# of Inviable eggs	Nesting Success	Brood Success		
12-MTW059	2007	Barrow (nest)	0 of 6	Hatched	Failed	≥7	2007 nest hatched. Hen radio-marked in 2012, and brood failed after 15 days of age.
12-MTW071	2011	Barrow (nest)	0 of 5	Hatched	Fledged	≥3	Hen radio-marked in 2011 and 2012. In 2011, nest hatched, and brood of 5 fledged. In 2012, brood of 2 fledged.

Spectacled eiders
Eight spectacled eider hens were captured on the nest during late incubation from 8 to 16 July, 2012. Average body weight was 1062 ± 25 g, with a range of 985 to 1218 g. We sampled females for viral and bacterial exposure and collected a feather sample. We collected blood samples from seven birds, and attached VHF transmitters to all eight. All females that were captured successfully hatched ducklings. Of the eight females captured, one was previously marked. This spectacled eider was originally marked on the nest near Barrow in 2010, and in 2012 her nest was 45 m from the previous nest site.

Other sea ducks
Five long-tailed ducks and four king eiders were also captured on the nest during late incubation to increase sample sizes for disease and contaminant exposure surveillance. We collected viral and bacterial swabs and blood samples. Two of the four king eiders had been previously marked on the nest near Barrow, and none of the long-tailed ducks had been previously marked. Neither of these two species was marked with radio-transmitters.

<u>Brood survival</u>
Steller's eiders
Eight female Steller's eiders were marked with VHF radio-transmitters near hatch, and all females hatched at least one duckling. We monitored movements of females and duckling from hatch to 12 September or until females could no longer be located in the Barrow area. Seven of eight females were observed at least once with a brood (one brood failed between hatch and first visit at 5 days of age). Four of eight broods fledged at least one duckling (i.e., ducklings were documented to survive ≥36 days of age). The other three unsuccessful females lost their broods when the ducklings were between 15-18, 16-22, and 31-34 days of age. For successful females, we first observed flighted juveniles in broods at 39-44 days of age, though juveniles were likely capable of flight prior to observation. Juveniles from the four successful broods were confirmed to survive to ≥43 days of age (and up to 53). After this time, females and juveniles began dispersing from the Barrow area, and most radio signals were lost. The average number of ducklings at hatch from nests that fledged young was 5.8 ± 0.6, and the number of ducklings that fledged (count of number alive at ≥36 days of age) was 3.8 ± 0.8 (range 2-5). Daily survival rate estimated from the constant survival model for Steller's eiders was 0.984 ± 0.008. Brood

survival probability (probability a brood will fledge at least one duckling) was 0.57 (95% CI 0.22, 0.81; 36 day period). No radio-marked adult females were known to have died during the study period.

Spectacled eiders

Eight female spectacled eiders were marked with VHF radio-transmitters near hatch, and eight hatched at least one duckling. We monitored movements of females and duckling from hatch to 12 September or until females could no longer be located in the Barrow area. Seven of eight females that hatched nests were observed at least once with a brood. The eighth female was found dead near her nest 3 days after hatching, and we presumed she was killed by a snowy owl and lost her entire brood. Three broods were confirmed to fledge at least one duckling (i.e., juveniles were observed flying). Four additional broods were assumed to fledge, as ducklings survived to ≥35 days of age (range was at least 38-44) and then the broods could no longer be located. It is possible one or some of these broods failed and the females left the study area, but more likely they fledged as duckling survival is relatively high after ~30 days of age. In one of these four cases, we found a radio transmitter in a lake, but could not locate the female's carcass. The ducklings were last known to be alive at 38 days of age. The female either shed the radio or was killed by a predator and the transmitter was pulled out. In either case, this brood had previously crèched with another brood on that lake, and likely survived to fledging age. For the known successful females, we first observed flighted juveniles at 51, 52, and 52 days of age. Juveniles may have been capable of flight before we first observed them flying. Juveniles from the seven apparently successful broods were confirmed to survive to ≥38 days (and up to 55 days of age). After this time, females and juveniles began dispersing from the Barrow area, and most radio signals were lost. Spectacled eiders moved longer distances during brood rearing than Steller's eiders, and were more difficult to locate and confirm fate. The average number of ducklings at hatch from nests that apparently fledged young was 4.4 ± 0.6, and the number of ducklings that were assumed to fledge (count of number alive at ≥38 days of age) was 3.0 ± 0.9 (range 1-5; data not available for three broods that crèched). Daily survival rate estimated from the constant survival model for spectacled eiders was 0.997 ± 0.003. Brood survival probability (probability a brood will fledge at least one duckling) was 0.86 (95% CI 0.34, 0.98; 50 day period). One radio-marked female was known to have been killed and one was potentially killed during the study period (see details above).

<u>Brood movements and habitat use up to ~36 days of age</u>

Steller's eiders

Steller's eider females moved their broods an average of 500 ± 223 m (N=7, range 95-1811) from the nest between hatch and first observation (1-4 days post-hatch; Table 13 and Figure 14). The mean maximum distance a brood moved from their nest site until ~36 days of age was 1667 ± 477 m (N=4, range 780-2760). The average distance moved between sightings of a brood to ~36 days of age was 486 ± 97 m (N=7, range 194-931). Mean area used by broods to ~36 days of age was 73 ± 33 hectares (N=4, range 26-169; Figure 15). Habitat types used by broods up to 36 days of age were primarily shallow *Carex* and shallow *Arctophila* (Table 14), and a comparison of brood movements and sample sizes since 1995 is in Table 15. In 2012, we collected more detailed information on characteristics of waterbodies used by broods (Tables 16 and 17). On average Steller's eider broods were observed in waterbodies that were <200 m long, ~20 cm deep, with ~40% of the wetland filled with emergent vegetation (Table 16). All waterbodies were freshwater, as the maximum salinity was <0.5 ppt or 500 ppm. Broods were most commonly found in waterbodies with emergent vegetation that was either *Carex* only or both *Carex* and

Arctophila (Table 17). Movements varied among broods. Two females made distinct longer movements soon after hatch from the nest site to a rearing area, and did not to return to the nest area. One female began brood rearing near the nest site (within ~500 m), and later moved to an area ~2 km away prior to fledging. The other females stayed in the vicinity of the nest site (within 1 km) until fledging.

Spectacled eiders

Spectacled eider females moved their broods an average of 791 ± 162 m (N=7, range 289-1424) from the nest between hatch and first observation (2-4 days post-hatch; Table 13 and Figure 16). The mean maximum distance a brood moved from their nest site until ~35 days of age was 3235 ± 526 m (N=7, range 1845-6013). The average distance moved between sightings of a brood to ~35 days of age was 875 ± 113 m (N=7, range 400-1181). Mean area used by broods to ~35 days of age was 266 ± 62 hectares (N=7, range 55-500; Figure 15). Habitat types used by broods up to 35 days of age were primarily deep open, deep Arctophila, and shallow *Carex* (Table 14). More detailed information on characteristics of waterbodies used by spectacled eider broods is in Tables 16 and 17. On average, broods were observed in waterbodies that were ~700 m long, ~40 cm deep, with ~20% of the wetland filled with emergent vegetation (Table 16). All waterbodies were freshwater, as the maximum salinity was <0.5 ppt or 500 ppm. Broods were about as likely as not to be found in waterbodies in any of the four categories of emergent vegetation (*Carex* or *Arctophila* only, both species, or no emergent vegetation; Table 17).

Table 13. Steller's eider and spectacled eider brood movements near Barrow, Alaska in 2012. Standard errors are in parenthesis.

Species	Distance to first resight (m)	N	Maximum distance moved from nest (m)	N	Average distance moved between resightings (m)	N	Total area used (hectares)	N
Steller's eider	500 (223)	7	1667 (477)	4	486 (97)	7	73 (33)	4
Spectacled eider	791 (162)	7	3235 (526)	7	875 (113)	7	266 (62)	7

Table 14. Habitat types used by broods of Steller's and spectacled eiders up to 36 days of age near Barrow, Alaska in 2012.

	Steller's eider (N=7)		Spectacled eider (N=7)	
	#	%	#	%
Deep *Arctophila*	2	4%	14	24%
Deep open	3	5%	23	39%
Dry tundra	0	0%	0	0%
Shallow *Arctophila*	26	46%	6	10%
Shallow *Carex*	26	46%	12	20%
Stream	0	0%	4	7%
Total	57		59	

Table 15. Distances moved and habitats used by Steller's eider broods near Barrow, Alaska 1995-2012.

Year	# broods	# resightings	Maximum # days tracked post-hatch	Ave. maximum distance from nest (m)	Dominant Habitat Type Used
1995	8	39	32	650	*Arctophila* (80%)
1996	5	20	35	700	*Arctophila* (85%)
2005	3	26	41	3500[a]	*Carex* (58%)
2006	8	56	37	1200	*Arctophila* (54%)
2008	7	47	39	488	*Arctophila* (43%)
2011	9	77[b]	51	1354[b]	*Arctophila* (48%)[b]
2012	8	58[b]	53	1667[b]	*Arctophila* (49%)[b]

[a]Not including last two movements of brood 06-05.
[b]Only includes data for broods up to 36 days of age.

Table 16. Characteristics of waterbodies used by broods of Steller's and spectacled eiders up to 36 days of age near Barrow, Alaska in 2012. Estimates are listed ± standard error.

	Pond length (m)	Pond width (m)	Pond depth (cm)	Emergent cover (%)	Salinity (ppm)	Temperature (°C)
Steller's eider	124 ± 40	66 ± 18	23 ± 2	42 ± 5	98.7 ± 4.9	12.4 ± 0.5
Spectacled eider	696 ± 123	301 ± 50	42 ± 3	21 ± 4	127.8 ± 11.5	13.2 ± 0.4

Table 17. Species of emergent vegetation present in waterbodies used by broods of Steller's and spectacled eiders up to 36 days of age near Barrow, Alaska in 2012. Numbers are proportion of total observations for each species in a category.

	Carex sp. only	Both species	*Arctophila* sp. only	No emergent
Steller's eider	44%	37%	18%	2%
Spectacled eider	29%	19%	24%	29%

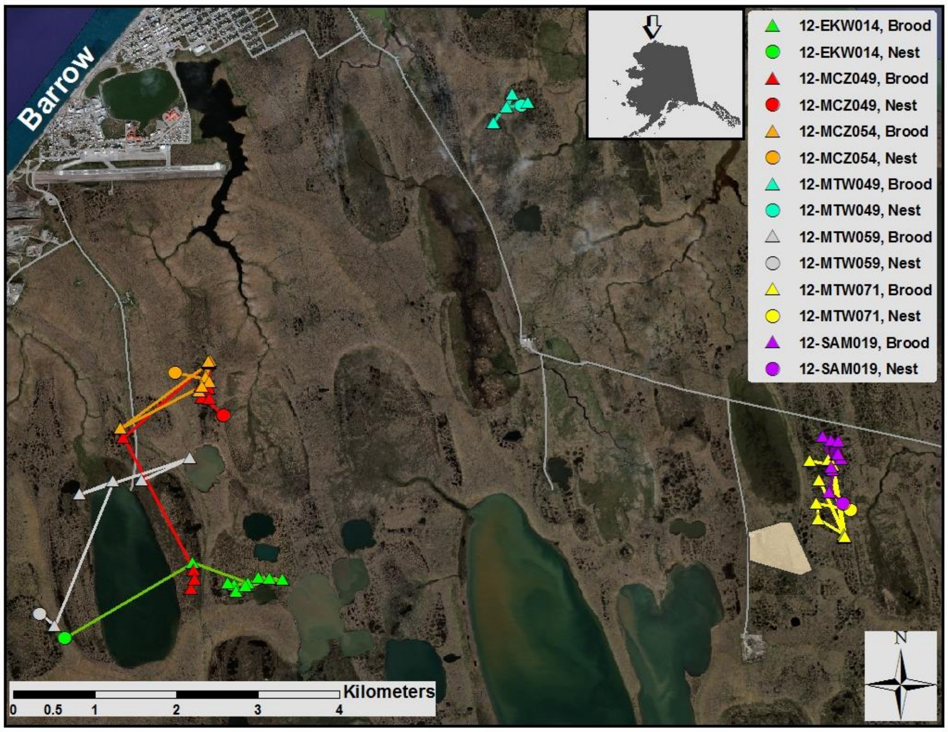


Figure 14. Radio-marked Steller's eider female and brood locations (and nest sites) for all marked females observed at least once with a brood up to 36 days of age near Barrow, Alaska in 2012.

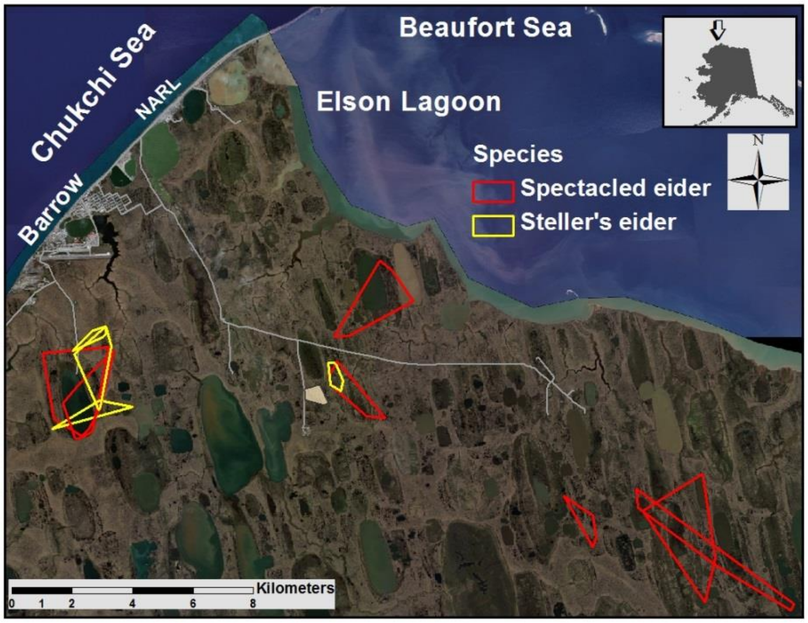


Figure 15. Minimum convex polygons for the total area used by Steller's and spectacled eider broods that survived to 36 or 35 days of age, respectively near Barrow, Alaska in 2012.

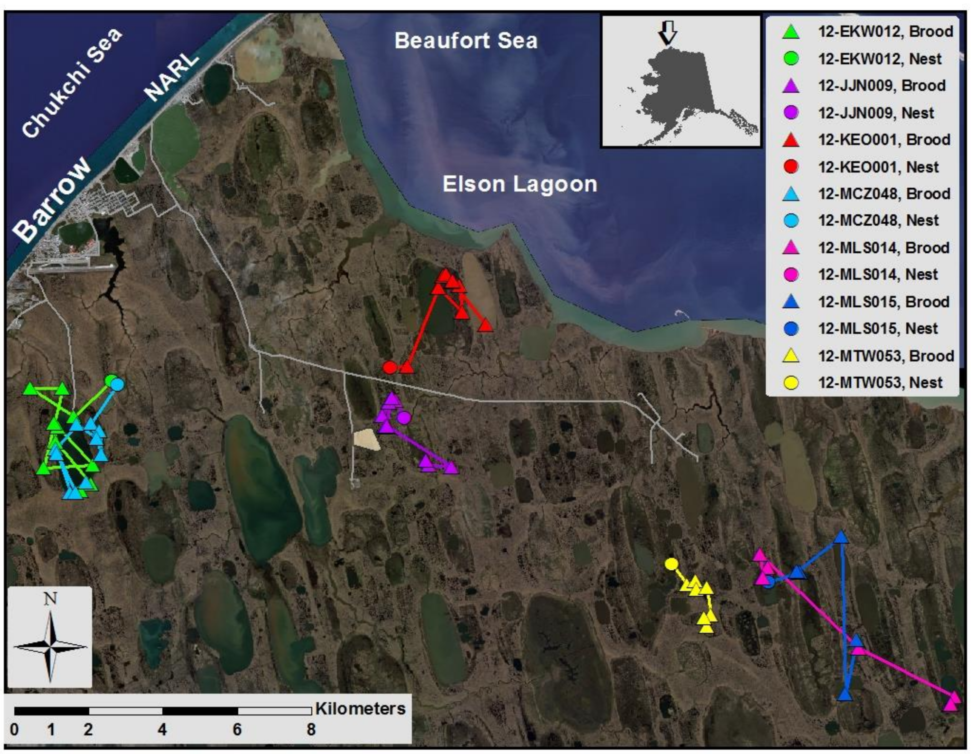


Figure 16. Radio-marked spectacled eider female and brood locations (and nest sites) for all marked females observed at least once with a brood up to 35 days of age near Barrow, Alaska in 2012.

Brood movements and habitat use after 36 days of age

Steller's eiders

After juveniles could fly (≥36 days of age), broods were still observed in freshwater wetlands within 4 km of their brood rearing areas for a period of time. This period ranged from 7-17 days (N=4; minimum estimate using last known day on tundra). After this time, females and broods either left the study area and could no longer be located (2 of 4) or moved to salt water areas (1 of 4; Figure 17). One brood was still near its brood rearing area on our last day of tracking, 12 September (at 44 days of age). In 2012, only one successful radio-marked adult female was observed in a marine area near Barrow. This female (and her brood) was not seen, so the location was approximated. The radio signal indicated the female was in Elson Lagoon near the Twin Lakes area (Figure 17). After this location on 30 August, this female was not observed again in the study area. In 2012, there were no radio-marked females with broods observed in the waterfowl hunting areas north of Barrow. For broods that fledged, radio signals were last heard in the study area between 2-12 September. After these dates, females are presumed to have begun their migration south to molting areas.

Spectacled eiders

For the three spectacled eider broods that were confirmed to fledge, the female and ducklings remained in the vicinity of the brood rearing area until achieving flight at approximately 50 days of age. After these broods were observed flying (51 or 52 days of age), they began to make longer movements and later left the study area (Nests #12-JJN009, 12-KEO001, and 12-MLS015; Figure 18). First flight was observed for these broods on 30 August and 2 September. Two broods were observed on Ikpik Slough (east of Cakeeater Rd.) after fledging. One of these broods continued on to the Chukchi Sea south of Barrow and the other was not observed again. The third brood was not seen after 52 days of age, but the signal was heard briefly north of Gaswell Rd. on 4 September (54 days of age) as the birds presumably left the study area. Radio signals for all three females were last heard on 4, 5, and 8 September. There were four broods that apparently fledged (i.e., survived to ≥35 days but were not seen at fledging age). The signal of one of these females was recorded several times in the Chukchi Sea west and south of Barrow, but due to marine conditions she could not be seen to confirm her status (12-MCZ048; Figure 18A). Approximate locations were recorded for this female, and she was last heard in the Chukchi Sea on 5 September. The other females were not heard again after their last confirmed sighting (except the bird that was likely killed, see discussion in "Brood survival" section above).

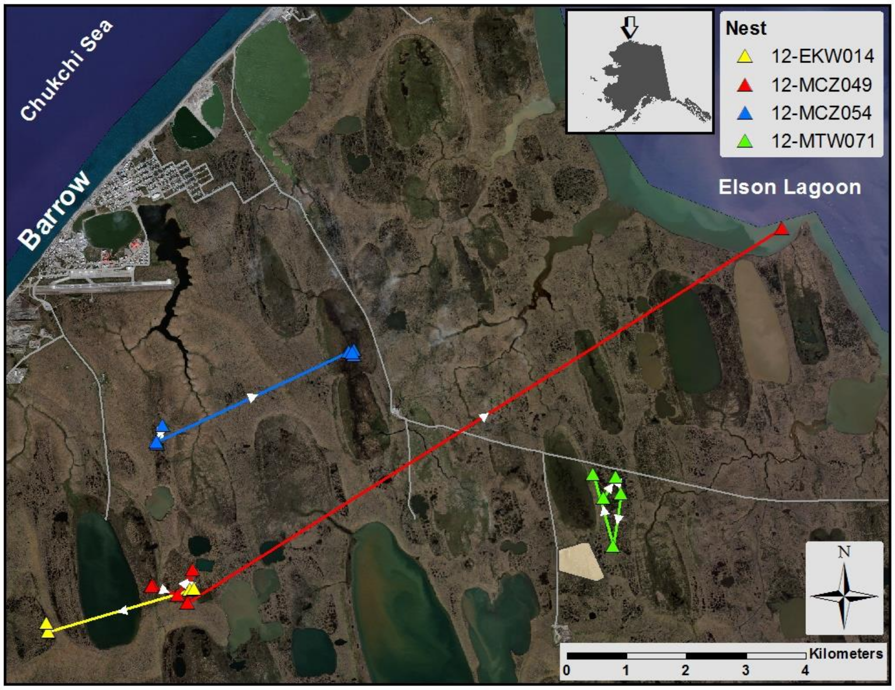
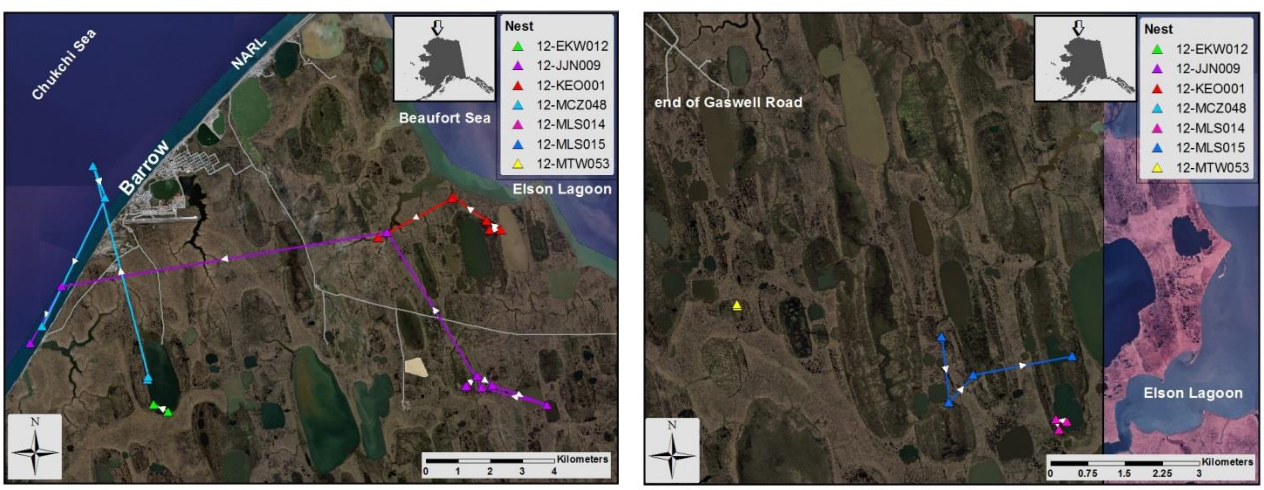


Figure 17. Locations of adult female and juvenile Steller's eiders from fledged broods after 36 days of age near Barrow, Alaska from mid-August to mid-September, 2012. Map includes one observation of ≤36 days of age for each brood to show movement. White arrows indicate the direction of movement.



A. B.

Figure 18. Locations of adult female and juvenile spectacled eiders from apparently fledged broods after 35 days of age near Barrow, Alaska from mid-August to early September, 2012. Map includes one observation of ≤35 days of age for each brood to show movement. Map A. shows birds in the western and central study area, and map B. shows the southeastern study area. White arrows indicate direction of movement.

<u>Movements of females after nest or brood loss</u>

Steller's eiders

We tracked four females after nest or brood failure. One female lost her brood between hatching and 5 days of age (20-25 July), and was seen subsequently in Footprint Lake and between the Twin Lakes, and then not seen again after 10 August (Figure 19). One female lost her brood after 16 days of age (>7 August), and was seen once in the vicinity of the brood rearing area, then not seen again (Figure 19). The other two females were observed once in the vicinity of their brood rearing area post-failure (brood loss occurred after 15 and 31 days of age), and then sighted in marine areas north of Barrow. The brood that failed after 15 days used marine areas north of Barrow (from Pigniq [Duck Camp] to Plover Point) from ~13-30 August (Figure 19). The other female was also observed once in the Chukchi Sea near Pigniq, and then later observed in the ocean south of Barrow near the end of Nunavak Road. We observed this female in marine areas from 30 August to 5 September.

Spectacled eiders

We only tracked one female spectacled eider that was known to fail, the female that was killed and discussed in the "Brood survival" section above. This female was found dead 3 days after hatching approximately 15 m from the nest site (Figure 19).

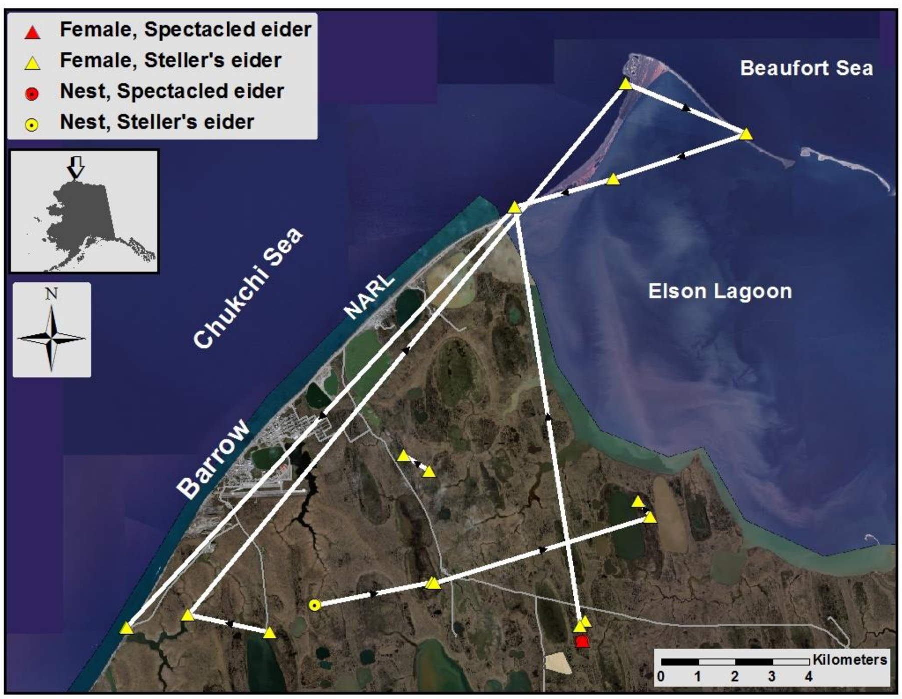


Figure 19. Locations of adult female Steller's and spectacled eiders after failure of their nest or brood loss near Barrow, Alaska from mid-July to early September, 2012. Map includes one observation of nest site or last active brood observation to show movement. Black arrows show the direction of movement.

Unmarked broods
During brood tracking on the tundra (mid-July to late August), unmarked Steller's and spectacled eider broods were seen along the road system, near other marked females, or en route to radio-marked broods. We did not observe any unmarked broods after fledging (e.g., late August and early September) in marine area near Barrow.

Brood captures
From 16-20 August we captured marked (N=5) and unmarked (N=2) broods of spectacled eiders. From these seven broods, we captured a total of 6 adult females and 30 ducklings, and the known age ducklings were 34 to 38 days of age at capture. Mean mass of the adults was 1169 ± 47 g, which was ~10% higher than average mass at nest capture (1062 ± 25). Mean body mass of all ducklings (known and unknown age) was 879 ± 20 g. Mean mass of known age ducklings only was ~50 g lower, 828 ± 15 g. We collected blood, feces, and cloacal swabs to sample for health indices and disease and contaminant exposure.

DISCUSSION

Compared to past years of the study, 2012 was a year of moderate abundance and nesting effort by Steller's eiders near Barrow. Compared to recent years (2009-2011), we found more nests of nearly all waterfowl species than the poor production years 2009 and 2010, but similar to fewer nests of most species when compared to 2011. Spectacled eider nests were found in numbers similar to 2010 and 2011. One notable exception was the high number of Northern Pintail nesting in the study area this year, compared to recent years (possibly linked with poor conditions in the prairie pothole region).

Lemming abundance was similar to 2011 (K. Ott/USFWS unpublished data), but likely higher than what was observed in 2009 and 2010. We found a similar number of pomarine jaeger nests in the study area, but snowy owl nests were slightly more abundant than 2011. As in 2011, there were sufficient lemming numbers for predatory birds to nest, although numbers were not likely sufficient to meet nutritional needs of adults and young. We believe this led to the avian predation we observed on bird nests in 2012 (predator identification from nests monitored by camera). This was the first year our nest cameras recorded a nesting sea duck (king eider) being killed by a snowy owl, and a snowy owl taking part in the depredation of a Steller's eider nest. Evidence found at some sea duck nests in 2011 and 2012 was consistent with snowy owl predation, but nest cameras in 2012 confirmed this was the case. Snowy owl predation has also been reported in past years, Quakenbush et al. (2004) reported that at least two adult female Steller's eiders were killed during brood rearing. Both jaegers and owls are capable of nest predation, but it is unlikely an adult female eider would be killed by a jaeger(s). In addition to known negative effects of jaegers on eider nest survival, there are also likely positive effects. Successful Steller's eider nests tended to be closer to pomarine jaeger nests than unsuccessful nests in 2012 (Figure 11, 1302 vs. 2535 m, respectively), and the same pattern has been observed in past years (Quakenbush et al. 2004, Rojek 2006, Safine 2012). The nesting association between pomarine jaegers and Steller's eiders has been well documented throughout the study at Barrow, however the relationship with snowy owls is not as clear. The relationship between nest success of Steller's eiders and proximity to snowy owl nests was not observed in recent years (Rojek 2006, Safine 2012, this study), but was observed in earlier years of the study (Quakenbush et al. 2004). One hypothesis is that nesting close to snowy owls may be favorable when arctic fox densities are high. Recent fox control may have reduced fox numbers to a level where nesting near owls is no longer favorable (given the possible trade-off in adult female survival). However, the limited sample size of nests (eider, jaegers, and owls) and difficulty finding them in a randomized fashion have made a quantitative test of this relationship difficult.

The nest survival estimate for Steller's eiders in 2012 was below average for years since fox control began (2005-2012; 0.36 compared to average of 0.47). This estimate agreed with qualitative observations in the field, but the difference was not statistically significant due to small sample size. The estimate of brood survival for Steller's eiders in 2012 was 0.57, and was lower than 2011 (0.91; the highest recorded during this study), and again was not statistically different. The 2012 estimate was similar to brood survival estimates from past years (2005, 2006, and 2008; Figure 20), and was relatively high for a duck species. Number of ducklings fledged from a successful Steller's eider brood was about 3 in 2005, 2006, and 2008 (3.0, 3.4, and 2.8, respectively), in 2011 the average was 5.1, and in 2012 it dropped down to 3.8.

Though nest survival was similar for Steller's and spectacled eiders, brood survival was higher for spectacled eiders in 2012 (0.86 vs. 0.57 until fledging; though confidence intervals overlapped). This was the second year we collected data on brood survival for spectacled eiders, and the results were opposite in 2011 (when Steller's eiders had higher brood survival). However, nest survival for both species was lower in 2012. This result (brood survival not following the same pattern between species between years) could indicate that brood survival is affected by different factors for each species, or it could simply be an artifact of a small sample of broods in each year (~eight broods marked per species per year). Additional years of data would help to tease out these two possible explanations.

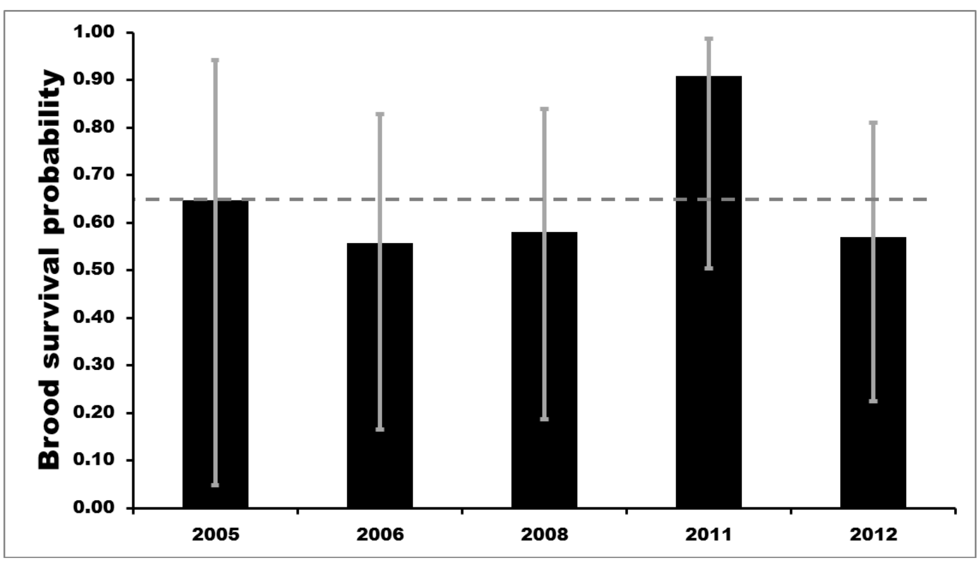


Figure 20. Brood survival probability of Steller's eiders from 2005-2012 near Barrow, Alaska. The gray dashed line is average brood survival, and the error bars represent 95% confidence intervals.

As in past years, spectacled eiders initiated and hatched nests earlier than Steller's eiders (mean hatch was 11 days earlier in 2012). However, the longer period from hatch to fledge (50 versus 36 days) offsets the earlier nesting dates, and spectacled eiders fledge a little later than Steller's eiders. Based on the range of hatch dates, Steller's eiders would fledge from 20 August to 4 September and spectacled eiders from 26 August to 7 September, 2012. Egg inviability was rarely detected in 2012 for Steller's or spectacled eiders. Inviable eggs were observed in only one (1 of 12) Steller's and no (0 of 17) spectacled eider nests. However, due to limited egg candling, this is a minimum estimate of the true prevalence.

Brood movements of Steller's eiders were generally similar to movement data for other years of the study. Some movement metrics were similar between species, but the maximum distance a brood moved from their nest and the total area used were substantially larger for spectacled eiders, both in 2011 and 2012 (Safine 2012). Brood movements appear to vary among females within a species, but in general spectacled eiders are more likely to make longer movements during brood rearing. For some spectacled eider broods, movements were long enough that we could no longer detect the radio signal, particularly during late brood rearing. In 2011 and 2012, we did not lose the signal for any Steller's eiders broods before confirming their final fate (failed or fledged), but we could not confirm the fate of several spectacled eider broods (3 of 8 broods in each year; Safine 2012). We believe the females may have moved their brood to salt water before fledging, and by 50 days of age they moved far enough that their radio signal was not heard. Other possibilities include late brood failure, adult females abandoned their broods prior to fledging (and left the study area), or that radio transmitters were shed or batteries failed. Given that some spectacled eider hens move their broods long distances, periodic aerial telemetry may be required to ensure brood fate is known with certainty (an assumption of known fate models).

Most (92%) observations of Steller's eider broods up to 36 days of age were in shallow wetlands regardless of plant species (*Carex* and *Arctophila*). The dense emergent vegetation in these *Carex* and *Arctophila* wetlands likely provided good cover from predators and abundant invertebrate food resources. Spectacled eider broods also used wetlands with emergent vegetation frequently up to 35 days of age (54% of observations in *Carex* and *Arctophila*), however only 30% of the total observations were in shallow wetlands. Most observations of spectacled eider broods were in deeper wetlands or lakes (63%; deep open or deep *Arctophila*). Many observations of spectacled eider broods were in larger lakes with little to no emergent cover (deep open category; 39%), compared to only 5% of observations of Steller's eiders in that habitat. The waterbody characteristics data we collected in 2012 further supports these trends. On average, spectacled eider broods used waterbodies that were larger, deeper, and had less emergent cover than Steller's eiders (Table 16). Observations of spectacled eider broods were more evenly distributed among the four categories of emergent vegetation types (Table 17). In contrast, Steller's eiders were more likely to be found in waterbodies with some emergent cover, and specifically with either *Carex* only or both *Carex* and *Arctophila* (*Carex* tends to grow in shallow wetlands; Table 17). We also verified that both species were only using freshwater wetlands during early brood rearing (up to 36 days of age) in the study area near Barrow. Use of brackish water wetlands for brood rearing has been recorded for spectacled eiders on Kigigak Island on the Yukon Kuskokwim Delta (B. Lake/USFWS Unpublished data), and has been hypothesized to reduce duckling growth rates. Overall, the data collected for Steller's and spectacled eiders near Barrow in 2011 and 2012 suggests that these species have different patterns of wetland use during brood rearing. However, there was only one year of waterbody characteristics data, and samples sizes were limited.

This was the second year we monitored Steller's eider movements after fledging. The general pattern in both years (2011 and 2012) was for successful Steller's eider broods to remain in the vicinity of the brood rearing area after fledging (for up to 17 days), then either move to marine areas in the study area or leave the study area. However, details differed between years. First, birds appeared to remain on the tundra longer after fledging in 2012 (2-12 days in 2011, 7-17 days in 2012). Secondly, there was no recorded use of the marine areas north of Barrow (from NARL to Point Barrow) by successful broods in 2012. This area was used by adult females and juveniles after fledging in 2008 and 2011 (Safine 2011, Safine 2012, and USFWS unpublished data). More than half of the successful broods in 2011 (5 of 8) were observed in these areas after fledging, and some broods were observed multiple times. In 2012, only one of four broods was briefly observed in salt water in the study area (in Elson Lagoon; Figure 17). In addition, unmarked broods were not observed in these areas in 2012 (unmarked broods were seen in 2011; Safine 2012). However, two female Steller's eiders that failed to fledge broods in 2012 did use the marine areas north of Barrow. In general, this apparent decrease in use of marine areas near Barrow may have been the result of fewer broods fledging in the Barrow area in 2012, and/or some annual variation in the propensity of adult females and broods to stage in those areas. All broods use marine areas after leaving the breeding grounds, but in some years they may prefer to head directly to other areas (e.g., the Chukchi Sea southwest of Barrow), without first making a stop in the Chukchi Sea or Elson Lagoon in the vicinity of Pigniq (Duck Camp).

Arctic fox control was conducted for the 8th consecutive year in the study area in 2012. Between 2 May and 15 July 2012, 110 arctic fox were removed from the study area (Stevens and Smith 2012). Numerous fox dens were located, and 35% of female fox taken were either lactating or pregnant (Stevens and Smith 2012). This was the second year with an earlier and more spatially extensive effort using snowmachines during May. This effort, as in 2011, appeared to be very effective at reducing fox numbers in the study area (and likely beyond) during the nesting season. Arctic fox were not completely eliminated from the study area during the nesting season, as we observed one arctic fox during the breeding pair survey and recorded one arctic fox depredating a camera monitored duck nest. Although some nests were likely taken by foxes, we believe the majority of nest predation in 2012 was avian (based on nest camera observations). We plan to continue this early trapping effort using snowmachines in 2013. Like 2011, this year also had a low rate of incidental take (Stevens and Smith 2012), and we commend USDA Wildlife Services on this low level of by-catch.

Mean nest survival rate for Steller's eiders during the entire duration of the study (1991-2012) was 0.35 (± 0.07). The lowest nest survival occurred in 1997 (0.0) and highest in 2006 (0.88). In years prior to fox control (1991-2000), mean nest survival was 0.23 ± 0.09, after fox control began (2005-2012) nest survival was higher (0.47 ± 0.08; Figure 21). A comparison of mean nest survival rate in years with and without fox control is confounded by a variety of factors, including variable fox control effort among years and annual variation in lemming, fox, and jaeger abundance independent of fox control. Despite the confounding factors, the continued trend of relatively high nest survival after fox control began suggests there is a positive effect of fox control on nest survival. The continued trend of higher brood survival rates after fox control was initiated also suggests there may be a positive effect of fox control on duckling survival. However, there is only one year with comparable brood survival data from the 1990s

(1995), making any comparisons difficult.

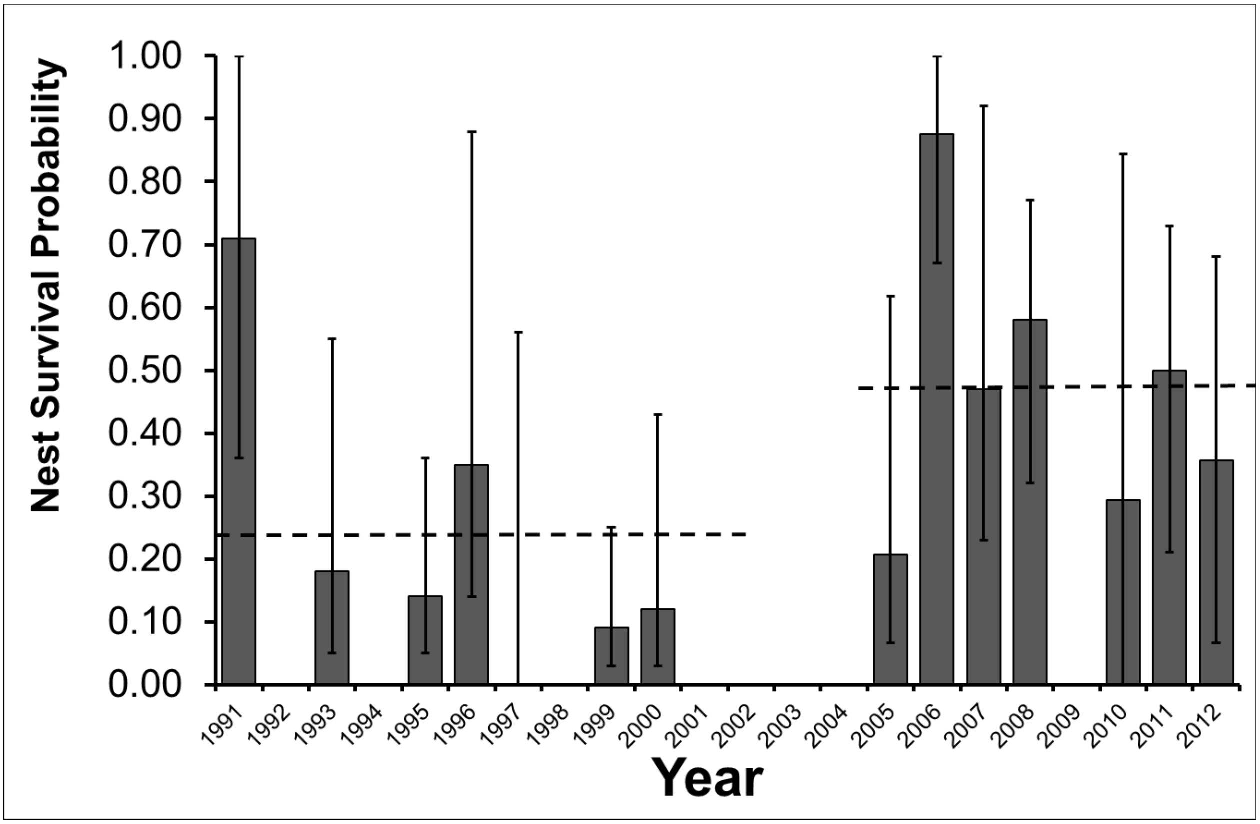


Figure 21. Nest survival probability for Steller's eiders near Barrow, Alaska from 1991-2012. Error bars are 95% confidence intervals. The dashed horizontal lines are mean nest survival before (0.23) and after (0.47) fox control was initiated in 2005.

Overall, production of Steller's eiders in the study area near Barrow in 2012 appeared to be low to moderate compared to other recent years of the study (2005-2011). There were a moderate number of birds present in mid-June, nest survival was low to moderate, and brood survival was moderate. During late brood rearing and the post-fledging period, broods were not seen in the marine areas near Barrow, but this may have been only partly due to lower productivity. If either more birds had been present in the study area or nest survival rates had been higher, local production of juvenile Steller's eiders would likely have been increased (similar to 2006, 2008, and 2011).

LITERATURE CITED

Bacon, B. R. and J. O. Evrard. 1990. Horizontal mist net for capturing upland nesting ducks. North American Bird Bander 15:18-19.

Bergman, R. D., F. L. Howard, K. F. Abraham, and M. W. Weller. 1977. Water birds and their wetland resources in relation to oil development at Storkersen Point, Alaska. U.S. Fish and Wildlife Service Resource Publication 129, Washington D.C. 38 pp.

Billings, W. D. and K. M. Peterson. 1980. Vegetational change and ice-wedge polygons through the thaw-lake cycle in arctic Alaska. Arctic and Alpine Research 12:413-432.

Bowman, T. D. 2004. Field guide to bird nests and eggs of Alaska's coastal tundra. Alaska Sea Grant College Program, University of Alaska, Fairbanks. 81 pp.

Britton, M. E. 1957. Vegetation of the arctic tundra. Pages 26-61 *in* H.P. Hansen (ed.), Arctic Biology: Eighteenth Annual Biology Colloquium. Oregon State University Press, Corvallis, Oregon.

Dinsmore, S. J., G. C. White, and F. L. Knopf. 2002. Advanced techniques for modeling avian nest survival. Ecology 83:3476-3488.

Flint, P. L., J. B. Grand, and R. F. Rockwell. 1998. A model of northern pintail productivity and population. Journal of Wildlife Management 62:1110-1118.

Flint, P. L., and J. B. Grand. 1999. Incubation Behavior of Spectacled Eiders on the Yukon-Kuskokwim Delta, Alaska. The Condor 101: 413-416.

Flint, P. L. and M. P. Herzog. 1999. Breeding status of Steller's eiders, *Polysticta stelleri*, on the Yukon-Kuskokwim Delta, Alaska. Canadian Field-Naturalist 113:306-308.

Johnson, D. H. 1979. Estimating nest success: the Mayfield method and an alternative. Auk 96:651-661.

Kertell, K. 1991. Disappearance of the Steller's eider from the Yukon-Kuskokwim Delta, Alaska. Arctic 44: 177-187.

Klett, A. T., H. F. Duebbert, C. A. Faanes, and K. F. Higgins. 1986. Techniques for studying nest success of ducks in upland habitats in the prairie pothole region. U.S. Fish and Wildlife Service, Resource Publication 158. 24 pp.

Mauser, D. M. and R. L. Jarvis. 1991. Attaching radio transmitters to 1-day-old Mallard ducklings. Journal of Wildlife Management 55:488–491.

Mayfield, H. F. 1961. Nesting success calculated from exposure. Wilson Bulletin 73:255-261.

Mayfield, H. F. 1975. Suggestions for calculating nest success. Wilson Bulletin 87:456-466.

National Oceanic and Atmospheric Administration (NOAA). 2011. Climate Resources. Web page of the National Climatic Data Center at http://www.ncdc.noaa.gov/oa/climateresearch.html

Obritschkewitsch, T., P. D. Martin, and R. S. Suydam. 2001. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 1999-2000. U.S. Fish and Wildlife Service, Northern Alaska Ecological Services, Fairbanks, Alaska. Technical Report NAES-TR-01-04. 113 pp.

Obritschkewitsch, T. and P. D. Martin. 2002a. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2001. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report NAES-TR-02-01. 43 pp.

Obritschkewitsch, T. and P. D. Martin. 2002b. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2002. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 33 pp.

Obritschkewitsch, T. and R. J. Ritchie. 2010. Steller's eider surveys near Barrow, Alaska, 2009. ABR, Inc. Fairbanks, Alaska. 11 pp.

Obritschkewitsch, T. and R. J. Ritchie. 2013. Steller's eider surveys near Barrow, Alaska, 2012. ABR, Inc. Fairbanks, Alaska. 17 pp.

Ott, K. E. 2012. 2011 Report: Estimation of lemming abundance and distribution near Barrow, Alaska. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 61 pp.

Pearce, J. M., D. Esler, and A. G. Degtyarev. 1998. Nesting ecology of spectacled eiders *Somateria fischeri* on the Indigirka River Delta, Russia. Wildfowl 49:110–123.

Petersen, M. R., J. B. Grand, and C. P. Dau. 2000. Spectacled Eider (*Somateria fischeri*). *In* The Birds of North America, No. 547 (A. Poole and F. Gill, editors). The Birds of North America, Inc., Philadelphia, PA.

Petersen, J. and D. W. Holt. 1999. Observations on the snowy owl (*Nyctea scandiaca*) at Barrow, Alaska: A progress report 1992-1998. Report submitted to the Department of Wildlife Management, North Slope Borough, Barrow, Alaska, by Owl Research Institute, Charlo, Montana. 130 pp.

Pitelka, F. A. 1974. An avifaunal review for the Barrow region and North Slope of arctic Alaska. Arctic and Alpine Research 6:161-184.

Quakenbush, L., and R. Suydam. 1999. Periodic nonbreeding of Steller's eiders near Barrow, Alaska, with speculations on possible causes. Pages 34-40 *in* R. I. Goudie, M. R. Petersen, and G. J. Robertson (eds.), Behavior and ecology of Sea Ducks. Occasional Paper, Number 100. Canadian Wildlife Service, Ottawa.

Quakenbush, L. T., R. S. Suydam, K. M. Fluetsch, and C. L. Donaldson. 1995. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 1991-1994. U.S. Fish and Wildlife Service, Northern Alaska Ecological Services, Fairbanks, Alaska. Technical Report NAES-TR-95-03. 53 pp.

Quakenbush, L., R. Suydam, K. Fluetsch, M. Johnson and T. Obritschkewitsch. 2000. Habitat use by Steller's Eiders during the breeding season near Barrow, Alaska, 1991-1996. Unpublished report, University of Alaska, Fairbanks, Alaska; North Slope Borough Department of Wildlife Management, Barrow, Alaska; and U.S. Fish and Wildlife Service, Northern Alaska Ecological Services, Fairbanks, Alaska. 45 pp.

Quakenbush, L., R. Suydam, T. Obritschkewitsch, and M. Deering. 2004. Breeding biology of Steller's eiders (*Polysticta stelleri)* near Barrow, Alaska, 1991-99. Arctic 57: 166-182.

Rojek, N. A. and P. D. Martin. 2003. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2003. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 35 pp.

Rojek, N. A. 2005. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2004. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 40 pp.

Rojek, N. A. 2006. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2005. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 53 pp.

Rojek, N. A. 2007. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2006. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 53 pp.

Rojek, N. A. 2008. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2007. U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 52 pp.

Rotella, J. J., D. W. Howerter, T. P. Sankowski, and J. H. Devries. 1993. Nesting effort by wild Mallards with 3 types of transmitters. Journal of Wildlife Management 57:690–695.

Safine, D. E. 2011. Breeding ecology of Steller's and spectacled eiders nesting near Barrow, Alaska, 2008-2010. U. S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 66 pp.

Safine, D. E. 2012. Breeding ecology of Steller's and spectacled eiders nesting near Barrow, Alaska, 2011. U. S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, Alaska. Technical Report. 65 pp.

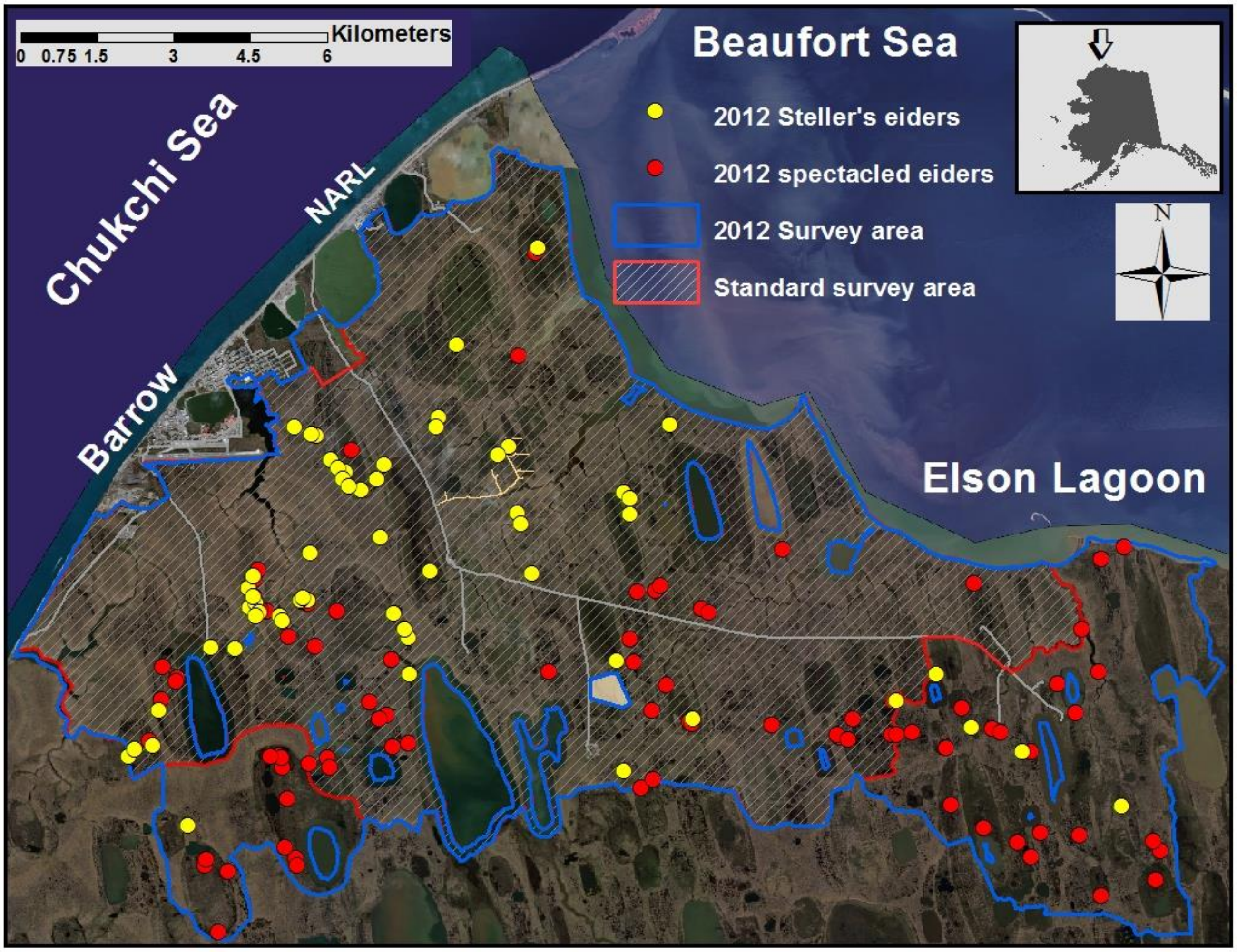
Stehn, R., and R. Platte. 2009. Steller's eider distribution, abundance, and trend on the Arctic Coastal Plain, Alaska, 1989-2008. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska. 35 pp.

Stevens, M. S., and T. L. Smith. 2012. Fox Control on the Barrow Steller's Eider Conservation Planning Area: 2012 Report. U. S. Department Of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Palmer, Alaska.15 pp.

White, G. C., and K. P. Burnham. 1999. Program MARK: survival estimation from populations of marked animals. Bird Study 46: 120-139.

Williams, B. K., J. D. Nichols, and M. J. Conroy. 2002. Analysis and management of animal populations. First edition. Academic Press, California.

Appendix A. Observations of Steller's and spectacled eider adults and extent of annual survey area from the ground-based breeding pair surveys near Barrow, Alaska, 2012. Yellow and red dots are Steller's and spectacled eiders, respectively. The blue outline is the total area surveyed and the cross hatched area outlined in red is the standard area that has been surveyed every year since 1999.

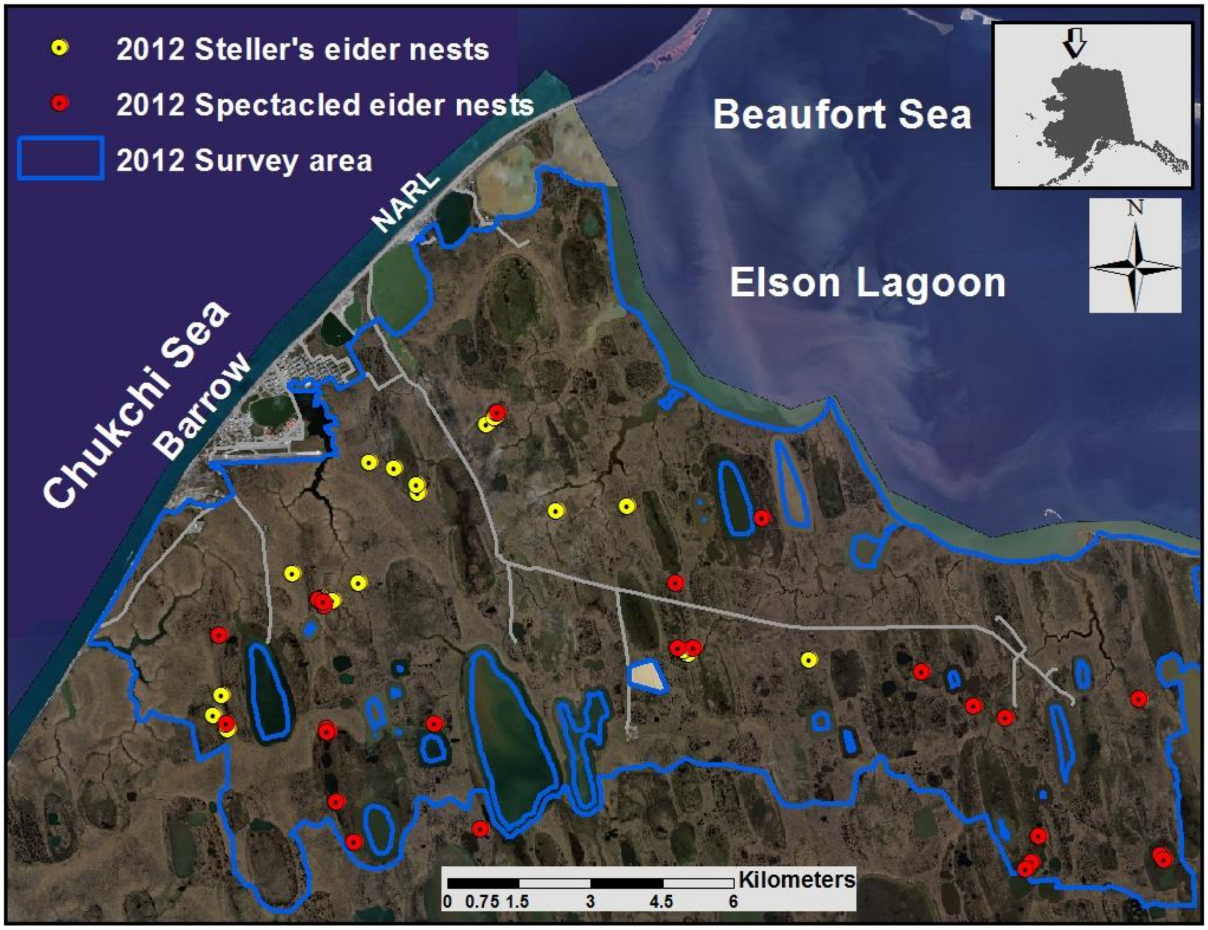


Appendix B. Ground-based pair survey results for all species counted near Barrow, Alaska 2012. The number of confirmed nests is reported for survey results only; additional nests were found during nest searches or incidentally for Steller's eiders and other species.

	2012		
Species	Count	Density[a]	Nests/dens[b]
Arctic fox	1	0.01	0
Common raven[c]	24	0.14	0
Eider species	1	0.01	0
Glaucous gull	799	4.54	14
Jaeger species	1	0.01	0
Long-tailed jaeger	47	0.27	1
Parasitic jaeger	115	0.65	2
Pomarine jaeger	161	0.91	1
Short-eared owl	1	0.01	0
Snowy owl	79	0.45	6
Spectacled eider	154	0.88	9
Steller's eider	113	0.64	0

[a] Density is number of birds observed (male and female) in the entire survey area for that year (birds/km^2).
[b] Number of confirmed nests and dens found during the pair survey. Dens are generally not found during the survey but they do exist in the study area.
[c] There are a minimum of two pairs near Barrow, with confirmed nesting on dewline towers north of NARL and satellite dishes off Freshwater Lake Road.

Appendix C. Steller's and spectacled eider nests found near Barrow, Alaska 2012. Yellow and red symbols represent Steller's and spectacled eider nests, respectively.



Appendix D. Egg fates for Steller's eider nests in 2012 near Barrow, Alaska.

Nest	Known eggs laid	Found viable?	Egg fates				
			Hatched	Inviable or found whole post-hatch[a]	Abandoned whole	Vanished	Depredated shells present
12-EKW014	6	Y	6	0	0	0	0
12-EKW016	5	Y	0	0	0	3	2
12-MAB015	5	Y	0	0	0	5	0
12-MCZ040	6	Y	0	0	0	6	0
12-MCZ049	7	Y	7	0	0	0	0
12-MCZ052	≥1	N	0	0	0	≥1	0
12-MCZ054	6	Y	6	0	0	0	0
12-MCZ062	≥1	N	0	0	0	0	≥1
12-MCZ067	6	Y	2	3	0	3	1
12-MTW048	5	Y	0	0	0	1	4
12-MTW049	7	Y	5	0	0	2	0
12-MTW059	6	Y	5	0	0	0	1
12-MTW070	3	N	2	0	0	0	1
12-MTW071	5	Y	4	0	0	1	0
12-MTW073	≥1	N	0	0	0	≥1	0
12-RRG014	≥1	N	0	0	0	0	1
12-SAM019	3	Y	3	0	0	0	0
12-VC012	6	N	0	0	0	0	6
12-VC019	≥1	N	0	0	0	0	≥1

[a] This is a minimum estimate only, and includes any eggs found whole after hatch. Due to limited egg candling, many inviable eggs may not have been detected, and subsequently destroyed by predators.

Appendix E. Steller's eider nest survival near Barrow, 1991-2012.

Year	Nests found	Nests hatched	Apparent nest success (%)	Found viable	Number failed	Mayfield[a] nest survival	Lower 95% CI[b]	Upper 95% CI
1991	6	5	83	6	1	0.71	0.36	1.00
1992	0	0		0	0		0.00	0.00
1993	20	4	20	13	9	0.18	0.05	0.55
1994	0	0		0	0		0.00	0.00
1995	78	8	10	25	17	0.14	0.05	0.36
1996	22	6	27	11	5	0.35	0.14	0.88
1997	4	0	0	3	3	0.00	0.00	0.56
1998	0	0		0	0		0.00	0.00
1999	36	7	19	27	20	0.09	0.03	0.25
2000	21[c]	4	19	17	11[c]	0.12[d]	0.03	0.43
2001	0	0		0	0		0.00	0.00
2002	0	0		0	0		0.00	0.00
2003	0	0		0	0		0.00	0.00
2004	0	0		0	0		0.00	0.00
2005[e]	21	6	29	15	9	0.21[d]	0.07	0.62
2006[e]	16	15	94	16	1	0.88	0.67	1.00
2007[e]	12	7	58	12	5	0.47	0.23	0.92
2008[e]	28	19	68	27	8	0.58[d]	0.32	0.77
2009[e]	0	0						
2010[e]	2	1	50	2	1	0.29	0.00	0.84
2011[e]	27	14	52	22	8	0.50	0.21	0.73
2012[e]	19	9	47	12	4	0.36	0.07	0.68
Total	**291**	**105**	**41**	**208**	**91**	**0.35 (SE 0.07)**		

[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 on any nest that was known to fail due to observer activities.

[e] Fox control occurred in study area.

Appendix F. Nesting by Steller's eiders and avian predators near Barrow, 1991-2012.

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
2008	Yes	Yes	Yes (31)	Yes	27	1	28
2009	Yes	No	No (0)	No	0	0	0
2010	Yes	Yes	No (0)	No	2	0	2
2011	Yes	Yes	Yes (3)	Yes	22	5	27
2012	Yes	Yes	Yes (7)	Yes	12	6	19

[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 km2 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 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 G. Steller's eider breeding biology study, 1991-2012: a brief review.

Steller's eider abundance and breeding effort vary widely near Barrow from year to year. We do not find Steller's eiders nests near Barrow in some years, and adults can be absent from the tundra by mid-June. During this study, nesting by Steller's eiders has been correlated with nesting by avian predators and lemming abundance. Following is a brief review of results from each year of this study. Details can be found in annual reports and other publications (Appendix H).

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 owls did not nest but six pomarine jaegers nests were found in the study area.

2008 Steller's eiders were present in the study area in early June when the field crew arrived. Nests were initiated primarily during mid-June in the central and eastern portions of the study area along Cake Eater and Gaswell Roads. Four of the radio-marked broods fledged, and there were several other unmarked broods observed in the study area.

2009 Steller's eiders arrived in pairs and mixed sex flocks in small numbers in early June, then dispersed. Only one pair seen during survey in mid-June (total of nine Steller's counted), and very few Steller's present after mid-June. Three male and later three female Steller's eiders were seen feeding in Middle Salt Lagoon in early and mid-July. No Steller's eider, pomarine jaeger, or snowy owl nests found. Nest survival was low for sea ducks that did nest.

2010 Steller's eiders present in study area in early June when the field crew arrived. Breakup was quite late in 2010. Two Steller's eider nests were found in the study area, and a few other females likely initiated nests but failed before detection. One of the two nests hatched. This was only the second year since 1991 with Steller's eider nests found and no nesting by snowy owls and pomarine jaegers. Nest survival for sea ducks was slightly higher than 2009, but still low.

2011 Steller's eiders were present in study area on 1 June when the field crew arrived. Timing of breakup was fairly average, and there was not much melt water along the road system in early June. Steller's eider pairs and nests were found in moderate numbers in the study area. Snowy owls and pomarine jaegers nested in the study area after a 2 year hiatus, but were found nesting in low numbers. Nest survival for Steller's eiders was average for years after fox control was initiated, and brood survival was the highest that has been recorded.

2012 Steller's eiders were not seen regularly in the study area until 6 June. Timing of breakup was a little later than average. Steller's eider pairs and nests were found in moderate numbers in the study area. Snowy owls and pomarine jaegers also nested in the study area, in slightly greater numbers than the previous year. Nest survival for Steller's eiders was below average for years after fox control was initiated, and brood survival was average.

Appendix H. Reports of the Steller's eider breeding biology study for 1991-2012.

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
Rojek 2008	2007
Safine 2011	2008-2010
Safine 2012	2011
This report	2012