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

2012

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SUMMARY

Nesting spectacled eiders were monitored for the 21st consecutive year on Kigigak Island, Alaska in 2012. Clutch size, hatch date, and final nest status were recorded to estimate nesting success of spectacled eider females. In addition, adult females were resighted, captured, and marked to estimate annual survival. Brood capture efforts were reintroduced in 2012, having been absent since 2008. We capture spectacled eider broods to monitor changes in body weights, recruitment, and duckling survival. Size, shape, depth, temperature, salinity, percent emergent cover, and surrounding vegetation/habitat type were recorded for ponds where broods were captured.

All 48 plots on Kigigak Island were searched resulting in the detection of 122 spectacled eider nests that were monitored through hatch. Mean clutch size averaged 4.5 ± 0.9 (SD) eggs. Mean nest initiation and hatch were 11 and 10 days later than 2011, respectively. The estimated Mayfield nest success of 106 nests was 67.7% (95% CI; 55.5-77.2%). Ninety-six adult females were identified during the breeding season: 69 nest-trapped and 27 visually identified by nasal disc or tarsal band. Brood captures included 28 broods from which 22 females and 84 ducklings were captured. The average duckling weight was 695 g ± 98.6 (SD), average culmen was 21.0 mm ± 1.3 (SD), and average tarsus was 53.5 mm ± 2.0 (SD). The average weight of adult females was 1,180 g ± 46.0 (SD), average culmen was 25.1 mm ± 1.7 (SD), and average tarsus was 55.7 mm ± 2.4 (SD). Broods were mainly caught in ponds surrounded by high graminoid meadow. The average temperature (°C) of brood ponds was 13.1 ± 2.1 (SD), the average depth (cm) was 31.8 ± 11.8 (SD), and the average salinity (ppt) was 9.3 ± 3.6 (SD).

Nesting chronology was delayed in 2012 due to a late spring break-up. Even still, nesting spectacled eiders on Kigigak Island experienced an increase in nest success compared to 2011. Additional analyses are needed on trends occurring on Kigigak Island and their significance to the success of the spectacled eider population.

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 Ban

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 reason(s) 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/biannually). The most recent update occurred in December of 2010. The research on Kigigak Island directly or indirectly addresses the priorities identified in the updated 2010 document.

Over the last 21 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). In addition, adult females were captured and marked, and subsequently resighted to estimate annual survival of adult females (see 2010 list of High Priority Tasks: 7, 20a, 27b). The data collected from Kigigak Island has been used to analyze nesting success, adult female annual survival, duckling survival, and recruitment. The research on Kigigak Island continued in 2012 along with a graduate research project (conducted by N.Graff, University of Alaska Fairbanks), to determine habitat use of spectacled eider broods in relation to salinity and food availability (see 2010 list of High Priority Tasks: 6,18).

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.

Graduate Research Objectives

1. Collect salinity samples within four habitat strata and observe brood habitat to determine the effect of salinity on brood habitat selection, as well as to determine annual variation between strata.
2. Sample ponds (selected via a stratified random design) for macro-invertebrates and seeds to assess food availability for spectacled eider broods.
3. Determine brood habitat selection through observational study in four habitat strata.

STUDY AREA

Kigigak Island (32.5 km^2) (60°50'N, 165°50'W) is located along the outer fringe 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 storm tides.

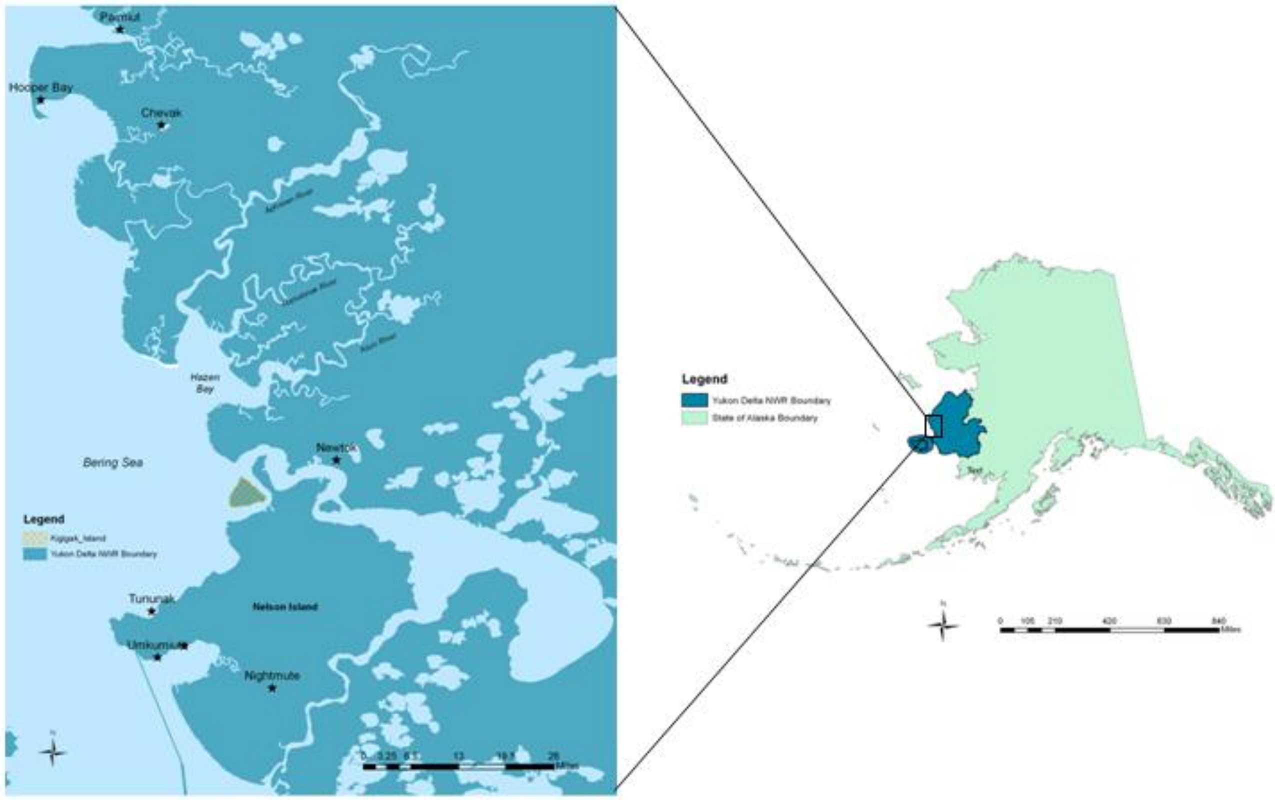

Figure 1. Location of Kigigak Island study area on Yukon Delta National Wildlife Refuge (YDNWR), Alaska

METHODS

Data Collection

A four-person research team searched for spectacled and Pacific common eider (*Somateria mollissima* v-nigra) nests on 48 - 412 m x 412 m plots previously identified as spectacled eider nesting habitat (Harwood and Moran 1993) (Figure 2). All plots were searched twice between 10 and 30 June. Each plot took 4-8 hours to search depending on distance from camp, number of islands to search, amount of water within plot, etc. Additional nests were located opportunistically while moving between plots. Three nesting aggregations of 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 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 visited 2-4 times (including hatch/final nest status) on average. On all nest visits, nest status (incubating, laying, depredated, abandoned, hatched) and egg status (number present, new, missing, inviable, depredated) 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, an attempt was made to capture the marked female within a few days of her expected hatch date. In addition, an attempt was made to capture any females without bands (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 resight. Trapping occurred late in incubation, usually 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 at the end of July, when ducklings were approximately 30-35 days of age. Broods included adult spectacled eider females previously observed/trapped during nest visits and females 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 ponds used by 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. Female ducklings were marked with a U.S. Fish and Wildlife Service metal leg band and a yellow, plastic, alpha-numeric tarsal band. Male ducklings were marked with only 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). Pond characteristics (pond size, salinity, temperature, depth, 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. 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.

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 nest success analysis due to the inability to date nest age. In addition, nests abandoned due to human disturbance were excluded from nest success analysis. 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; this topic warrants further research. 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 membranes from eggs might not be present or when signs of hatch were present (shells in nest), but the observer was unable to determine how many eggs actually hatched.

RESULTS

Nesting Chronology

A four-person research team arrived on Kigigak Island 11 May. The first spectacled eiders were observed on 18 May approximately 3 miles south of camp. The group of eiders observed was floating in open water between Kigigak and Nelson Island. Large groups of birds were beginning to congregate off the island at this time (e.g. loons, common eiders). The first group of spectacled eiders observed on Kigigak Island occurred 20 May. This was 7 days later than 2011.

Break-up began on the Ninglick River (east of Kigigak Island) and the camp lake on 4 June with full break-up (camp lake, river, and sloughs open) occurring on 8 June. The chronology of spectacled eider nesting is known to vary in response to the timing of spring break-up (Grand and Flint 1997). In 2012, a late break up extended cold temperatures and delayed snow melt, which in turn delayed spectacled eider nest initiation.

Spectacled eider nest initiation occurred between 24 May and 18 June (Figure 3), with mean initiation on 3 June. Mean initiation in 2012 was 11 days later than 2011. Hatch occurred between 21June and 15 July (Figure 4), with mean hatch on 2 July. Mean hatch in 2012 was 10 days later than 2011and 9 days later than the long-term average.

Personnel began nest searching 10 June, 11 days later than 2011. A total of 122 spectacled eider nests were found after searching all of the 48 plots twice.

Clutch Size

Spectacled eider clutch size ranged from 2 to 6 eggs (Figure 5), with a mean of 4.5 ± 0.9 (SD) (Table 1). Average clutch size for 2012 was slightly below the 2011 average and the long term trend line (Figure 6). Significant differences between years were not analyzed. Clutch size is known to decrease as nest initiation dates are delayed (Grand and Flint 1997). Chaulk and Mahoney (2012) found that late nest initiation, caused by extended ice cover, corresponded to significantly smaller clutch sizes in common eiders. Dau (1976) also found that lower clutches were observed in years where spectacled eider nest initiation was delayed. A seasonal decline in clutch size is not uncommon in waterfowl species (Cooch 1958, Ryder 1972). Many waterfowl species rely on nutrient reserves for egg formation. As the season progresses females will lose energy reserves hence, the reason late nesters tend to have smaller clutch sizes. Nest initiation was approximately 7 days later than average in a study conducted by Grand and Flint (1997) on the Kashunak River. They did not see a reduction in clutch size, which they attributed to the eiders being able to maintain enough energy reserves for egg laying. Further study is required to confirm the trends occurring on Kigigak Island and the factors that may be influencing it.

Apparent Egg Fate

The apparent fate of 547 eggs was determined, including: 309 hatched (56.5%), 80 depredated (14.6%), 22 abandoned due to natural causes (4.0%), 10 abandoned due to monitoring activity (1.8%), 12 inviable or addled (2.2%), 2 damaged during handling, trapping, or when the attending female flushed from the nest (0.4%), and 112 unknown (20.5%) (Table 2). The percent of unknown eggs in 2012 was the highest is has been in the 21 years of this study. The reason for this increase is due to the final nest status observations. Final nest checks occurred later in the season after all females had hatched. Membranes were recorded however, not <u>all</u> membranes were always present. If any egg membranes were missing from a nest between the last check and the final nest status they were documented as unknown. Any eggs that did not have a final status were also recorded as unknown.

We suspect that egg depredation was mainly due to glaucous gulls (*Larus hyperboreus*), mew gulls (*Larus canus*), and Arctic fox (*Alopex lagopus*). Actual observations of spectacled eider egg depredation were limited. A total of 8 eggs (10.0%) were attributed to gull depredation. The other 72 eggs (90.0%) could not confidently be attributed to a particular predator type. No trend in percent depredated eggs over time was apparent on Kigigak Island (Figure 7). Hence, percent depredated eggs were compared to the long-term average. Two years (2001 and 2003) were removed from the long-term average. These were years of high nest failure that resulted in low estimates of spectacled eider nests and eggs. When these two years were removed from the long-term average a much more normal pattern was apparent. Percent depredated eggs for many of the years were on or around the long-term average. Percent depredated eggs in 2012 were slightly below the long-term average. Significance of this trend is unknown. Further statistical analyses are needed. More research is needed in the area of predator prey relationships and how predators affect nest success.

Nest Success

The fate of 106 spectacled eider nests was determined, including: 83 hatched (78.3%), 17 depredated (16.0%), and 6 abandoned (5.7%). The estimated nest success, assuming an exposure period of 29 days, was 67.7% (95% C.I. 55.5 – 77.2) (Table 3). This was a 14.5% increase from 2011 and was 0.9% below the long-term average (Figure 8).

Female Resight/Capture

Sixty-nine spectacled eider females were nest-trapped in 2012; 30 new captures and 39 recaptures. Morphological measurements (weight, culmen, and tarsus) were recorded for all adult females that were captured. The average body mass of adult females was 1,145 g ± 72.8 (SD), the average culmen length was 25 mm ± 4.0 (SD), and the average total tarsus length was 55 mm ± 5.6 (SD). Morphometric measurements have not been collected for adult females since 2008. All average morphometric measurements of adult spectacled eider females were below 2008 and long-term (199-2008, 2012) averages (Table 4). This could be due to a depletion of nutritional resources that would otherwise have been available in a normal year.

Of the recaptured females (n=39) 34 (87.2%) were previously marked but had lost their nasal discs. This initiated questions about nasal disc retention and suitability for the project. A summary analysis of the 34 recaptured females revealed that the average female has had 3 nasal discs (range = 1-7) since the time of her initial banding (range = 1996-2011). The average number of years between nasal disc replacements was 2, with the highest frequency (mode) equal to 1. Further analysis is warranted and will be completed and summarized in a separate report, scheduled for submission in December 2012.

An additional 27 spectacled eider females were visually identified (scope, binoculars, or camera). The first resight occurred on 5 June, 21 days after observations began. We increased the resighting effort in 2012. When females were flushed we noted if bands were present and made an additional effort to read all bands/nasal discs. Even with the increase in resighting, most our effort was put into trapping females later in the nesting season. As the season progressed it became clear that trapping efforts could have been further reduced had nasal discs been retained.

In 2012, 70.9% of the nests found were initiated by females that were previously marked on Kigigak Island.

Brood Capture

Between 4 and 7 August, 28 spectacled eider broods were captured. Brood captures occurred across Kigigak Island (Figure 9). Different parts of the island were searched each day. Plots acted as boundaries. Captures encompassed the plots and surrounding areas. A total of 84 ducklings (37 female, 47 male) were captured, measured, and banded. The average duckling weight was 695 g ± 98.6 (SD), average culmen was 21.0 mm ± 1.3 (SD), and average tarsus was 53.5 mm ± 2.0 (SD). An unpublished analysis (B. Lake) of mean duckling body mass on Kigigak Island was conducted between 1999 and 2008. There was a decline in duckling body mass over this time period. In 2008, the mean body mass of ducklings on Kigigak Island were 26% lower than the mean body mass of ducklings in1999. It is unclear if duckling recruitment is influenced by poor body condition prior to fledging, increases in pond salinity, changes in food abundance/quality, or changes in brood rearing/wintering areas. We are in the process of correlating duckling mass with age and survival for 1999-2008, including the most recent 2012 data. Preliminary analysis indicates that the average body mass of ducklings in 2012 is 14.6% above the 2008 reported average body mass. Additional analysis will be reported in January 2013.

We also captured or visually identified 22 adult females with broods, 14 of which were recaptures and 8 new captures. Out of the 14 recaptures 8 were previously encountered in 2012 the other 6 had not been previously encountered during the field season. We would not expect to find so many new females during brood captures. Especially, since all the plots on the island are searched at least twice. We were continuing to find nests in late June. It is possible that these birds were late nesters that were missed or birds that chose to nest in areas outside of the designated plots. The average weight of adult females was 1,180 g ± 46.0 (SD), average culmen was 25.1 mm ± 1.7 (SD), and average tarsus was 55.7 mm ± 2.4 (SD).

Broods were mainly caught in ponds surrounded by high graminoid meadow (Grand et al.1997). The average temperature (°C) of the ponds was 13.1 ± 2.1 (SD), the average depth (cm) was 31.8 ± 11.8 (SD), and the average salinity (ppt) was 9.3 ± 3.6 (SD). All of the ponds were irregular shaped. Perimeter (m) ranged from 97.30 to 32,002.63 (Mean = 7,287.39). A larger perimeter represents more irregularity in the pond shape. Area (m^2) ranged from 183.39 to 260,219.46 (Mean = 58,738.94). The average percent emergent vegetation was less than 2%. 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 male duckling mortality occurred during brood captures on 7 August. The duckling was part of a 10 duckling capture. He was one of the first ducklings to swim into the mist net. He became severely tangled and any movement by the other ducklings in the net increased entanglement. We could not free him in time.

On 12 June, while searching for eider nests, an adult female brant was found dead next to its nest (near plot 29). No visible wounds were found, so death was attributed to unknown natural causes. The brant had a metal band that was removed at the time of discovery. The band was submitted to the Bird Banding Laboratory. The bird was banded as an adult (AHY) in 2006, on Kigigak Island.

On 19 September, Kigigak Island was visited in order to relocate the main field camp. The reason for the camp relocation was documented in a memo dated February 9, 2012. At the time of the camp relocation two tarsal bands were found on scavenged spectacled eider carcasses. The carcasses were found near the original long-term camp site on camp lake. The tarsal bands were removed and the codes were reported to the Bird Banding Laboratory. The bands originated from 2 female ducklings that were banded on Kigigak Island earlier in August 2012.

Fox Observations

All predator observations were limited to qualitative observations on an ad hoc basis.

An Arctic fox was observed 16 May approximately 1.5 miles west of camp. At this time, Kigigak Island was still completely covered in snow and ice and was connected to the mainland. A second fox sighting occurred on 15 June during the first round of nest searching. The fox was seen in plot 51 and a second sighting, probably the same individual, occurred later that afternoon in plot 14.

A fox den was found on the island on 13 July. Two Reconyx (HC600) Hyperfire Cameras were placed at the den site on 15 July. The cameras monitored the den and fox activity through 7 August. When in the area, personnel documented fox den characteristics such as expansion of the den site and carcasses present. At the end of July the den had been expanded. A new area had been dug out and was active (carcasses present).

Adult fox were seen caching eggs and bringing eggs to and from the den site in mid-July. Carcasses at the original den site were identified (wing samples, etc) to species when possible. On 19 July, wing samples were collected from the den site. Wings were mainly from adult birds. Wings included adult glaucous gull, adult northern pintail (*Anas acuta*), juvenile Sabine's gull (*Xema sabini*), and adult cackling geese (*Branta hutchinsii* minima). At the end of July more cackler gosling carcasses were observed around the den site. In August during brood captures the den site was visited to remove trail cameras. Cackler goslings made up the majority of the carcasses seen outside the den. This is not surprising as cacklers were a dominant species in the area. By September, the original den site had been abandoned. At the same time, the old camp site had newly dug holes under the weather port base, and strewn carcasses around the camp site. It was thought that this might have been a potential "new" site for the fox however; no fox were seen in the area.

Cameras captured fox activity at the den site between 15 July and 7 August. Activities included digging/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 and adult and young ducks/geese) to den site, pups dragging food around den site, adults moving/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 carrying for the pups. Pups became more active as they started to grow. By the end of July/August pups and 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 justify that the family was composed of 2 adults and 6 young). 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 either 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

Gulls were one of the first birds to initiate nesting; because of this, they were the first birds to hatch. 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 and their eggs and broods (e.g. cacklers, brant, loon, long-tailed duck, 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.

DISCUSSION

In November of 2011, a large storm affected the western coast of YDNWR (Figure 11). Surges associated with the storm submerged all but the highest elevation (terraces, top 6-12 inches) on Kigigak Island (approximated from obvious sediment and debris lines on upland terraces). The affects of this surge were unknown until the crew arrived in May. It was observed that the top layer of snow was covering a solid layer of ice (4-6 inches thick). This layer of ice covered a large expanse of the island (terraces, lowlands, ponds). Large ice slabs were displaced across the island; on the tundra, terraces, and in sloughs and ponds. Pieces of tundra were also displaced across the island. Ice layers slowed snow melt and clogged slough mouths, hindering drainage of accumulating melt water during break-up. The island was under water for a couple of days before it was able to properly drain. Sloughs and ponds on the island, as well as the Ninglick River finally broke 8 June.

Storm surges are a typical occurrence on Kigigak Island however; this storm surge was much larger in magnitude to more recent storms. It is believed that storm surges will increase in frequency and severity as climate change progresses. If this is the case the nesting season may continue to be condensed in future years. Another prediction is that there will be long-term increases in spring temperatures and earlier occurrences of spring events (Fischer 2011). Nesting chronology varies in response to the timing of break-up. It will be important to document spring conditions and the response of nesting chronology.

Due to the late break-up, most nesting sites on the island were unavailable until 9 June when the majority of the island was free of ice. Displaced tundra and terraces were the first open areas available. Some birds took advantage of these areas while the majority of the birds waited for typical habitats (grassflats, islands, pond shores) to become available. Mud mats and standing water reduced nesting areas over many parts of the island until later in June.

The late break-up resulted in a shorter nesting season. Initiation, hatch, trapping, and brood captures were all later than in previous years. Nest success did not seem to be affected by the late break-up. The estimate for nest success in 2012 (67.7%) was higher than the estimate for nest success in 2011 (57.9%) and just below the long-term average (68.3%). This may suggest that even though the breeding season was late, the females were in good enough body condition to initiate nesting and successfully hatch a clutch. Grand and Flint (1997) found that spectacled eiders were able to maintain reserves for egg laying with a seven day delay in their nesting chronology. The eiders were able to produce ducklings with a condensed nesting season (Grand and Flint 1997). This was true for Kigigak Island as well, though further research is needed in this area to determine statistical significances of nest success between years.

Predators were present on Kigigak Island, although we have no quantification or contribution to overall predation of the eiders. Most of the depredation events that occurred on spectacled eider nests in 2012 could not be attributed to any particular predator. 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. This is especially true when eggs are removed from a nest since both fox and gulls are known to take eggs from nests.

Kigigak Island has a very high density of nesting birds, resulting in an abundance of eggs. Predators did not seem to be targeting any one species. Alternate prey species should buffer high predation pressure from fox. In 1992, a combined density estimate for geese (4 species) and eiders (2 species) on Kigigak Island was 233 nests/km^2 (Harwood unpubl data). That equated to an estimate of more than 33,000 eggs including geese, eider, gull (3 species), and loon (2 species) eggs. Spectacled eider nests made up less than 2% of the total number of eggs, while brant and cackler made up the majority, with 43 % and 33%, respectively (Harwood unpubl data). The current densities of birds on Kigigak Island are unknown. 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. 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 population changes would help to determine a better understanding of the predator prey relationship that is thought to occur.

Resighting efforts were increased in 2012 due to the condensed field season. Resighting with scopes, binoculars, and cameras allowed us to make fewer trips to nests, reduce nest/female disturbance, and reduce trapping efforts later in the season. We were able to resight twenty-seven females. During our trapping efforts we discovered that many of the females (87.2%) were already banded, but had lost their nasal discs. With approximately 87% of the re-captured females being banded, concerns arose about retention rates of nasal discs and their usefulness to the research being conducted on Kigigak Island. A separate analysis has been made regarding this subject and will be included with this report. Given that use of nasal discs in subfreezing temperatures has been identified as increased risk for the birds (Greenwood and Bair 1974), the low level of resights relative to the nest-derived resights, along with the rate of loss of nasal discs which further increases error of survival rates based on resights, we should give serious consideration to eliminating use of nasal discs for these populations.

Around 1,700 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 to continue 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.

No first year breeders (first resight since being banded) were detected in 2012. Between 1999 and 2008, 482 female ducklings were banded, sixty-two of which have been observed returning to Kigigak Island. In recent years, ducklings banded have not been returning in any great numbers. A total of 198 ducklings were banded between 2005 and 2008; however, only 5 (2.5%) have returned to Kigigak Island to breed. The mean body mass of ducklings on Kigigak Island was analyzed in 2008 (Lake unpubl data). There was a decline in duckling body mass between 1999 and 2008. In 2008, the mean body mass of ducklings on Kigigak Island were 26% lower than ducklings in1999. It is unclear if duckling recruitment is influenced by poor body condition prior to fledging, increases in pond salinity, changes in food abundance/quality, or changes in brood rearing or wintering areas. Duckling morphological measurements were collected in 2012. Preliminary analysis indicates that the average duckling mass in 2012 is still well below the 1999 value though higher than 2008. We are in the process of correlating duckling mass with age and survival. It is unclear what factors are influencing duckling recruitment on Kigigak Island. 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. 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, 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. An annual update from Graff will occur at the Recovery Team Meeting in December 2012; a final thesis is expected Fall 2013. 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.

FUTURE WORK

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) or the overall affect that abundance of alternative prey species has on nest success/survival of spectacled eiders.

Reducing researcher impacts on spectacled eiders is an ongoing concern. We will address this by being aware and observant of potential impacts and continuing to improve our protocols whenever applicable. Currently, nasal disc retention is being analyzed to determine if use of nasal discs is 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 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, can be 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 genetics 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.

We would like to determine nest densities of spectacled eiders and other species on Kigigak Island to compare to the Harwood (unpubl data) analyzed in 1992. Currently, spectacled eider, common eider, and pacific 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. (2011) 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. 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.

Currently, spatial references of successful and unsuccessful spectacled eider nests on Kigigak Island are being analyzed. It is thought that there are “hot spots” on the island where a majority of the productivity is occurring. Knowing and understanding the use of the island by spectacled eiders will give us an idea of what the island is producing, 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 2012 data. With so few ducklings returning to Kigigak Island between 2005 and 2012 it is possible that ducklings, when of breeding age, are nesting elsewhere. It would be advantageous to scout surrounding areas (i.e. Naskonat Peninsula) to look 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.

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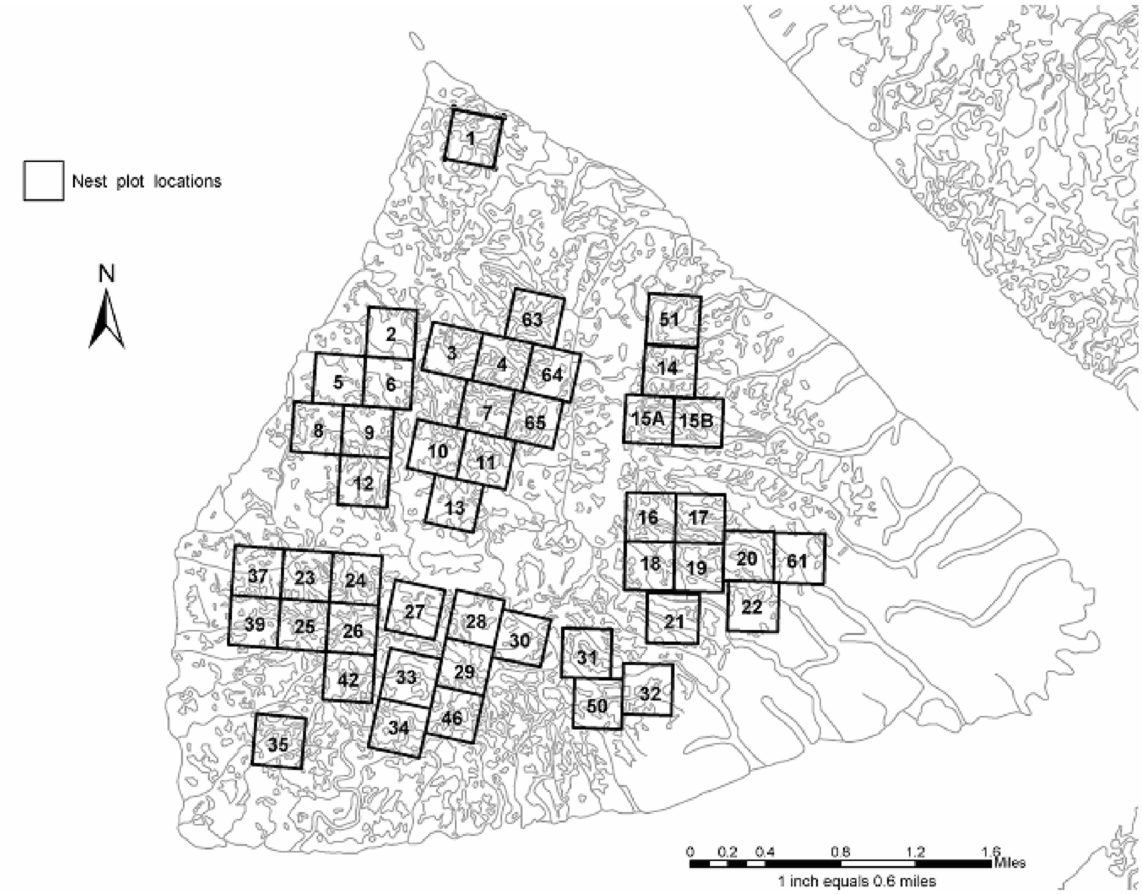

Figure 2. Location of spectacled eider plots (n=48) on Kigigak Island, Yukon Delta National Wildlife Refuge, Alaska. Plots 66 and 68 are not shown (66 is east of 11 and 68 is east of 13).

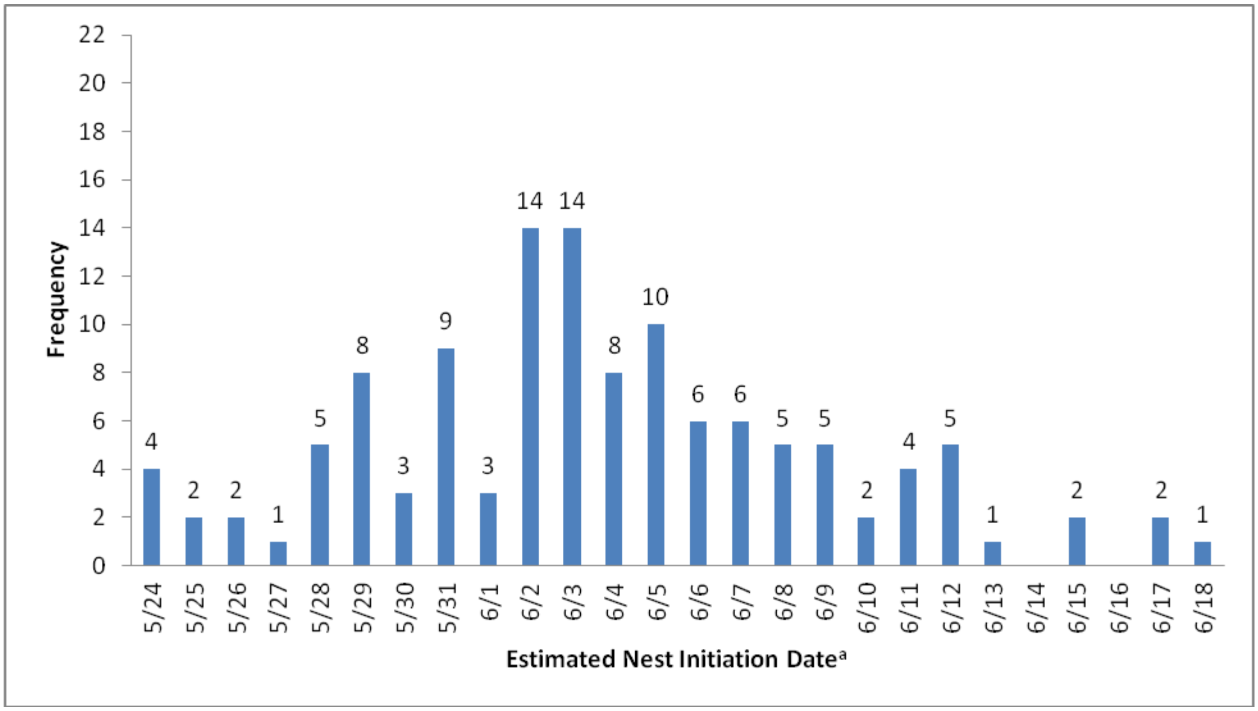

Figure 3. Estimated nest initiation dates for spectacled eider nests in 2012.
[a] Estimates assume an incubation period of 24 days and a laying rate of one egg per day.

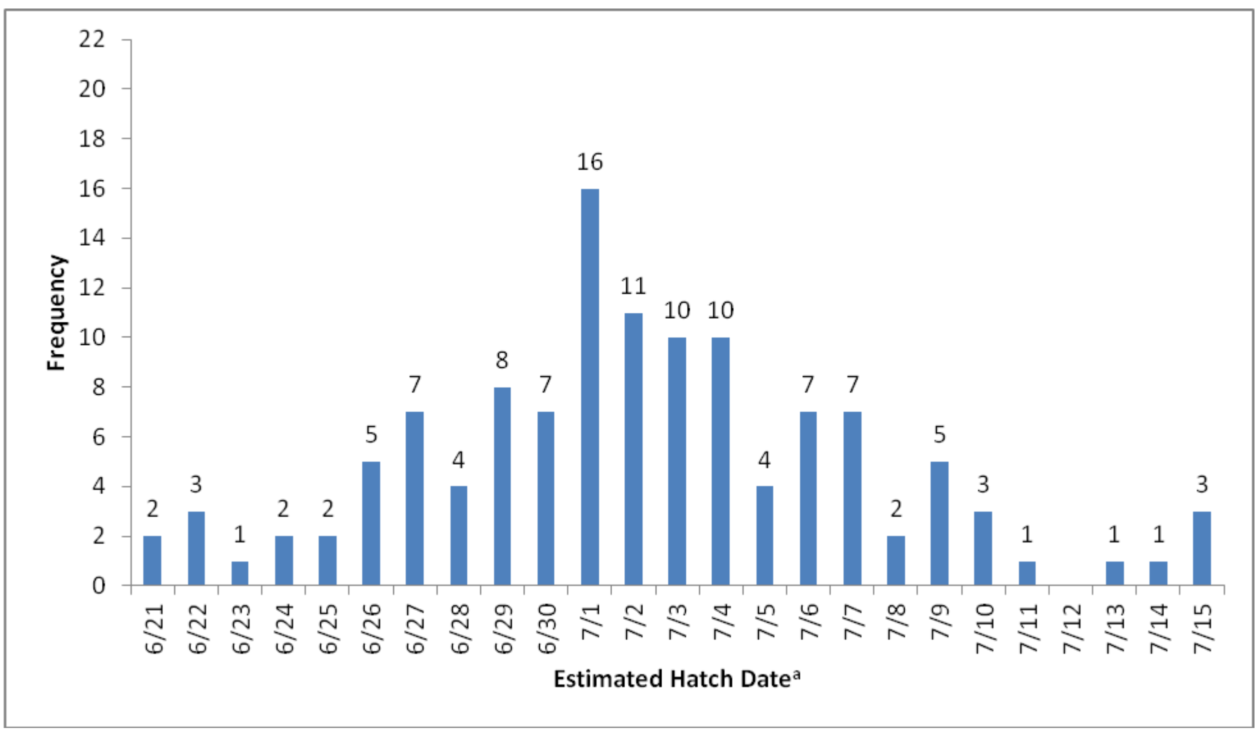

Figure 4. Estimated hatch dates for spectacled eider nests in 2012.
[a] Estimates assume an incubation period of 24 days.

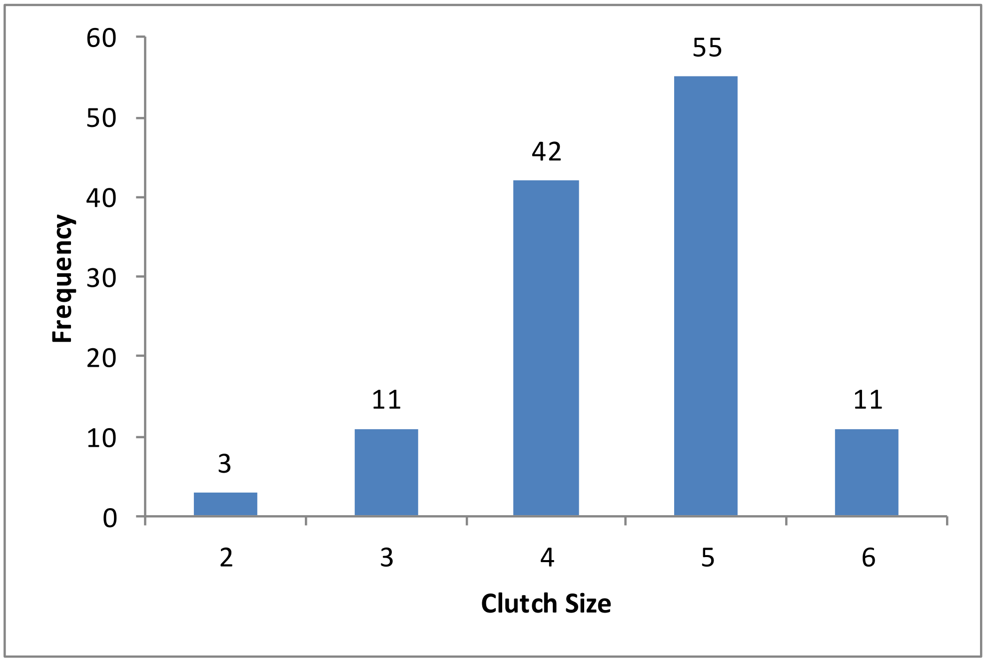

Figure 5. Clutch size frequencies for spectacled eider nests in 2012

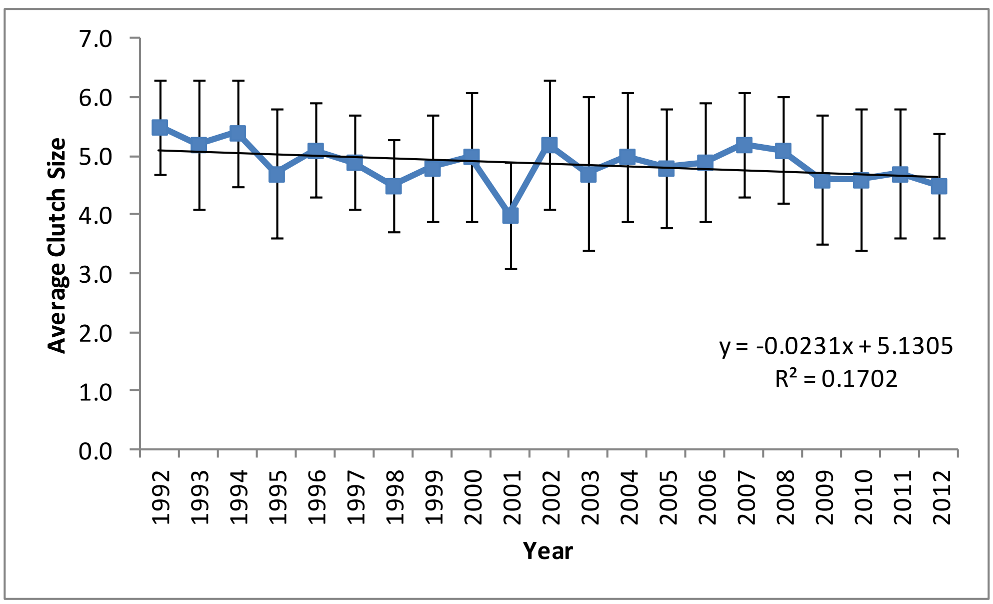

Figure 6. Estimated average clutch size for spectacled eiders nesting on Kigigak Island. Includes 1992-2012. Error bars represent standard deviation occurring within each year.

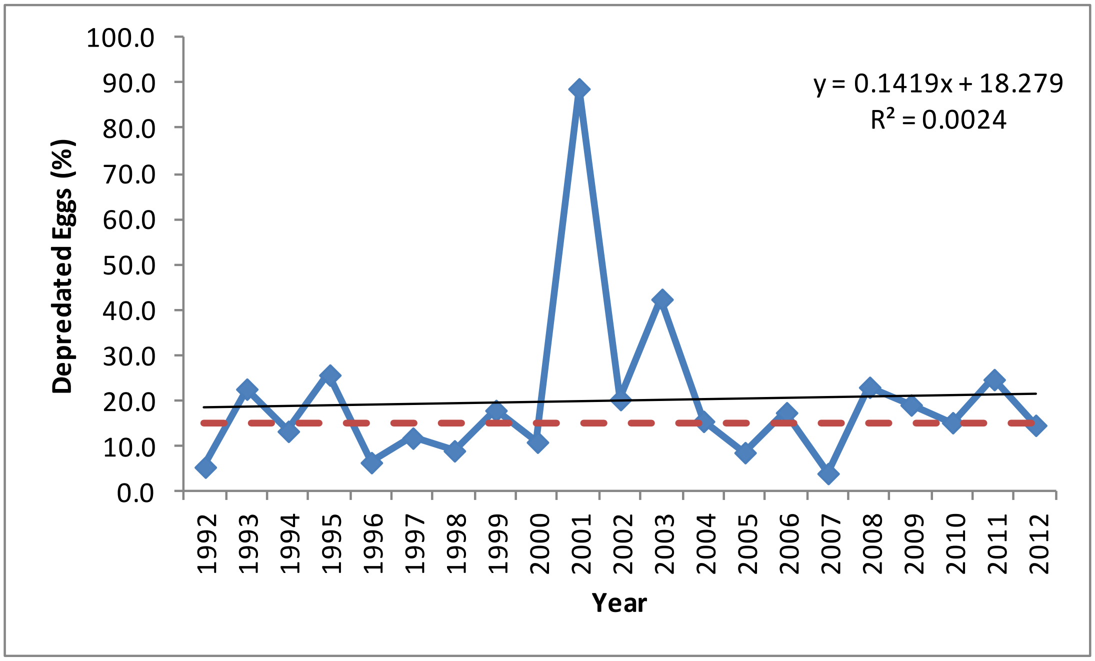

Figure 7. Spectacled eider egg depredation occurring on Kigigak Island. Data includes 1992-2012. 2001 and 2003 represent years of high nest failures. Solid black line represents best-fit trend line; however this line was highly influenced by 2001 and 2003. Red-dashed line represents average clutch size excluding two outlier years

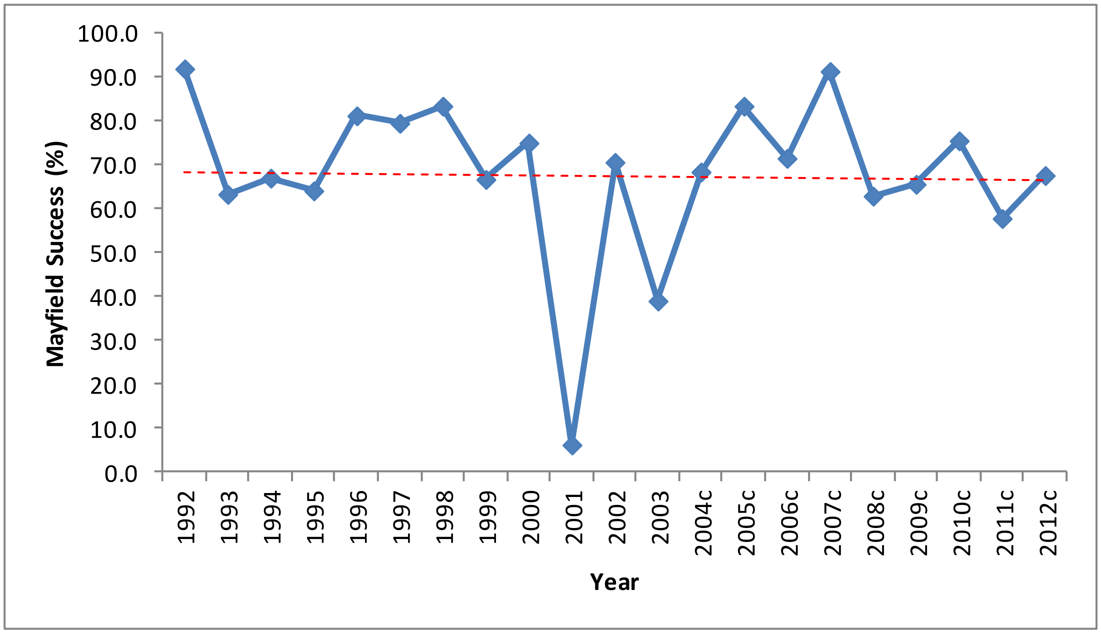

Figure 8. Yearly estimate of Mayfield Nest Success (%). Estimates exclude nests whose fates were suspected of being influenced by visitor impact, specifically trapping. All estimates were calculated using the model of Dinsmore et al. (2002). The red dashed line represents the long-term average (68.3%).

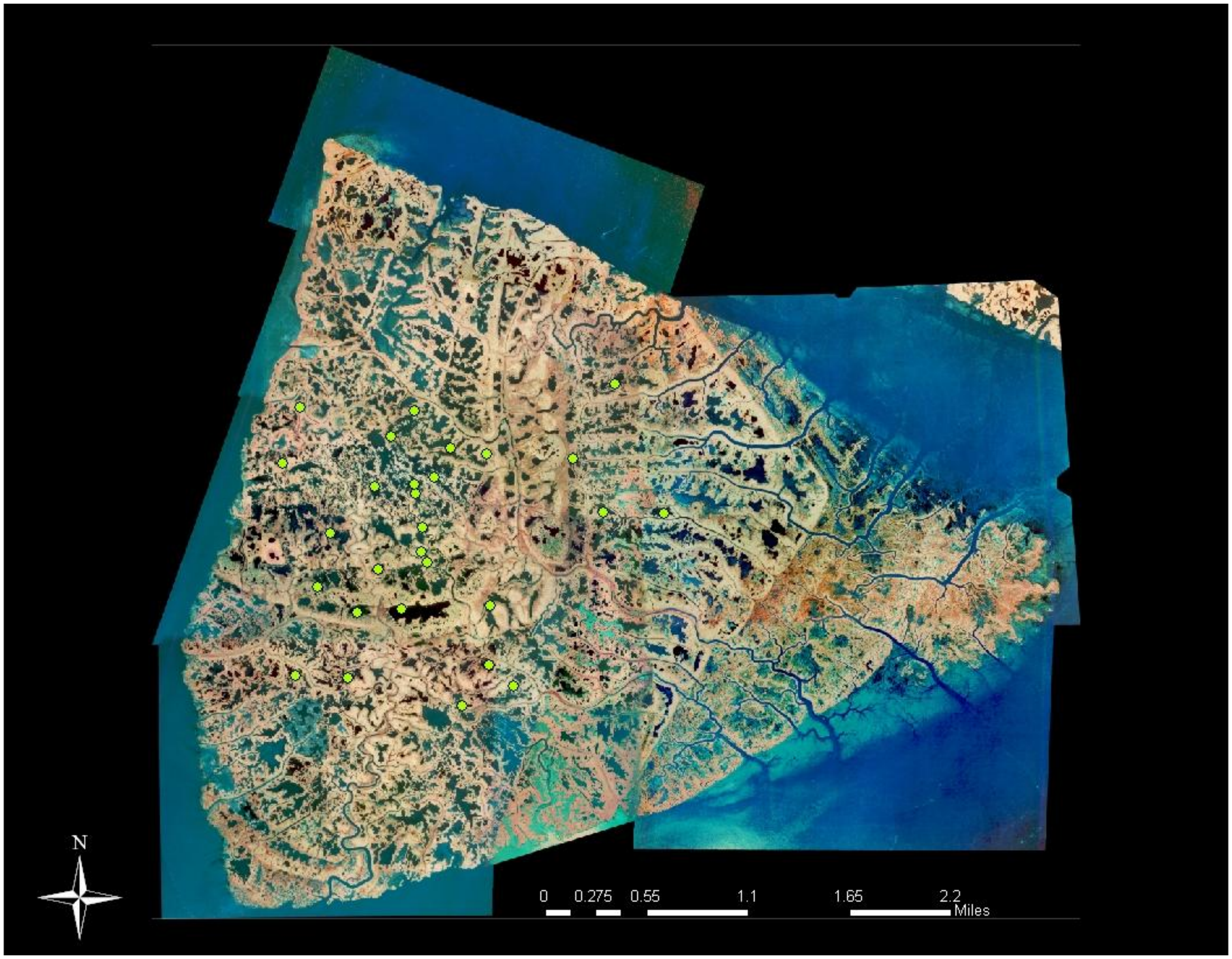

Figure 9. Brood capture sites on Kigigak Island, August 2012.

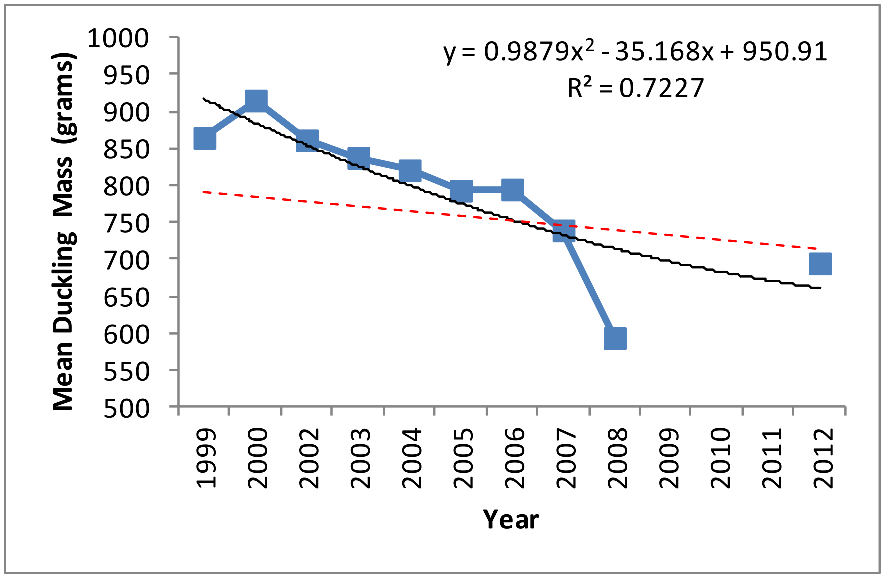

Figure 10. Average body mass of ducklings at 34 days of age (grams). Years include 1999-2008, and 2012. The best fit trend line was a polynomial curve with an r^2 value of 7.23 (black line). Red-line represents average body mass of ducklings (797.6 g).

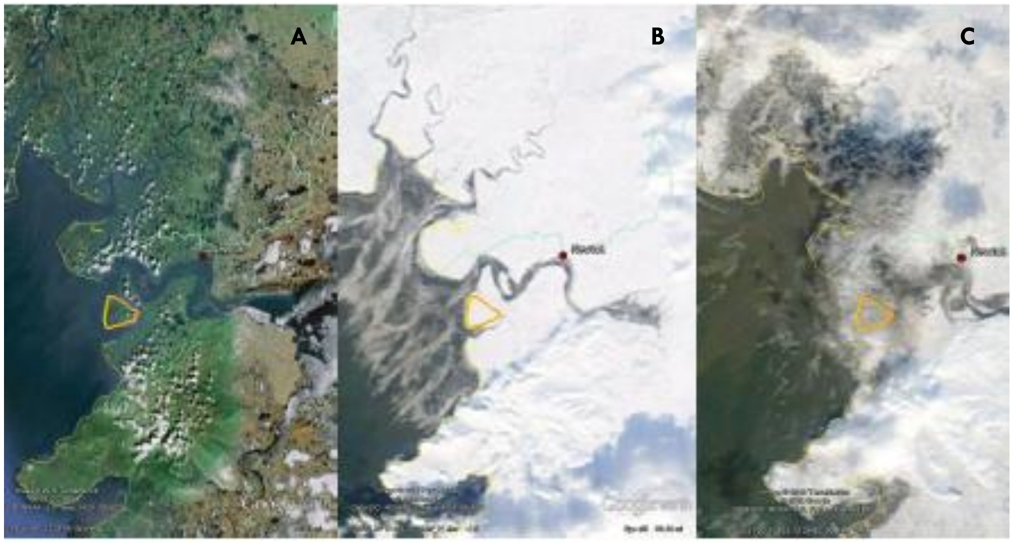

Figure 11. November 2011 storm surge extent on coastal zone of YDNWR. Kigigak Island is outlined in orange in all of the pictures. Photo A represents Kigigak Island on a typical day during the summer months. Photo B was taken on 7 November 2011. This photo shows the snow/ice extent of the coastal zone of YDNWR. Photo C was taken on 9 November 2011 and shows the water intrusion that occurred during the storm surge. The dark areas represent the extent of salt water intrusion including all of the study area (Kigigak Island), and approximately 8 miles inland.

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

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	0	0	20.5

[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

[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

[a] Sample size only 4 adult spectacled eider females