MONITORING OF NESTING SPECTACLED EIDERS ON KIGIGAK ISLAND, YUKON DELTA NWR

2013

Melissa Gabrielson and Kyle Spragens

U.S. Fish & Wildlife Service, Yukon Delta National Wildlife Refuge, P.O. Box 346, Bethel, AK 99559

SUMMARY

Nesting spectacled eiders were monitored for the 22nd consecutive year on Kigigak Island, Alaska in 2013. Field crews recorded clutch size, hatch date, and final nest status to estimate nesting success of spectacled eider females; resighted, captured, and marked adult females to estimate annual survival; captured spectacled eider broods to monitor changes in body weight, recruitment, and duckling survival; and recorded size, shape, depth, temperature, salinity, percent emergent cover, and surrounding vegetation and habitat type of ponds where broods were captured.

Thirty-five of 48 plots on Kigigak Island were searched in 2013 resulting in the detection of 107 spectacled eider nests that were monitored through hatch (97 on plot, 10 off plot). Mean clutch size averaged 4.8 ± 1.1 (SD) eggs. Mean nest initiation and hatch dates were 2 days earlier than 2012. The estimated Mayfield nest success of 75 nests, where fates could be determined, was 12.5% (95% CI; 6.2-21.3%). Sixty unique adult females were identified during the breeding season: 33 nest-trapped (13 recaptures and 20 new) and 27 visually resighted. Average weight of adult females was 1,239 g ± 83.9 (SD), average culmen was 24.9 mm ± 2.0 (SD), and average tarsus was 54.3 mm ± 2.6 (SD). Brood captures resulted in the capture of 16 broods (16 adult females and 44 ducklings). Fifteen of the 16 adult females caught during brood captures were previously marked, however only 2 were previously encountered in 2013 (*i.e.* 13 additional new recaptures for 2013). Two additional females (in addition to the 16 captured) were visually resighted, but were not captured, during brood captures. The average duckling weight was 804 g ± 127.9 (SD), average culmen was 21.6 mm ± 1.6 (SD), average tarsus was 55.1 mm ± 2.6 (SD), and the average 9th primary was 59.8 mm ± 23.9 (SD). The average weight of adult females was 1,231 g ± 66.8 (SD), average culmen was 25.9 mm ± 1.7 (SD), and average tarsus was 56.0 mm ± 1.5 (SD). Broods were captured in ponds characterized as being surrounded by high sedge meadow habitat. The average temperature (°C) of brood ponds was 14.9 ± 1.2 (SD), the average depth was 35.2 cm ± 9.8 (SD), and the average salinity was 7.9 ppt ± 2.2 (SD).

Nesting chronology was delayed in 2013 due to a late spring break-up. The late break-up affected the timing of field camp deployment. Ice chunks from slough and river break-up hindered float plane access to many camp sites along the central Yukon-Kuskokwim Delta (YKD) coast. Nest initiation and incubation for emperor geese, cackling geese, and eiders had begun by the time that researchers arrived on Kigigak Island. Spectacled eider nest success in 2013 was the second lowest recorded and was below the long-term average on Kigigak Island. Additional analyses are needed to incorporate the 22 years of spectacled eider nesting and demographic parameters to update population models.

KEY WORDS

Spectacled Eider, Nest Success, Survival, Recruitment, Mark-Resight, Food Availability, Habitat Use Brood observations, Salinity, Brood Capture, Mist-net, Bow-trap, Nasal Disc, Tarsal Band

INTRODUCTION

Since spectacled eiders (*Somateria fischeri*) were listed as a threatened species in 1993, the U.S. Fish & Wildlife Service has monitored the population, assessed possible reasons for the decline, and developed management strategies to facilitate population recovery (U.S. Fish & Wildlife Service 1996). A Spectacled Eider Recovery Plan was prepared in 1996 by the Spectacled Eider Recovery Team. Recovery priorities addressed in the 1996 Recovery Plan have been revised periodically (annually or biannually). The most recent update occurred in December of 2010. The research on Kigigak Island directly or indirectly addresses several priorities identified in the updated 2010 document.

Over the last 22 years, research on Kigigak Island has documented clutch size, hatch date, and final nest status to estimate nesting success of spectacled eider females (see 2010 list of High Priority Tasks: 20b); resighted, captured, and marked adult females to estimate annual survival (see 2010 list of High Priority Tasks: 7 and 27b); and captured spectacled eider broods to monitor changes in body weight, recruitment, and duckling survival (see 2010 list of High Priority Tasks: 18 and 20a). The research and monitoring on Kigigak Island continued in 2013.

USFWS Study Objectives

1. Determine clutch size, hatch date, and final nest status of spectacled eider females to estimate nesting success.
2. Resight or capture and mark adult females to generate estimates of adult female annual survival.
3. Capture and mark ducklings prior to fledging to estimate recruitment and duckling survival.

STUDY AREA

Kigigak Island (32.5 km^2; 60°50'N, 165°50'W) is located along the central coast of Yukon Delta National Wildlife Refuge (YDNWR) near the mouth of Baird Inlet (Figure 1). The island, bordered by the Ninglick River and the Bering Sea, contains many shallow ponds, lakes, and a network of tidal sloughs. Habitat types include high-sedge meadow, high-graminoid meadow, dwarf-shrub upland, and intermediate-sedge meadow (Grand et al. 1997). Spring and fall storm tides regularly inundate the island, except for upland areas which are flooded only during severe tidal storms.

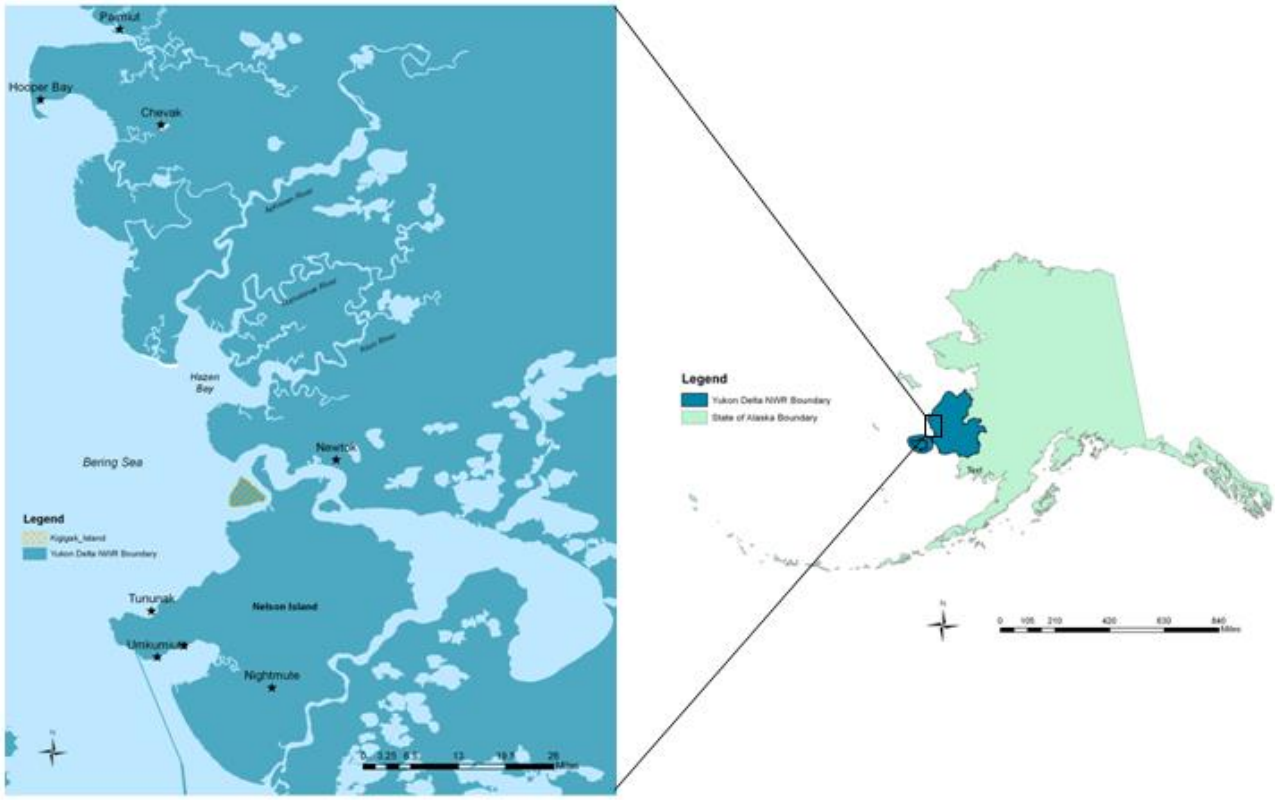

Figure 1. Location of Kigigak Island study area on Yukon Delta National Wildlife Refuge (YDNWR), Alaska

METHODS

Data Collection

A four-person research team searched for spectacled eider and Pacific common eider (*Somateria mollissima* v-nigra) nests on 35 of 48 - 412 m x 412 m plots previously identified as spectacled eider nesting habitat (Harwood and Moran 1993) (Figure 2). Plots (n=35) were thoroughly searched once between 13 and 20 June. Each plot took 4-8 hours to search depending on distance from camp, number of islands to search, influence of tidal sloughs, etc. Additional nests were located opportunistically while moving between plots. Three nesting aggregations of Pacific black brant (*Branta bernicla* nigricans) were also monitored over the course of the field season.

Data were recorded according to methods developed by the USGS – Alaska Science Center (Grand 1993). On the initial nest visit a white flag was placed approximately 3 m north of the nest. The nest location was recorded on a topographic map and with a Garmin eTrex HC GPS unit. All nest location data was collected in WGS 1984 but was converted to North America 1983 (UTM), Zone 3N when projected in ArcMap. Each egg in the nest was uniquely numbered to document the number of new and/or missing eggs on subsequent visits. Each egg was floated (Westerkov 1950) and candled (Weller 1956) to estimate days of incubation and viability. Contour feathers (10-20) were collected from each nest bowl for future DNA and stable isotope analyses.

Nests were revisited every 7-10 days until a few days before hatch when visitation may increase due to trapping efforts. Nests were typically visited 2-4 times (including hatch/final nest status). On all nest visits, nest status (incubating, laying, depredated, abandoned, hatched) and egg status (number present, new, missing, inviable, depredated, hatched) were recorded. We attempted to identify marked spectacled eider females on all nest visits by reading nasal and tarsal band codes with spotting scopes, binoculars, or a Nikon D700 camera with 80-400mm zoom lens. If we were unsuccessful at visually resighting any marked female, an attempt was made to recapture her within a few days of her expected hatch date. In addition, an attempt was made to capture any unmarked females (i.e. new birds).

Bownet traps (Salyer 1962) and mist nets were used to trap all unmarked spectacled eider females (i.e. new birds) and marked females that we were unable to visually resight. Trapping occurred 3-4 days before the estimated hatch date. Hatch dates were calculated based on egg float angle and candling data, assuming a 24-day incubation period for spectacled eiders. Unbanded female spectacled eiders were marked with a metal U.S. Fish & Wildlife Service leg band; an alpha-numerically coded, yellow, plastic tarsal band; and a nasal disc (Lokemoen and Sharp 1985). Nasal discs and tarsal bands of marked females were replaced when necessary. Morphological measurements of all trapped spectacled eiders females (weight, culmen, and tarsus) were recorded following the guidelines of Dzubin and Cooch (1992).

Spectacled eider broods were captured in early August, when ducklings were approximately 30-35 days of age. Captures encompassed the plots and surrounding areas where plots acted as boundaries. Different areas of the island were searched each day. Broods included adult spectacled eider females previously observed or trapped during nest visits and females (marked and unmarked) that were not previously observed during the field season. Spectacled eider ducklings and the attending female(s) were gently maneuvered into mist nets placed in the ponds used by the spectacled eider broods. Unbanded adult females were marked with a metal U.S. Fish & Wildlife Service leg band; an alpha-numerically coded, yellow, plastic tarsal band; and a nasal disc (Lokemoen and Sharp 1985). Nasal discs and tarsal bands of marked females were replaced when necessary. All ducklings (male and female) were marked with a U.S. Fish and Wildlife Service metal leg band. The mass, tarsus, and culmen of all captured individuals were measured (Dzubin and Cooch 1992). In addition, the 9th primary feather was measured for ducklings. Pond characteristics (pond size, salinity, temperature, depth, % emergent, etc.) were collected at each brood capture site.

Banding data was entered into the BANDIT software program from the USGS Bird Banding Laboratory and electronically submitted to the Bird Banding Lab at the end of the field season. All encounters of banded spectacled eiders and non-target species were entered online (www.reportband.gov).

The U.S. Fish & Wildlife Service has issued permits under Section 10 of the Endangered Species Act to authorize take of endangered or threatened species for purposes of enhancement of propagation or survival (USFWS 2010). Capture-related injuries may include accidental mortality or broken wings/legs (USFWS 2010). Since the spectacled eider was listed under the Endangered Species Act in 1993, only 3% (11 birds) of the permitted, lethal, incidental take of adult spectacled eiders has occurred, and only 1% (5 eggs) of the permitted, lethal, incidental take of spectacled eider eggs has occurred (USFWS 2010). Even though lethal, incidental take has occurred in the past, it is unlikely that nest searching/monitoring or capturing females on the nest will result in the lethal take of adult spectacled eider females or their eggs (USFWS 2010). Any incidents that occur on Kigigak Island are reported to the Regional Endangered Species Coordinator in Anchorage, AK.

Data Analysis

Nest initiation and hatch dates, clutch size, and egg and nest fate were reported for only spectacled eiders in this report. Pacific common eider and Pacific black brant data are archived at Yukon Delta National Wildlife Refuge (Bethel, AK) and will be analyzed by December 2014.

Estimated spectacled eider hatch dates were used to determine timing of nest trapping. Clutch initiation dates for spectacled eider nests found during laying were estimated by subtracting 1 day for each egg present. For nests found during incubation, egg float angle and candling data were used to estimate clutch age. Initiation dates were then estimated by backdating the estimated clutch age according to the incubation period for each species and a laying rate of one egg per day (Grand and Flint 1997). Hatch date was similarly estimated using egg float angle and candling data. For nests that survived to the start of incubation, clutch size was the total number of eggs laid.

Apparent nest success (#nests/total nests) was calculated for all hatched, depredated, abandoned, and unknown nests. Nests were defined as successful if ≥ 1 egg hatched. Nests with unknown fates, found depredated on initial visit, or found with all inviable eggs on initial visit were excluded from Mayfield nest success analysis due to the inability to accurately determine nest age. In addition, nests abandoned due to human disturbance were excluded from Mayfield nest success analysis. Mayfield nest success was estimated using the model of Dinsmore et al. (2002). A constant daily survival rate was derived from an overall exposure period of 29 days (Harwood and Moran 1993).

Apparent egg success (#eggs/total eggs) was calculated for all hatched, depredated, abandoned (natural and human), inviable/addled, damaged, collected, destroyed, and unknown eggs. Eggs were classified as hatched if detached membranes or ducklings were observed. Cold eggs were assumed to be abandoned, if the clutch was intact or some eggs had hatched. If abandonment occurred after trapping the female, it was assigned to human cause. Missing eggs were classified as such however, during summary and analysis all missing eggs were assumed to be depredated. The predators in these cases were usually unknown. When the fate of an egg could not be determined it was classified as unknown. This classification was important during the final nest check (determining final nest status) when females were still incubating.

RESULTS

Nesting Chronology

Break-up began on the Ninglick River (east of Kigigak Island) in early June, however large ice chunks prevented float-plane access until 9 June. A four-person research team arrived on Kigigak Island on 9 June. Large ice chunks were still present in the Ninglick River but most ponds and sloughs on Kigigak Island were ice-free. The first spectacled eiders were observed on 13 June while searching spectacled eider nest plots. Most of the birds were paired and incubating at this time.

In 2013, spectacled eider nest initiation occurred between 22 May and 17 June (Figure 3), with mean initiation on 1 June. Mean initiation in 2013 was 2 days earlier than 2012. Hatch occurred between 21June and 17 July (Figure 4), with mean hatch on 30 June. Mean hatch in 2013 was 2 days earlier than 2012.

Personnel began nest searching 13 June, 2 days later than 2012. A total of 107 spectacled eider nests were found (97 on plot and 10 off plot) after thoroughly searching 35 of 48 plots once (13 – 20 June).

Clutch Size

Spectacled eider clutch size ranged from 2 to 7 eggs (Figure 5), with a mean of 4.8 ± 1.1 (SD) eggs (Table 1). Average clutch size for 2013 was slightly above the 2012 average and the long term trend line (Figure 6). Significant differences between years were not analyzed.

Apparent Egg Fate

The apparent fate of 437 eggs was determined, including: 103 hatched (23.6%), 256 depredated (58.6%), 0 abandoned due to natural causes (0.0%), 2 abandoned due to monitoring activity (0.5%), 4 inviable or addled (0.9%), 2 damaged during handling, trapping, or when the attending female flushed from the nest (0.5%), and 70 unknown (16.0%) (Table 2).

Annual egg depredation is typically attributed to known native avian (primarily: glaucous gulls (*Larus hyperboreus*) and mew gulls (*Larus canus*)) and mammalian (Arctic fox (*Alopex lagopus*)) nest predators, however direct observations of spectacled eider egg depredation were limited. A total of 22 eggs (5.0%) were attributed to gull depredation based on commonly referred to indicators. The other 234 eggs (53.5%) could not confidently be attributed to a particular predator type. The percent of depredated eggs in 2013 (~60%) is the second highest recorded on Kigigak Island, following 2001 (~90%). No trend in percent depredated eggs over time is apparent on Kigigak Island (Figure 7), rather with the exception of three sporadic years (2001, 2003, and now 2013) the 19-year average of depredated eggs is 17.2% (range = 4.0-25.7, Table 2).

Nest Success

The fate of 92 spectacled eider nests was determined, including: 29 hatched (31.5%), 16 unknown (still incubating, no final nest status recorded; 17.4%), 1 abandoned (human caused, 0.01%), and 46 depredated (13 by known predator, 33 unknown; 51.1%). The estimated Mayfield nest success of 75 spectacled eider nests, with accurately determined nest age and known fates while assuming an exposure period of 29 days, was 12.5% (95% C.I. 6.2 – 21.3) (Table 3). This represents a 55.0% decrease compared to 2012 nest success and a 53.0% decrease compared to the long-term average (Figure 8).

Female Resight/Capture

In 2013, 43% of the nests found were initiated by females that were previously marked on Kigigak Island. Thirty three spectacled eider females were nest-trapped in 2013; 20 new captures and 13 recaptures. Morphological measurements (weight, culmen, and tarsus) were recorded for all adult females that were captured. The average body mass of adult females was 1,239 g ± 83.9 (SD), the average culmen length was 24.9 mm ± 2.0 (SD), and the average total tarsus length was 54.3 mm ± 2.6 (SD) (Table 4).

Of the recaptured females (n=13), all (100.0%) were previously marked but had lost their nasal discs. Initial questions about nasal disc retention and suitability for the project were raised in 2012 and continue to be of concern. Further analysis is warranted and will be completed and summarized in a separate report tentatively scheduled for submission in December 2014.

The first 2013 resight on Kigigak Island occurred on 13 June. When females were flushed from their nest we noted if bands were present and made an additional effort to read all bands and nasal discs. In 2013 we increased efforts towards resighting tarsal bands. A total of 27 spectacled eider females were visually resighted (scope, binoculars, or camera) in 2013. This total included 4 birds where both nasal and tarsals were read, 14 birds where only the tarsal bands were read, and 9 birds where only the nasal discs were read. Of the birds resighted (n=27) two were encountered for the first time since each bird was banded as a duckling (one in 2002 and one in 2003).

Brood Capture

Sixteen spectacled eider broods were captured between 2 and 6 August across Kigigak Island (Figure 9). A total of 44 ducklings (27 female, 16 male, 1 local) were captured, measured, and banded (except local who was too small for a band). The average duckling weight was 804 g ± 127.9 (SD), average culmen was 21.6 mm ± 1.6 (SD), average tarsus was 55.1 mm ± 2.6 (SD), and average 9th primary was 59.8 mm ± 23.9 (SD) (local duckling was not included in average measurements as he was too small to get a band).

A total of 16 adult females were captured with broods, 15 of which were recaptures (9 previously having had nasal discs, 60.0%). Two of the 15 recaptured females were previously encountered in 2013 and an additional two females were encountered for the first time since each bird was banded as a duckling (one in 2007 and one in2008). In addition to capturing adult females with broods, we also visually resighted 2 females that were unable to be captured, one which was previously encountered in 2013. The average weight of captured adult females was 1,231 g ± 66.8 (SD), average culmen was 25.9 mm ± 1.7 (SD), and average tarsus was 56.0 mm ± 1.5 (SD).

Broods were predominantly caught in ponds surrounded by high sedge meadow (Grand et al.1997). The average temperature of the ponds was 14.9 °C ± 1.2 (SD), the average depth was 35.2 cm ± 9.8 (SD), and the average salinity was 7.9 ppt ± 2.2 (SD). All of the ponds were irregularly shaped. The average percent emergent vegetation was 5.6%. Less emergent cover would be expected in larger, deeper ponds. Most of the emergent cover occurred around the edges of ponds or in small "bays".

Observed Mortality

No adult female spectacled eiders died as a direct result of our field efforts; however, one adult female spectacled eider morality was documented during the 2013 field season. The bird was found on 20 June while searching eider nest plots. Depredation by an Arctic fox was assumed as the head was removed and everything was stripped off the bird except for the wings, feet, and tail. The female was banded and had a coded tarsal band. The bands were removed and the encounter was reported to the Bird Banding Laboratory.

On 4 August during brood captures a male spectacled eider duckling mortality was documented. The brood had been captured earlier that day. When initially located, the brood had 1 adult female and 3 ducklings. When recaptured later in the afternoon only 2 ducklings were captured. Upon searching the vicinity of the capture site for the other duckling, it was found dead. A fresh wound had been made in its back by glaucous gulls, which were still in the area. The metal band was recovered from the duckling and the encounter was reported to the Bird Banding Laboratory.

Fox Observations

All predator observations were limited to qualitative observations on an ad hoc basis. Arctic fox were first observed and a den site was found on 13 June. A total of 6 fox were observed on the island (2 adults, 4 pups) (see Appendix A for more detailed observations of predators on Kigigak Island).

DISCUSSION

Due to the late break-up, the crew was not able to arrive on Kigigak Island until 9 June. Most of the island was snow and ice free upon crew-arrival. It is uncertain when nesting sites became available but many of the birds (CAGO, EMGO) were nesting and already incubating (3-4 days). Initiation, hatch, trapping, and brood captures were all similar in timing compared to 2012.

The Mayfield estimate for nest success in 2013 (12.5%) was the second lowest estimate following only 2001and was well below the long-term average recorded for Kigigak Island (1992-2013). The Nest Plots Survey (Nest Plots), conducted within the spectacled eider designated critical habitat area of the central coastal zone of the YKD, monitors nests of several waterbird species including spectacled eiders (See Fischer 2013 Report). Typically, apparent nest success estimates of spectacled eiders monitored on Kigigak Island correspond with trends from nest success index estimates (number of active nests divided by total nests multiplied by 100 with correction for detection rate) from the Nest Plots, except in low nest success years (e.g. 2001 and 2003) when localized events may have a greater influence on nest success estimates on Kigigak Island. Nests monitored during the Nest Plots are visited one time, therefore estimates of nest success (number of nests that hatch at least one chick/total nests) tend to be overestimated as some nests will fail prior to hatch. In addition, nests that are destroyed during egg laying (before down is added to the nest bowl) are underestimated as they are more likely to go undetected (Fisher et al 2013). Due to the large spatial scale of coverage, localized sampling bias is reduced during the Nest Plots providing a more representative depiction of the type of breeding season for a given species. In 2013, the Nest Plots nest success index for spectacled eiders was 77%, indicating a moderate nest success for spectacled eiders across the central coast. This estimate was lower than in 2012 (as was the case on Kigigak Island), but was comparable with many of the past years estimates.

There are four considerations to take into account in regard to the low nest success on Kigigak Island in 2013: 1) Only 35 of the 48 (73%) plots were searched, though the plots searched were “core” areas where the majority of the birds would have been expected to have been found and monitored. Had the other 13 plots been searched, additional birds would have been found and added to the total nest number for the field season; 2) The crew arrived mid-season rather than before initiation as in past years. The timeframe only allowed plots to be searched once before trapping efforts had to be initiated. Had plots been searched thoroughly a second time additional females would have been found and added to the total nest number for the field season; 3) There were quite a few late nesters which is not uncommon in a later break-up year however, this meant that there were birds (n=16) that we did not have a final nest status for due to time constraints placed on field crews in returning to Bethel. Final nest status from these birds would have contributed to nest success estimates. Given the capture of several previously unidentified females during brood captures it may have been that late nesters were at an advantage in 2013; and 4) There were nests that were found, not just for eiders but for geese as well (brant and cacklers), where the nest bowl was intact, with plenty of down (indicating incubation had not started), but all of the eggs were missing. It was hard to say what had happened. The wind was unusually intense in 2013, and there were multiple weather systems that could have caused birds to abandon but ultimately depredation was assumed for these nests. This increased the number of nests that were removed from nest success analysis. Further research is needed in this area to determine the relationship of environmental conditions and predator impacts on nest success between years. In order to better understand the breeding chronology of spectacled eiders and other birds on the island it is advantageous to arrive on the island prior to initiation.

Most of the depredation events that occurred on spectacled eider nests in 2013 were difficult to attribute to a particular predator type. Few signs of depredation were present other than empty nest bowls or missing eggs. It can be hard to distinguish predation between avian and mammalian predators at nest sites, especially when eggs are removed from a nest since both fox and gulls have been observed to remove intact eggs from nests. Predators did not seem to be targeting any one species; instead efforts seem to follow a generalist strategy and seem to be spatially dispersed in relation to the known fox den site and gull nesting colony locations on the island. Egg availability, assigning accurate nest predator composition, and spatial association to known nest predator locations warrant further consideration in forming a boarder understanding of Kigigak Island community ecology dynamics.

Resighting efforts were increased in 2013 due to the compressed field season and to address the nasal disc retention issue brought to attention in 2012. Resighting with scopes, binoculars, and cameras allowed us to make fewer trips to nests, reducing nest and female disturbance, and focusing trapping efforts later in the season. During our trapping efforts we discovered that many of the females were banded, but had lost their nasal discs. With 100% (n=13) of the re-captured females previously having been marked with a nasal disc, concerns about retention rates of nasal discs and their usefulness to the research being conducted on Kigigak Island are still a concern. Tarsal resighting efforts were increased in 2013 to determine if the loss in nasal disc resights could be made up by tarsal band resights. This effort resulted in the resight of twenty-seven adult females, including 14 (51.9%) tarsal-only encounters. Efforts will be made to continue to improve visual resights on marked females to help balance efforts on improving detection and deploying newly marked birds.

Around 1,761 spectacled eiders have been marked on Kigigak Island since the start of the project in 1991. Many of the females returning to Kigigak Island have contributed to more than one nesting attempt over the years. With such a large portion of the female population being banded, we expect the continued need to mark between 20 and 30 new females each year. Given quantitative limitations of mark-recapture efforts, the Recovery Team may want to consider assessment of adult survival estimates based on broad scale (aerial) surveys versus mark-recapture results, particularly given high potential for bias in mark-recapture results if nesting locations or distribution changes over time due to changes in habitat or sea-level rise.

Four birds were encountered in 2013 for the first time since the birds were banded as ducklings in 2002, 2003, 2007, and 2008. Between 1999 and 2008, 482 female ducklings were banded, sixty-four of which have been observed returning to Kigigak Island. In recent years, banded female ducklings have been returning at a lower than average rate (long-term average = 13.2%). A total of 198 female ducklings were banded between 2005 and 2008; however, only 7 (3.5%) have returned to Kigigak Island to breed. The mean body mass of female ducklings on Kigigak Island was analyzed in 2008 (Lake, unpubl. data) noting a decline in duckling body mass between 1999 and 2008. In 2008, the mean body mass of female ducklings on Kigigak Island were 26% lower than ducklings in1999. The relationship between duckling recruitment and possible influencing factors such as poor body condition prior to fledging, increases in pond salinity, changes in food abundance or quality, or changes in brood rearing or wintering areas remains unclear. Duckling morphological measurements were collected in 2012 and 2013. Preliminary analysis indicates that the average duckling mass in 2013 is still below the 1999 value but approached values not recorded since 2005. Additional research is needed on ducklings and their survival, as well as an assessment of the relative contributions of duckling recruitment and first winter survival. It may be possible that spectacled eiders are moving to another breeding site on the Delta, perhaps expanding to sites adjacent to Kigigak Island that we do not monitor. Future monitoring should include a sampling methodology that will assess changes in both abundance and distribution of nesting eiders throughout the Delta.

The graduate project (2010-2012), conducted by N. Graff (UAF), will determine environmental conditions of brood rearing ponds. Graff's research focused on habitat components on Kigigak Island, such as salinity of ponds and invertebrates present, to answer and expand our understanding of the effect of prey composition and prevalence on spectacled eider duckling growth. This information is needed in order to model the effect of habitat changes on this population, given current and future changes in habitat in this region. A final thesis is expected Fall 2014.

FUTURE WORK

Monitoring of Spectacled Eiders has occurred on Kigigak Island for 22 years. As Region 7 and YDNWR have been in a state of declining budgets, the Yukon Delta NWR Waterfowl Program has been continually re-evaluating our efforts and assessing possible improvements to the overall operations of this valuable long-term research and monitoring program.

Currently, spatial references of successful and unsuccessful spectacled eider nests on Kigigak Island are being analyzed. It is thought that there may be "hot spots" on the island where the majority of the productivity is occurring, or perhaps where future recruits are being hatched. Alternatively, it may be that certain regions of the island are more consistent in production whereas other regions are far more variable, perhaps driven by seasonal variation in predation pressure experienced on Kigigak Island. Knowing and understanding spatial variability in the use of Kigigak Island by spectacled eiders may provide us with new insights as to what the island is producing in terms of young, where that production is happening, where there are important nesting and brood-rearing habitats, and determine if shifts have occurred over the years.

We will continue to capture spectacled eider broods to monitor changes in body weights, recruitment, and duckling survival. The 1999-2008 data is being analyzed at this time with the addition of the 2013 data. With so few ducklings returning to Kigigak Island between 2005 and 2013 it is possible that ducklings, when of breeding age, are nesting elsewhere; that dispersal distances have possibly increased due to Kigigak Island reaching a potential saturation threshold of not just nesting eiders, but increased nest site competition with other waterfowl and waterbirds. It would be advantageous to scout surrounding areas (e.g. Naskonat Peninsula) to search for marked birds and see if spectacled eiders are emigrating out of the study area. There are still many questions about what happens to ducklings between fledging and year of first breeding. Additional research is needed in this area to model what is happening with the population and produce more accurate survival estimates.

Reducing researcher impacts on spectacled eiders is an on-going concern. We will address this by being aware and observant of potential impacts and continuing to improve our protocols whenever applicable. Currently, an initial assessment of nasal disc retention is being analyzed to determine if use of nasal discs is still an appropriate tool to address the objectives of this project. Improved estimates of hatch dates would allow researchers to reduce the time spent checking nests and minimize disturbance to spectacled eiders during the incubation and hatching periods. The refuge is considering deployment of temperature data loggers in the future. Temperature loggers deployed in spectacled eider nests would provide more precise data on hatch dates, incubation intervals and address other biological questions associated with nest attendance, incubation, etc. Isotope analysis of spectacled eider feathers collected from this project could minimize trapping efforts in the future. Feathers, if present, have been collected from all nests found on the island (successful, unsuccessful, abandoned, depredated, destroyed, etc.). Females associated with each nest could be identified as individuals through the development of a genetic database, which included all females present on Kigigak Island. The ultimate goal of our project would be to identify ALL females on the island without having to trap them and register ALL future encounters on the island, with the potential to expand the spatial scale of detection.

Additional analysis is needed on trends occurring on Kigigak Island and their significance to the success of the spectacled eider population. Improved knowledge on predator-prey interactions is needed. We don't understand the dynamics among the various predators and their suite of prey species (e.g. fox vs. vole, cackling goose, and spec eider), the overall affect that abundance of alternative prey species has on nest success and survival of spectacled eiders, or the role that differential timing between eider and gull hatch may play on gull dependency of waterfowl eggs, ducklings, and goslings in meeting energy requirements for gull chicks.

We would like to determine nest densities of spectacled eiders as well as other species on Kigigak Island to compare to those which Harwood (unpubl. data) analyzed in 1992. The relationship between nest density, community composition, and predation is something that needs to be clarified in order to determine changes that have occurred since 1992, as well as to evaluate the effectiveness of potential predator control and the proper implementation of such a management action. In addition, a quantitative study of predator diet composition (including all predators, not just fox), inter-annual and inter-decadal changes, prey alternatives, and the quantitative impact of predation on spectacled eider and other waterbird population changes would help to determine a better understanding of the predator prey relationship that is often (emotionally-influenced) assumed to occur. Currently, spectacled eider, Pacific common eider, and black brant nests are monitored through hatch. We would like to record nests of other species as encountered. This would include geese, ducks, loons, gulls, swans, cranes, etc. The protocol would be similar to that of Fischer et al. (1985 -2013) where data collected for each species encountered within a plot would include species, nest status (active, destroyed, or abandoned), nest site habitat, clutch size, and geographical coordinates. Annual estimates of densities and number of nests and eggs would be determined for each plot allowing estimates of total availability, as opposed to isolating any one species, of the Kigigak Island landscape. Knowing and understanding the use of the island by all species will give us an idea of what the island is producing, what alternative prey species are present, where production is happening, and determine if shifts have occurred over the years. Understanding these trends will be important for monitoring climate change impacts to habitat and species populations.

ACKNOWLEDGEMENTS

Thanks to everyone that provided logistic support, including: Migratory Bird Management for their help funding flights to Kigigak Island. Ptarmigan air for their time and expertise deploying the 2013 field crew and gear. Refuge pilots I. Bedingfield, R. Sundown, and M. Callahan for their flexibility and expertise providing logistical support. Field assistance was provided by volunteers K. Plourde, T. Hand, and J. Rickett to which many thanks are needed for their creativity, strength, dedication, and willpower. Thanks to K. Spragens and K. Bowerman for their additional biological assistance, expertise, and support. Thanks to the entire staff of the Yukon Delta National Wildlife Refuge, Western Alaska Landscape Conservation Cooperative, Migratory Bird Management Branch of USFWS, the Spectacled Eider Recovery Team, the Endangered Species Office in Fairbanks Fish & Wildlife Field Office, USGS Alaska Science Center, University of Alaska Fairbanks, Alaska Sea Life Center, and others who have provided guidance and support for this project throughout the years.

LITERATURE CITED

Chaulk, K. G., and M. L. Mahoney. 2012. Does spring ice cover influence nest initiation date and clutch size in common eiders. Polar Biology 35:645-653.

Cooch, F.G. 1958. The breeding biology and management of the blue goose (Chen caerulescens). Unpubl. Ph.D. Thesis, Cornell University, Ithaca, New York.

DAU, C. P. 1976. Capturing and marking spectacled eiders in Alaska. Bird-Banding 47:273.

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

Dzubin A. and E. Cooch. 1992. Measurements of geese: general field methods.

Grand, J. B. 1993. Standard operating procedures for spectacled eider field work. Unpubl. rept. USFWS, Anchorage, AK.

Grand, J. B., and P. L. Flint. 1997. Productivity of nesting spectacled eiders on the lower Kashunuk River, Alaska. Condor 99: 926-932.

Grand, J. B., P. L. Flint, and P. J. Heglund. 1997. Habitat use by nesting and brood rearing northern pintails on the Yukon-Kuskokwim Delta, Alaska. The Journal of Wildlife Management 61:1199-1207

Greenwood, R. J., and W. C. Bair. 1974. Ice on Waterfowl. Wildlife Society Bulletin 2:130-134. Published by: Allen Press Stable.

Harwood, C. M., and T. Moran. 1993. Productivity, brood survival, and mortality factors for spectacled eiders on Kigigak Island, Yukon Delta NWR, Alaska, 1992. Unpubl. rept. USFWS, Bethel, AK.

Lokemoen, J. T., and D. E. Sharp. 1985. Assessment of nasal marker materials and designs used on dabbling ducks. Wildl. Soc. Bull. 13:53-56.

Ryder, J.P. 1972. Biology of nesting Ross's geese. Ardea 60:185–215.

Salyer, J. W. 1962. A bownet trap for ducks. Journal of Wildlife Management 26:219-221.

U.S. Fish & Wildlife Service. 1996. Spectacled Eider Recovery Plan. Anchorage, Alaska. 157pp.

U.S. Fish & Wildlife Service. 2010. Biological opinion: Section 10 permit for spectacled eider population monitoring studies on the Yukon Delta National Wildlife Refuge, 2010. Issued by the Anchorage Fish and Wildlife Field Office.

Weller, M. 1956. A simpler waterfowl field candler for waterfowl eggs. Journal of Wildlife Management 20:111-113.

Westerkov, K. 1950. Methods for determining the age of game bird eggs. Journal of Wildlife Management 54:627-628.

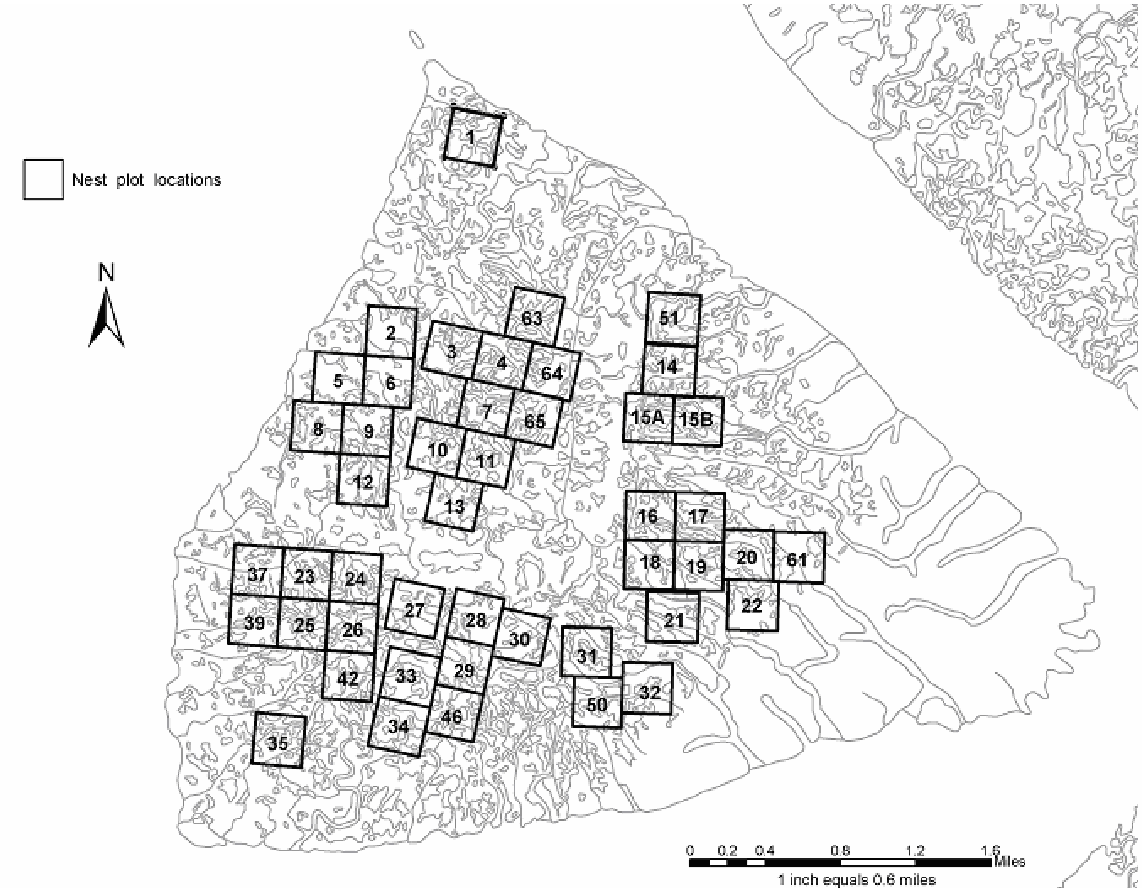

Figure 2. Location of spectacled eider plots (n=48) on Kigigak Island, Yukon Delta National Wildlife Refuge, Alaska. Plots 66 and 68 are not shown (66 is east of 11 and 68 is east of 13).

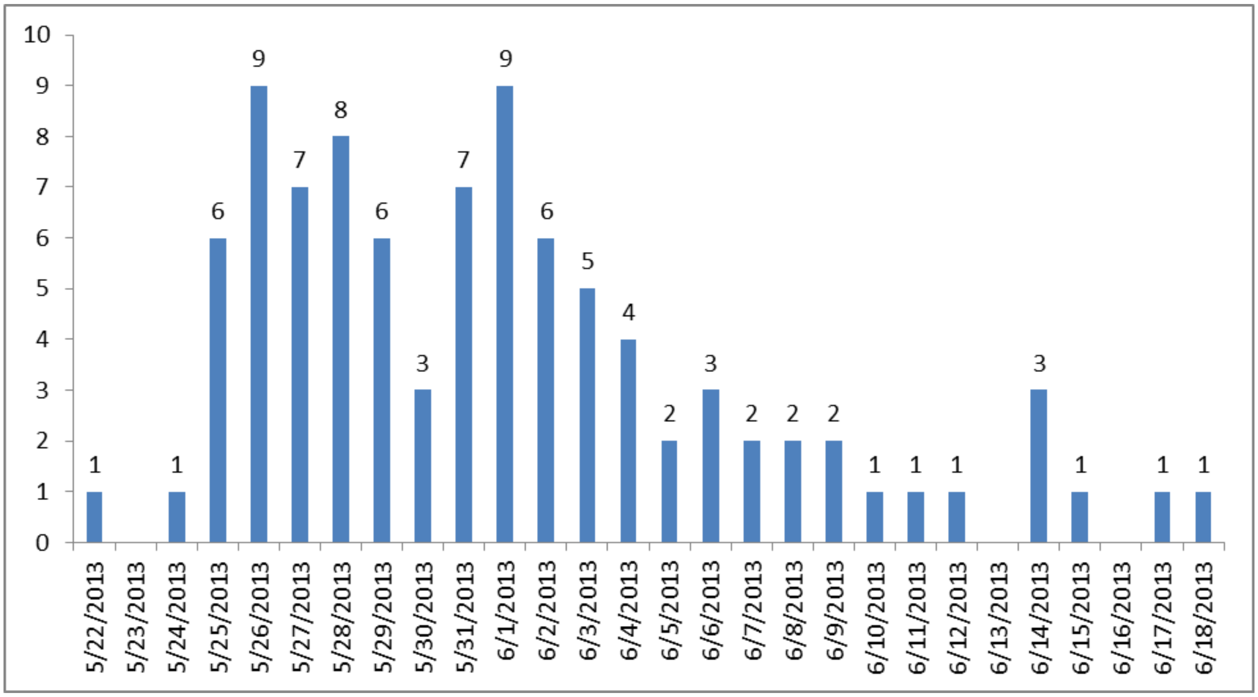

Figure 3. Estimated nest initiation dates for spectacled eider nests in 2013.
[a] Estimates assume an incubation period of 24 days and a laying rate of one egg per day.

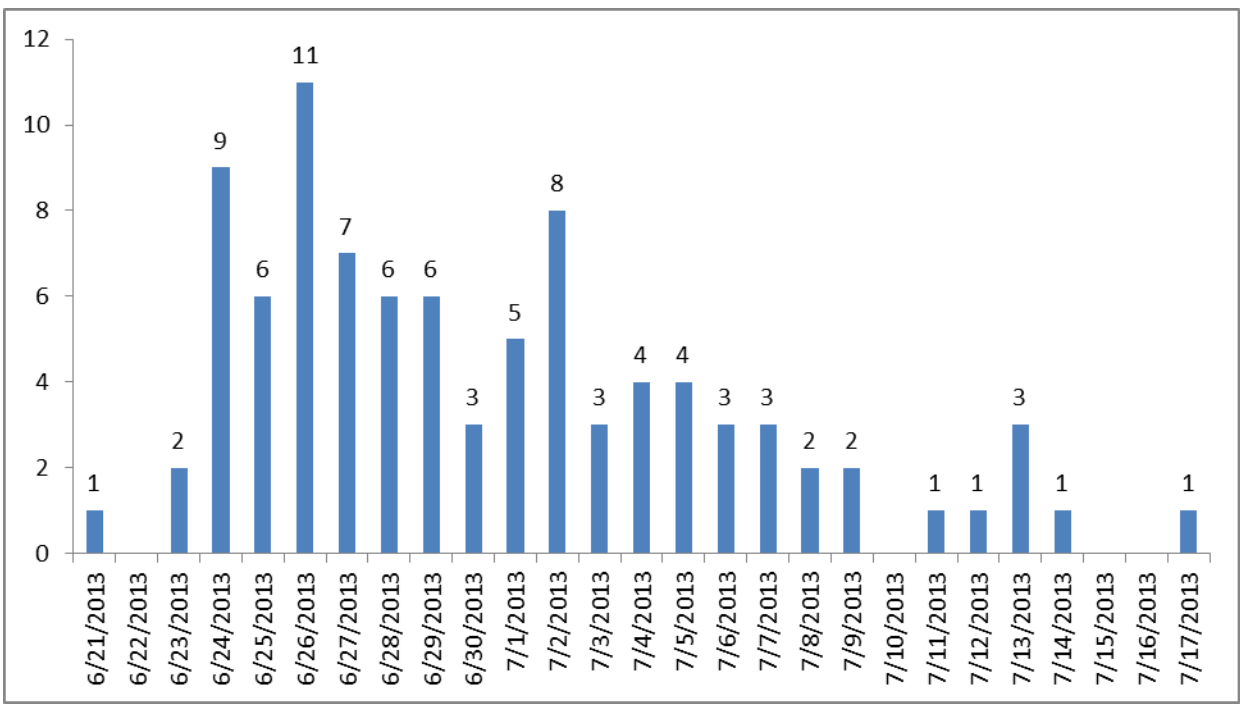

Figure 4. Estimated hatch dates for spectacled eider nests in 2013.
[a] Estimates assume an incubation period of 24 days.

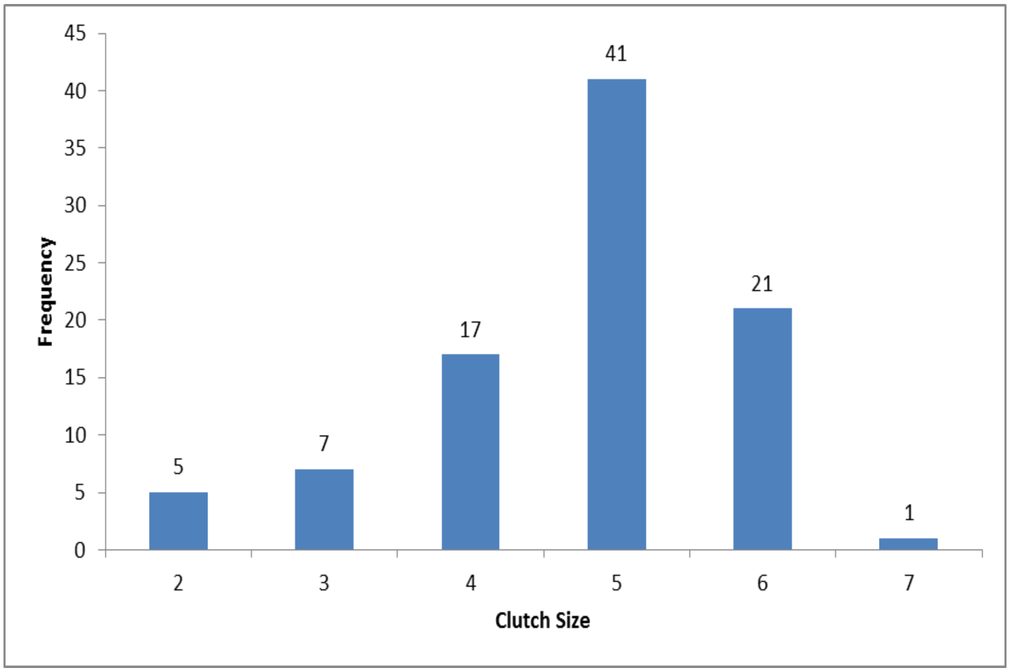

Figure 5. Clutch size frequencies for spectacled eider nests in 2013

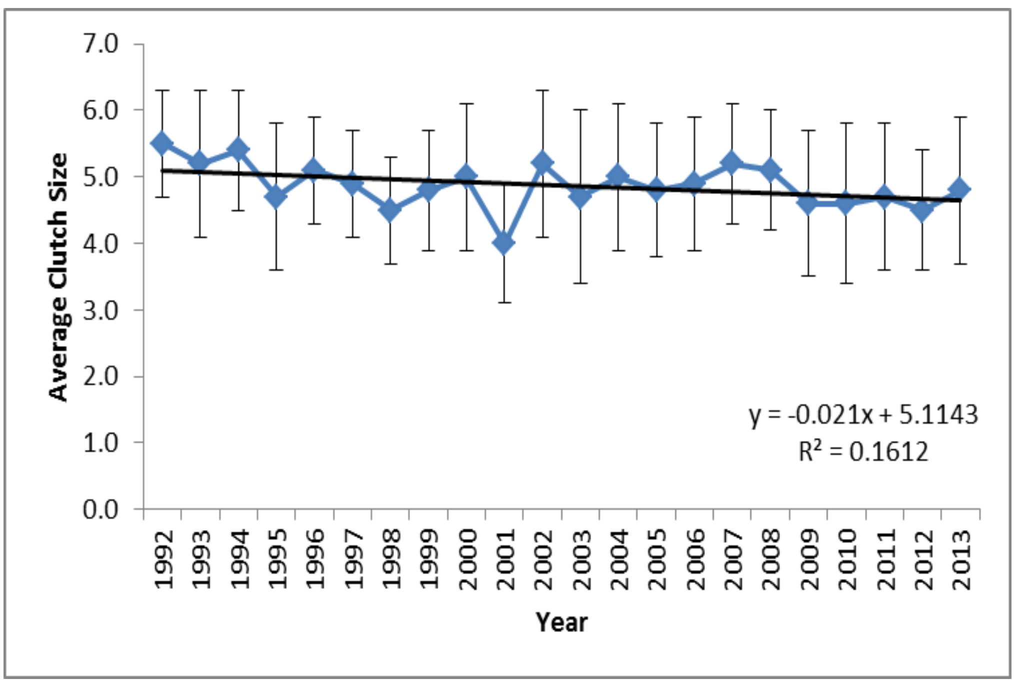

Figure 6. Estimated average clutch size for spectacled eiders nesting on Kigigak Island. Includes 1992-2013. Error bars represent standard deviation occurring within each year.

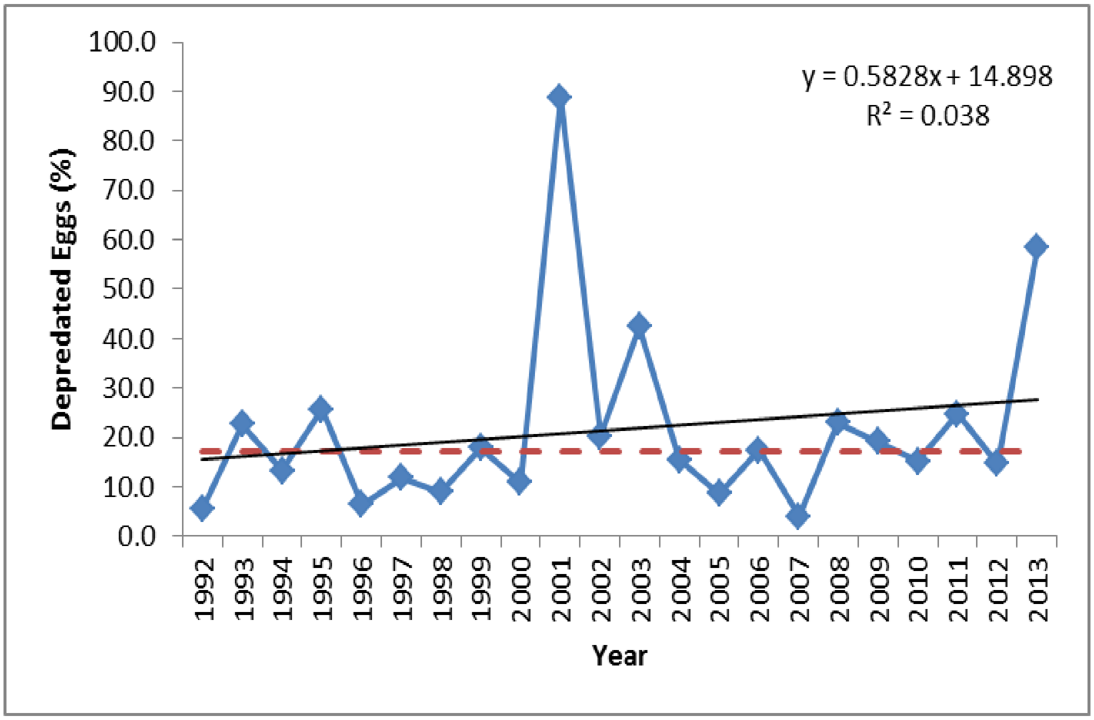

Figure 7. Spectacled eider egg depredation occurring on Kigigak Island. Data includes 1992-2013. 2001 and 2003 represent years of high nest failures. Solid black line represents best-fit trend line; however this line was influenced by 2001, 2003, and now 2013. Red-dashed line represents average percent of eggs depredated (17.2%) excluding two outlier years (2001 and 2003).

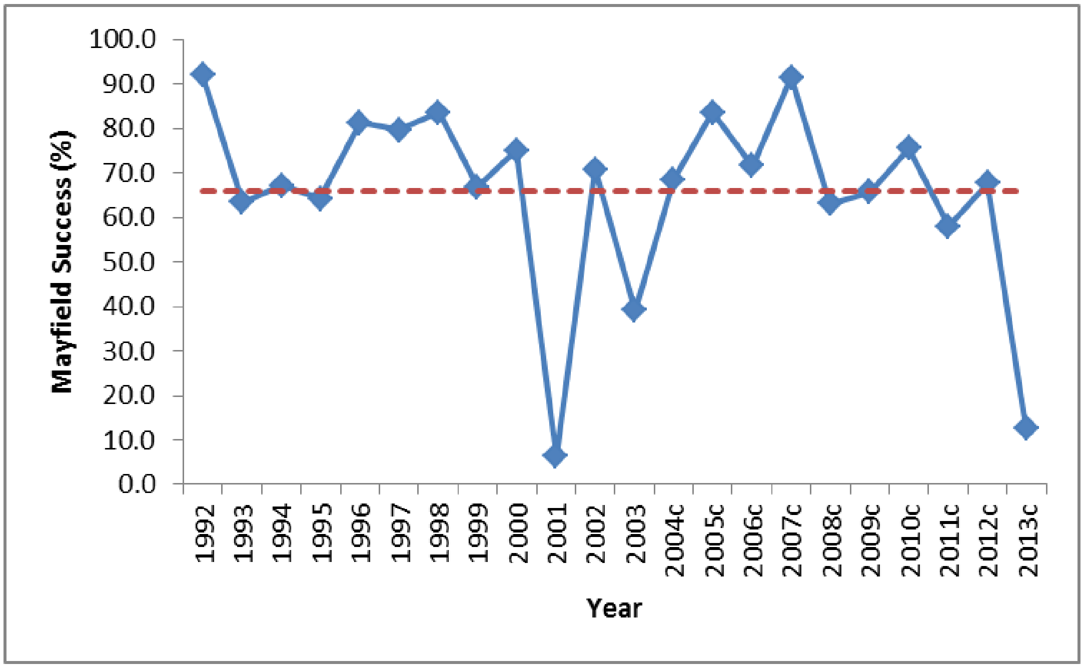

Figure 8. Yearly estimate of Mayfield Nest Success (%). Estimates exclude nests whose fates were suspected of being influenced by visitor impact, specifically trapping. All estimates were calculated using the model of Dinsmore et al. (2002). The red dashed line represents the long-term average (65.8%).

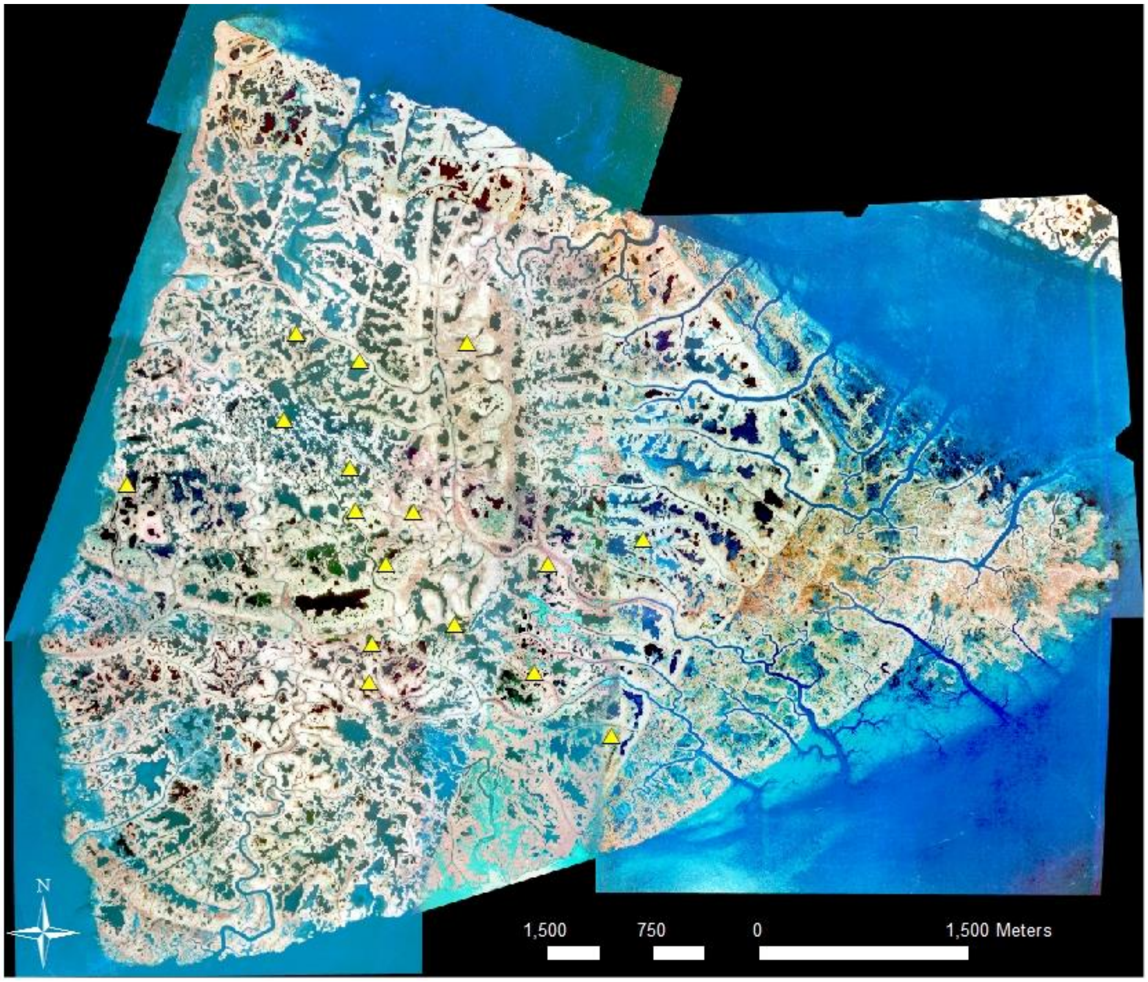

Figure 9. Brood capture sites on Kigigak Island, August 2013.

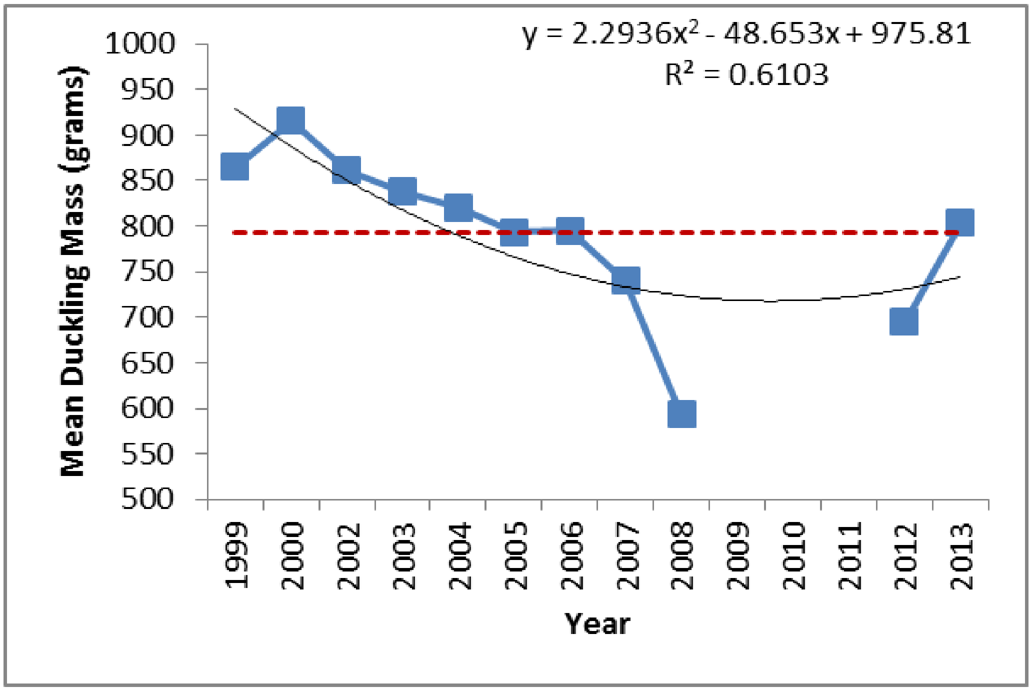

Figure 10. Average body mass of ducklings at 34 days of age (grams). Years include 1999-2008, and 2012-2013. The best fit trend line was a polynomial curve with an r^2 value of 0.61 (black line). Red-line represents average body mass of ducklings (792.88 g).

Table 1. Mean clutch size of spectacled eider nests

Year	n	$\overline{X}$	S.D.
1992	64	5.5	0.8
1993	74	5.2	1.1
1994	70	5.4	0.9
1995	92	4.7	1.1
1996	106	5.1	0.8
1997	132	4.9	0.8
1998	104	4.5	0.8
1999	121	4.8	0.9
2000	117	5.0	1.1
2001	22	4.0	0.9
2002	143	5.2	1.1
2003	131	4.7	1.3
2004	147	5.0	1.1
2005	147	4.8	1.0
2006	169	4.9	1.0
2007	180	5.2	0.9
2008	131	5.1	0.9
2009	98	4.6	1.1
2010	118	4.6	1.2
2011	112	4.7	1.1
2012	122	4.5	0.9
2013	92	4.8	1.1

Table 2. Apparent fate of spectacled eider eggs

Year	Total Eggs	Total Nests	Egg Fate (%) Hatched	Depredated	Abandoned (natural)	Abandoned (human)	Inviable/ Addled	Damaged	Collected	Destroyed/ Dead[b]	Unknown
1992	354	64	76.3	5.4	7.9	0	1.7	0.6	0.8	0	6.8
1993	390	75	62.3	22.6	2.1	2	2.8	1.0	0	0	0
1994	442	84	54.5	13.3	1.8	2	4.8	1.1	0	0	10.4
1995	479	103	52.0	25.7	0.4	0	7.1	2.7	0	0	12.1
1996	594	120	69.7	6.4	4.5	5	5.5	3.4	0	0	10.3
1997	690	147	63.0	11.8	1.3	13	9.9	0	0	0	7.8
1998	480	111	81.9	9.0	0.4	0	4.2	0	0	0	1.0
1999	602	134	73.8	17.9	3.2	3	5.5	1.0	0	0	3.5
2000	587	119	70.5	10.9	0.1	0	9.2	0	0	0	7.2
2001	143	43	7.7	88.8	3.5	4	0	0	0	0	0
2002	744	143	65.3	20.3	0.1	0.7	10.9	1.1	0.5	0	1.6
2003	597	135	40.9	42.4	3.0	0.2	9.5	0	0	0	3.7
2004	754	157	71.6	15.5	1.5	1.1	4.1	0	4.9	0	1.2
2005	674	140	57.4	8.6	3.4	0.6	12.0	0	0	0	18.0
2006	840	174	57.2	17.4	4.2	0	7.0	0.7[a]	0	0	13.5
2007	954	183	63.0	4.0	3.0	0	12.0	1.0[a]	0	0	17.0
2008	698	139	61.0	23.0	2.0	0	9.0	0.4[a]	0	0	4.0
2009	450	98	65.1	19.1	3.8	1.3	4.4	0.7a	0	0	5.6
2010	545	118	61.3	15.2	1.7	3.5	6.2	0.6[a]	0	3.9[c]	7.5
2011	530	112	64.0	24.7	1.9	0.9	4.3	1.1[a]	0	0	3.0
2012	547	122	56.5	14.6	4.0	1.8	2.2	0.4[a]	0	0	20.5
2013	437	92	23.6	58.6	0.0	0.5	0.9	0.5[a]	0	0	16.0

[a] Includes those damaged during handling, trapping, or when the attending female flushed.

[b] Includes eggs broken/destroyed due to a storm surge in June.

[c] Includes 1 duckling that was found dead at nest site.

Table 3. Daily survival rate and Mayfield success of spectacled eider nests on Kigigak Island, Yukon Delta National Wildlife Refuge, Alaska

Year	n	DSR[a]	Exposure Days	Apparent Success (%)	Mayfield Success (%)[b]	95% Mayfield C.I.		
1992	64	0.997	1043	95.0	92.0	83.5	-	101.2
1993	74	0.984	1025	78.4	63.4	50.4	-	79.5
1994	73	0.986	1099	79.5	67.1	54.6	-	82.4
1995	95	0.985	1451	76.8	64.2	53.1	-	77.5
1996	113	0.993	1969	87.6	81.3	72.8	-	90.8
1997	138	0.992	2429	86.2	79.6	71.7	-	88.4
1998	111	0.994	1770	90.1	83.5	74.8	-	93.1
1999	127	0.986	2102	77.2	66.8	57.5	-	77.6
2000	118	0.990	2038	83.1	75.1	66.0	-	85.4
2001	39	0.909	295.5	7.7	6.3	2.5	-	15.6
2002	136	0.988	2356	76.2	70.7	62.0	-	80.6
2003	131	0.968	2104	48.9	39.1	29.8	-	48.0
2004[c]	154	0.986	---	81.8	68.5	57.2	-	77.5
2005[c]	129	0.994	---	89.1	83.5	72.6	-	89.0
2006[c]	171	0.989	---	81.9	71.6	62.2	-	79.1
2007[c]	173	0.997	---	94.2	91.4	85.0	-	95.3
2008[c]	134	0.984	---	75.0	63.0	52.1	-	72.0
2009[c]	90	0.986	---	75.6	65.7	52.2	-	76.3
2010[c]	98	0.990	---	84.7	75.6	63.3	-	84.2
2011[c]	103	0.981	---	73.8	57.9	45.0	-	68.7
2012[c]	106	0.987	---	86.9	67.7	55.5	-	77.2
2013 [c]	75	0.931	---	31.5	12.5	6.2	-	21.3

[a] Daily Survival Rate
[b] Estimates exclude nests whose fates were suspected of being influenced by visitor impact, specifically trapping
[c] Estimated using model of Dinsmore et al. (2002)

Table 4. Average morphological measurements of adult female spectacled eiders on Kigigak Island, Yukon Delta National Wildlife Refuge, Alaska

Year	Weight	SD	Culmen	SD	Tarsus	SD
1993	1191	102.4	25.8	1.9	57.1	1.9
1994	1151	90.3	25.9	1.6	56.1	7.2
1995	1126	79.7	27.5	4.6	55.1	5.2
1996	1154	76.2	26.6	1.5	57.4	2.3
1997	1208	113.9	26.5	1.4	56.6	2.8
1998	1096	158.8	26.0	1.3	56.9	2.8
1999	1127	86.7	26.9	1.6	56.0	6.0
2000	1204	99.5	27.1	1.4	56.8	1.6
2001[a]	1255	351.5	25.0	1.3	55.0	2.2
2002	1203	90.9	26.2	5.8	47.2	4.4
2003	1199	91.9	26.8	3.4	49.1	5.9
2004	1217	141.6	27.7	5.9	55.1	8.2
2005	1171	124.9	28.0	6.0	55.3	7.2
2006	1193	107.9	26.6	2.1	57.3	2.6
2007	1186	81.5	26.1	2.1	56.3	1.7
2008	1166	103.6	25.8	1.5	55.6	1.6
2009						
2010						
2011						
2012	1145	72.8	24.7	4.0	54.5	5.6
2013	1239	83.9	24.8	2.0	54.3	2.6

[a] Sample size only 4 adult spectacled eider females

APPENDIX A.

Fox observation on Kigigak Island 2013

All predator observations were limited to qualitative observations on an ad hoc basis. Arctic fox were first observed on 13 June 300 m west of the new camp site. The fox was observed scouting the den site from the previous year, which was unoccupied in 2013. The fox made its way around the camp site, eventually moving farther east out of viewing range. Fox hair was found on many of the terraces with freshly dug holes for caching and presumably shelter but because of the permafrost layers ice blocked the fox from making any sort of den type structure. The male Arctic fox (identified by photos) was regularly seen around camp in the evenings and had a caching route that he followed. The female was seen on occasion, mainly near the den site (located at "historic" camp site) but also seen on terrace where den site was located.

On 13 June the Kigigak Island crew stopped at the "Historic" camp site. Some digging activity was observed around the old weatherport base but there was no other sign of fox. After a few minutes in the area barking could be heard from under the weatherport base. A Reconyx (HC600) Hyperfire Camera was placed at the den site on 14 June. Footage from the camera indicated that the old weatherport base at the "Historic" camp site was a den for one family of Arctic fox. The camera monitored the den and fox activity through 18 September. When in the area, personnel documented fox den characteristics such as expansion of the den site and carcasses present. In September there was little activity at the den site however new areas had been dug on the surrounding terrace (cache sites?).

Carcasses at the den site were identified (wing samples, etc) to species when possible. Wings primarily included adult and juvenile cackling geese (*Branta hutchinsii* minima). This is not surprising as cacklers are a prevalent species in that area of the island. The presence of feather tufts belonging to spectacled eider was also observed.

Cameras captured fox activity at the den site between 14 July and 18 September. Activities included digging and maintenance of den entrances, leaving and entering the den site (adults and young), grooming, adults playing with pups, pups playing with each other, adults bringing food (eggs, adult and young ducks and geese) to den site, pups dragging food around den site, adults moving and caching food from den site to places away from den site, eating, resting, and adults keeping watch over the pups and den site. The den was very active throughout the day. Adults were constantly maintaining the den and caring for the pups. Pups became more active as they started to grow. By the end of July, beginning of August pups had grown 2-fold and were regularly coming out of the den, playing, eating, moving food around, etc. It was very rare to have a good shot of the whole family but we were able to get a few pictures to verify that the family was composed of 2 adults and 4 young. We were also able to identify from other photos taken that the male fox was the one seen around the new camp site. More information could be gained through additional time spent going through photos and analyzing fox activity budgets.

Comparisons of fox predation between previous years or other sites cannot be made as observations have not been recorded systematically or quantitatively. Assessment of the number of predators, level of predation, or assessment of effect on the eider population requires development of a research design and sampling scheme for that purpose, and should include all predators, not just foxes. Use of the trail cameras resulted in large gains in qualitative information at little cost. Cameras will continue to be used to monitor fox if they are present on the island to determine daily activities, food sources, etc.

Other Predator Observations

We noticed an increase in gull activities and depredation in other waterfowl and geese species as hatch began. Multiple gull depredation events were documented on other waterfowl species eggs and broods (e.g. cacklers, brant, loon, long-tailed duck, and scaup). We are not sure exactly what overlap exists between gulls and other waterfowl species, and if there is a shift in prey sources (eggs to ducklings). More research is needed on the relationship between hatching chronology of gull species and other waterfowl.