Nest Population Size and Potential Production of Geese and Spectacled Eiders on the Yukon-Kuskokwim Delta, Alaska, 1985-2016

Julian B. Fischer, Alison R. Williams, and Robert A. Stehn[1]

U.S. Fish and Wildlife Service, Migratory Bird Management, 1011 E. Tudor Rd., Anchorage, Alaska 99503, USA.
[1]Retired

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ABSTRACT: The Spectacled Recovery Plan identified annual nesting surveys as the primary method to assess recovery status for Alaska's Yukon-Kuskokwim Delta (YKD) subpopulation. In addition to documenting population status for spectacled eiders, the survey provides annual information on egg production, nesting effort, phenology, and habitat use for three other focal species including cackling geese, emperor geese, and greater white-fronted geese. Numbers of nests of the four species are stable or increasing in the short-term (2007-2016) and long-term (1985-2016). In 2016, the estimated number of spectacled eider nests (9,464) was the second highest in the history of the survey, but nest success was poor and clutch size very low. Rates of growth in numbers of spectacled eider nests indicate increasing populations in the short-term and stable over the long-term. Cackling geese and greater white-fronted geese produced high numbers of nests and eggs but nest success was fair to poor and clutch sizes low to very low. Emperor geese produced low numbers of nests and eggs, had poor nest success and very low clutch sizes. Nest initiation and hatching dates in 2016 were among the earliest since the study began. The significant trend of earlier nesting suggests a response to advancing dates of spring conditions with waterfowl now hatching a week earlier than in the 1980s.

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INTRODUCTION

The coastal zone of the Yukon-Kuskokwim Delta (YKD), Alaska, has long been recognized as one of the most important waterfowl nesting areas in North America (Spencer et al. 1951). The YKD region supports the entire minima subspecies of cackling geese (*Branta hutchinsii minima*), over 95% of Pacific greater white-fronted geese (*Anser albifrons frontalis*), and over 90% of emperor geese (*Chen canagica*) in the world (King and Dau 1981, Timm and Dau 1979, Eisenhauer and Kirkpatrick 1977). In addition, virtually all spectacled eiders (*Somateria fischeri*) in the western Alaska population breed on the YKD (Dau and Kistchinski 1977).

Significant declines in populations of geese and eiders between the 1960s and 1980s are well documented. Changes in goose population size during this period were dramatic with cackling goose declines exceeding 90% from over 350,000 in the 1960s to 26,000 in the early 1980s, and greater white-fronted goose declines exceeding 80% from highs over 450,000 in the 1960s to 73,000 by the early 1980s (O'Neill 1979, Timm and Dau 1979, Raveling 1984). At the same time, Petersen and Gill (1982) estimated a 34% decline in spring abundance of emperor geese based on periodic surveys between 1964 (139,000) and 1981 (91,000), a finding that prompted initiation of annual spring surveys that subsequently documented a further 36% decline through 1986 (U.S. Fish and Wildlife Service 2016). Coinciding with changes in goose populations, spectacled eiders on the YKD also declined with estimates ranging from a loss of 79% between 1969 and 1992 (Ely et al. 1994) to 96% between 1971 (48,000 pairs) and 1992 (1,721 pairs) (Stehn et al. 1993).

Declines of spectacled eider led to its listing as a federally threatened species and the subsequent formation of a recovery team that developed a recovery plan (Federal Register 1993, U.S. Fish and Wildlife Service 1996). The Recovery Plan identified criteria for uplisting and delisting the species that required a five factor threats analysis, and specific population benchmarks (see Discussion) for each of three subpopulations including the YKD, North Slope Alaska, and Arctic Russia. The Spectacled Eider Recovery Team identified annual ground-based nest surveys as the primary method to assess status relative to recovery criteria for the YKD subpopulation (U.S. Fish and Wildlife Service 1996). Accordingly, annual assessment of spectacled eider status through nest surveys on the YKD is a priority for the USFWS.

In addition to addressing this priority monitoring need, annual YKD nesting survey results have also provided information on nest population size, egg production, phenology, habitat use, and predation for a suite of waterbirds including cackling geese, emperor geese, greater white-fronted geese, black brant (*Branta bernicla nigricans*), tundra swans (*Cygnus columbianus*), sandhill cranes (*Grus canadensis*), spectacled eiders, common eiders (*Somateria mollissima*), Pacific loons (*Gavia pacifica*), red-throated loons (*G. stellata*), glaucous gulls (*Larus hyperboreus*), mew gulls (*L. canus*), Sabine's gulls (*Xema sabini*), and Arctic terns (*Sterna paradisaea*). Biologists and managers use these long-term data sets to develop baseline inventory of wildlife resources, implement cooperative waterbird management plans (e.g. goose management plans), create habitat association models (Saalfeld et al. 2014), develop vulnerability assessments (Saalfeld et al. 2015), and calculate aerial detection rates (Stehn et al. 2011, Lewis and Schmutz *in prep*).

METHODS

Nest Plot Sampling

To estimate the annual numbers of nests of geese and eiders, we used a ground-based sampling procedure from 1985 to 2016 (Stehn et al. 1993). During this period we sampled approximately 2,600 ground plots totaling roughly 80,000 ha. Each year we used Geographic Information Systems (GIS) to randomly select plots within a "core nesting area" for spectacled eiders on the central coastal zone encompassing 716 km^2 surrounding Hazen Bay (Fig. 1). The core nesting area, is comprised of medium (>1 observed spectacled eiders/km^2) and high (>2 observed spectacled eiders/km^2) density eider nesting habitat as determined by aerial observations on systematic transects in 1988-1994 (USFWS unpubl. data). Data from these aerial surveys indicate the majority of all spectacled eider pairs occur in the core nesting area, yet the area represents just 5.6% of the total coastal zone (12,832 km^2). Several patches of privately owned nesting habitat within the core nesting area were excluded from sampling because annual access could not be ensured. Selection of plot locations was restricted by excluding points that were sampled in the current or previous five years. Prior to 1994, and in 1998, 1999, 2014 and 2015, some plots were also selected from other adjacent regions of the YKD coastal zone, but for this analysis we only used data from plots within the core nesting area. Plot size in most years (1988–1994 and 1997–2015) was 32.4 ha (plot size 402 m by 805 m). Plot sizes were variable in 1985–1987 (16–166 ha), and were 45 and 36 ha in 1995 and 1996, respectively.

In this report, our estimates of nest population size and egg production for 1985-2016 are based on data collected on plots within the core nesting area and expanded to the entire coastal zone of the YKD using aerial survey data (see below).

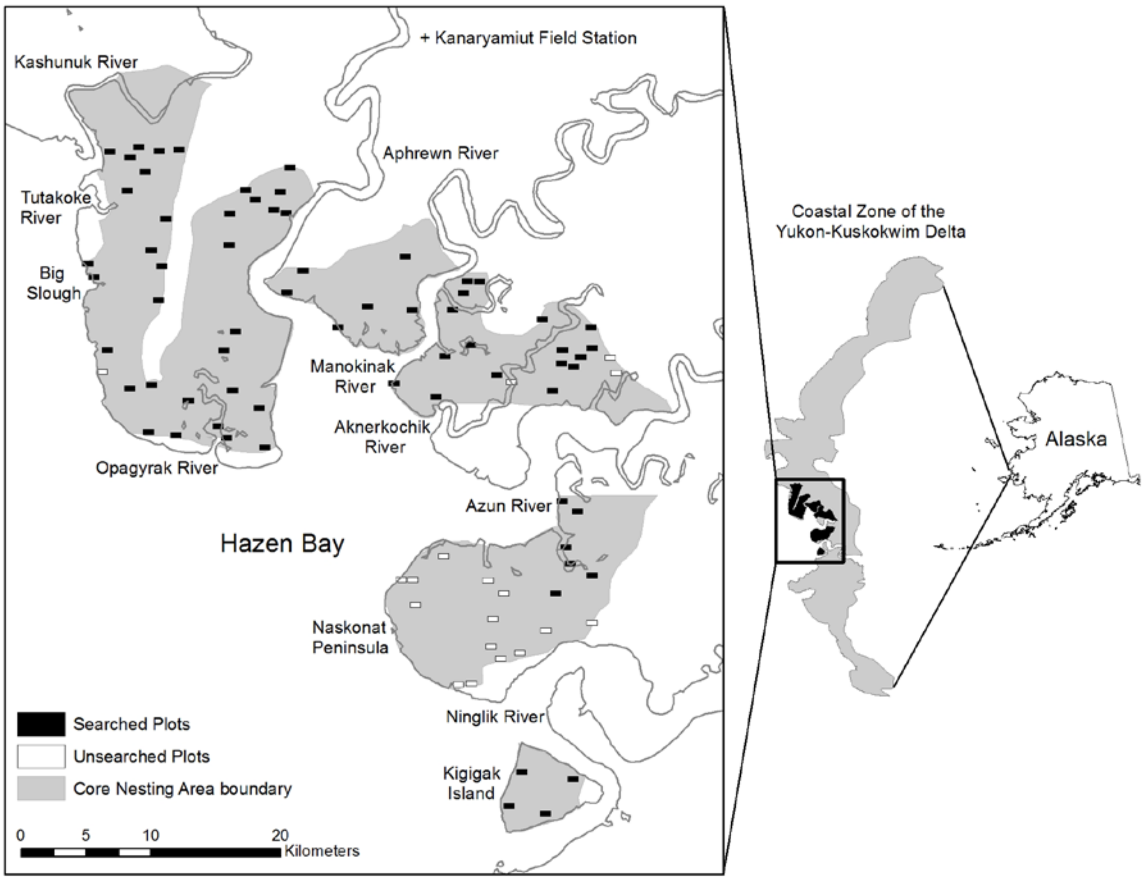

Figure 1. Location of 85 plots in 2016 that were randomly selected within a core nesting area (716 km^2) located within the Yukon-Kuskokwim Delta coastal zone (12,832 km^2), Alaska. Sampled plots are represented by solid rectangles; plots not sampled are shown as open rectangles.

One to four biologists searched for nests in each plot for up to 8 hrs, with search duration depending on crew size, available nesting habitat, nest density, and crew experience. Crews used aerial photographs (1985–2007) and IKONOS satellite imagery (2008–2016) as field maps. Access to plots was achieved by boat or float-equipped aircraft. In 2016, two crews were transported to the Azun and Anerkochik rivers via float plane where they accessed plots by foot or inflatable skiff. Three crews used 16'-18' aluminum skiffs to access plots near the Aphrewn, Opagyarak, Kashunuk, and Tutakoke rivers. In addition, data were collected at nine plots by collaborating biologists in adjoining scientific camps including Kigigak Island (FWS Endangered Species Program, four plots) and Manokinak River (U.S. Geological Survey, five plots). One crew that was assigned to complete plots on the Naskonat Peninsula was removed from the field prior to data collection.

We examined all nesting habitat within each plot for active and destroyed nests of waterfowl, cranes, loons, and gulls. We recorded nests of other species as encountered, but most nests of shorebirds and passerines were likely missed. At each nest, we recorded species, nest status (active, destroyed, abandoned), nest site location (meadow, slough bank, shoreline, peninsula, island; see Kincheloe and Stehn 1991), stage of incubation (see below), clutch size, presence of down, and geographic coordinates (2009–2016). We confirmed the species for each nest by visual identification of an adult at the nest or by comparing eggs, down, and contour feathers in the nest bowl with a photographic field guide (Bowman 2008).

Figure 2. Example of a field map to navigate within boundaries of two plots. Plot size was 402 m x 804 m.

Nesting Phenology

We measured stage of incubation (days following initiation of incubation) using float angles (Westerkov 1950) of three eggs per nest (or fewer when only 1 or 2 eggs were present). To measure float angle, we placed eggs into water and compared the angle of the resulting floating or sinking egg to a diagram (Fig. 3) indicating nine stages from sinking to very buoyant that corresponded to number of days following start of incubation. For cackling geese, the nine stages equated to 2, 5, 8, 10, 13, 15, 18, 22, and 24 days, respectively (U.S. Fish and Wildlife Service, unpubl. data). We then proportionally adjusted the incubation stage for each species based on the average 25 day incubation period for cackling geese (Afton and Paulus 1992; Table 1). For example, emperor geese have an incubation period of 24 days; thus, incubation stage 1 indicates 1.9 days of incubation (calculated as 2*[24/25]), where 2 is the estimate of days following initiation of incubation for cackling goose eggs indicated by stage 1, and 24/25 is the proportional adjustment for emperor goose incubation period relative to cackling geese (Table 1).

We calculated expected mean hatch date for each nest as the date of the nest visit plus the total days of the average incubation period (Table 1) minus the average days of incubation based on eggs floated at the nest. The reported average hatch date for each species was the average hatch date from all aged nests. We determined nest initiation date (day with first egg laid) as the date of the nest visit minus days of incubation at the time of the nest visit, minus observed clutch size divided by the laying rate expressed as eggs/day (e.g. 0.75 eggs/day for SPEI, see Table 2-2 in Alisauskas and Ankney 1992), plus 1. For example, the nest initiation date for a spectacled eider nest visited on day 20 June containing 5 eggs with an average float angle category of 5 (12.5 days of incubation; Table 1) was calculated as follows: 20 June-12.5-(5/0.75)+1 = 2 June. We report hatch date and clutch size estimates in 1982-1984 using data collected by Butler (1983) and based on the same techniques described above.

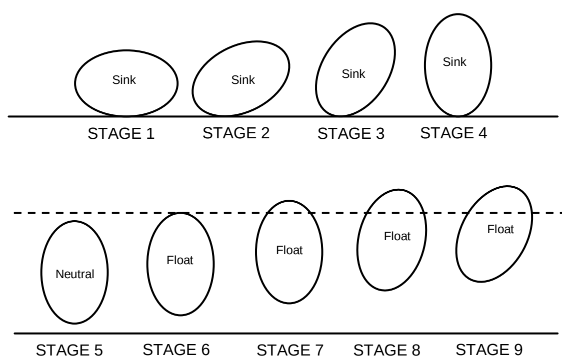

Figure 3. Float angles used to indicate stage of incubation.

Total Nest and Egg Estimation

We estimated the total number of nests and eggs by first calculating the detection-corrected average density of nests and eggs within the core nesting area. To do this we divided the total number of nests and eggs on plots by the total area searched, then we multiplied the density by the total ground sampled area (716 km^2). We calculated a density correction rate for each nest from a mark-recapture logistic model (Chao and Huggins 2005) using data from 30 plots sampled with two independent crews in 1995–1999 (Bowman and Stehn 2003). This provided regression coefficients for covariates relating nest detection rate that included nest status, species, nest site location, and crew experience. Nest status coefficients for active nests (containing at least one egg that was neither abandoned nor depredated) and inactive nests were 0.00 and 1.57, respectively. Species coefficients for cackling goose, greater white-fronted goose, emperor goose, and spectacled eider were 0.00, 0.49, 0.59, and -0.12, respectively. Nest site location coefficients for meadow, slough bank, shoreline, peninsula, and island were -1.84, -1.38, -1.25, -0.10 and 0.0, respectively. We categorized crew experience as high, medium, or low, based on the number of waterfowl nests each participant had previously recorded on the project. Coefficients for high (>400 prior nests), medium (150-400 prior nests), and low (<150 prior nests) crew experience were 0.00, -0.36, and -0.63, respectively. For example, if a destroyed emperor goose nest was found along a shoreline by a highly experienced crew member, the coefficients were: constant = 3.04, *Destroyed* nest activity status = -1.57, *Emperor Goose* species = 0.59, *Shoreline* nest site location = -1.25, *High* crew experience status = 0.0, for a sum of 0.81; the resulting detection rate = 1 / (1 + EXP (-0.81)) = 0.69. Thus, the discovered nest, corrected for detection rate, was estimated to represent 1 / 0.69 = 1.45 Emperor Goose nests. Coefficients remained constant across years but the proportion of nests in each activity status, nest site location, and the experience level of crews changed annually causing detection rates to vary somewhat among years.

We then expanded nest and egg estimates to the total YKD coastal zone (12,832 km^2) based on the inverse proportion of the aerially observed population within the ground-sampled area to the entire aerial survey area (Stehn et al. 1993, Taylor et al. 1996). To do this, we annually calculated the ratio of the YKD coastal zone aerial population index outside the ground-sampled area ("OUT") to the aerial index within the ground-sampled area ("IN") for each species. We used the annual "OUT:IN" ratios as expansion factors to estimate the number and variance of nests and eggs outside of the core nesting area. We then summed the indirect estimate of nests and eggs (OUT) and the direct plot sampled estimate (IN) to determine the total estimated population for the coastal zone of the YKD. For most species (geese [except brant], ducks, cranes), the aerial population index was based on twice the number of singles plus the number of birds in pairs observed, because observed single geese, cranes and ducks are assumed to be the mates of unobserved females on nests (U.S. Fish and Wildlife Service 1987, Bowman 2014). Flocks were included in aerial indices for brant, loons, and gulls. For swans, gulls, and loons, the number of observed single birds was not doubled because unlike ducks, both individuals in a pair were assumed to be equally visible to aerial observers.

Where aerial survey data were unavailable, we substituted the average OUT:IN ratios from the two nearest years where available. For example, aerial survey data were not collected for eiders in 1985-1987, thus for those years, we substituted the average of OUT:IN ratios from 1988-1989. Similarly, for loons, we substituted the average of OUT:IN ratios from 1989-1990 for the years 1985-1988; and for gulls we substituted the average of OUT:IN ratios from 1992-1993 for the years 1985-1991. For eiders, loons and gulls in 2011 we substituted the average of OUT:IN ratios from 2010 and 2012. Standard errors of the OUT:IN ratios were based on the variance of the quotient of the OUT and IN aerial population indices, and each was considered an independent variable with separate variance. Aerial population indices were based on stratified estimates of average densities as determined by standard index ratio procedures

(Cochran 1963, p. 158 eq. 6.4). Variance of the nest population in the OUT region included both the variance of nests and variance of the OUT:IN ratio.

Loon data were treated differently from other species because nest identification of red-throated (*Gavia stellata*) and Pacific loons (*Gavia pacifica*) is very difficult. Loons rarely remain near their nest sites when ground crews are present and their nests and eggs are effectively indistinguishable (Bowman 2008). Thus, to determine the relative numbers of Pacific loon nests, we calculated the proportion of Pacific loons to total loons based on aerial observations from transects within the ground sampled area (Swaim and Stehn *in prep*). We then multiplied this ratio by the total number of loon nests to derive an estimate for Pacific loon nests. We used the same approach to estimate the number of red-throated loon nests.

The estimated total number of nests measures the minimum number of breeding pairs in the population because some pairs may not establish a nest in a given year, and some nests are destroyed or abandoned at an early stage before they can be detected by ground crews. Nest success (nests with at least one egg hatched/total nests) is not directly measured because crews visited plots once and could not determine the ultimate fate of each nest; thus we report a nest success index (active nests/total nests). Similarly, we did not monitor fledging success or juvenile survival; thus number of eggs reported is an index that represents the maximum potential young that could augment the fall population if they survived through incubation, brood rearing, and the post-fledging periods. Definitions of these terms are summarized in the caption of Figure 4.

We describe 2016 nest and egg estimates relative to short-term (most recent 10-years 2007-2016) and long-term means (1985-2016). We provide qualitative descriptors of numbers of nests and eggs, and clutch size that correspond to quartiles (4^{th} quartile = *high*, 3^{rd} quartile = *moderate*, 2^{nd} quartile = *low*, 1^{st} quartile = *very low*) from the long-term data set. We report annual estimates of a nest success index and clutch sizes in 1985-2016, and describe 2016 estimates with qualitative descriptors by comparing the current estimate to long-term means that correspond to quartiles (4^{th} quartile = *excellent*, 3^{rd} quartile = *good*, 2^{nd} quartile = *fair*, 1^{st} quartile = *poor*). We analyzed growth rate at the alpha = 0.10 level; thus, annual growth rate is reported as stable when the 90% confidence interval of the growth rate includes 1.0. Annual nesting phenology is compared to average hatch dates (1982-2016).

RESULTS

In 2016, we searched 65 plots from 27 May to 10 June (Fig. 1) comprising 2.9% of the core nesting area (65 plots x 0.324 km^2/716 km^2). We did not visit 20 of the 85 randomly selected plots, primarily due to the unexpected cancelation of one field crew, and secondarily due to logistical constraints that prevented access to several sites prior to peak hatch. Together, crews in 2016 located 3,153 nests within core nesting area plot boundaries including 1,291 cackling goose, 240 emperor goose, 657 greater white-fronted goose, 238 black brant, 124 spectacled eider, 65 common eider, and 538 nests of other species. Calculations of clutch size and hatch date also included an additional 16 nests located outside of plot boundaries.

We present nest population, egg production, clutch size, and nest success estimates in figures with accompanying tabulated data for each species (Fig. 4). Estimated short-term and long-term annual growth rates, and nest initiation and hatch dates for all species are presented in Tables 2-4.

Environmental Conditions 2016

For the third year in a row, warm spring temperatures and low ice extent in the Bering Sea prompted early arrival of summer on the Yukon-Kuskokwim Delta. Arctic sea ice reached its maximum extent by the end in March and was the lowest maximum recorded in the satellite record (NASA Snow and Ice Data Center 2016). At Bethel, Kuskokwim River breakup occurred on 20 April, the earliest breakup date recorded since record keeping began in 1924 (NOAA 2017a). Mean May and June temperatures in Bethel, located approximately 160 km east of Hazen Bay, were 9.4 C and 13.2 C, respectively (NOAA 2017b) and were 4.5 C and 0.7 C above the long-term means, respectively (1923-2016). During the data collection period in 2016, weather was variable with occasional periods of rain and wind. Total precipitation in May and in June 2016 was within a third of an inch of the long term means (1924-2016, NOAA 2017b).

Species Descriptions 2016

Cackling Goose (*Branta hutchinsii minima*)

The number of cackling goose nests was high (see methods for definition of qualitative descriptors) with estimates 7% and 50% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also high with estimates 1% and 43% above short-term and long-term means, respectively (Fig. 4, Tables 2-3). In 2016, nest success (active nests/total nests) was fair (see methods for definition of qualitative descriptors) and clutch size (active eggs/active nest) was low relative to the long-term mean (Fig. 4). Rates of growth in nest numbers and eggs indicate stable populations in the short-term and increasing populations in the long-term (Fig. 4, Tables 2-3). Average hatch date for cacklers was 10 days earlier than the long-term mean (1982-2016; Table 4).

Emperor Goose (*Chen canagica*)

The number of emperor goose nests was low with estimates 14% and 2% below short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was very low with estimates 21% and 12% below short- and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was poor and clutch size (active eggs/active nest) was very low relative to the long-term mean (Fig. 4). Rates of growth in nests and eggs indicate stable populations in the short-term and increasing populations in the long-term (Fig. 4, Tables 2-3). Average hatch date for emperor geese was 10 days earlier than the long-term mean (1982-2016; Table 4).

Greater White-fronted Goose (*Anser albifrons frontalis*)

The number of white-fronted goose nests was high with estimates 27% and 122% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also high with estimates 21% and 107% above short-term and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was poor and clutch size (active eggs/active nest) was very low relative to the long-term mean (Fig. 4). Rates of growth in nests and eggs indicate increasing populations in the short-term and long-term (Fig. 4, Tables 2-3). Average hatch date for white-fronts was 10 days earlier than the long-term mean (1982-2016; Table 4).

Black Brant (*Branta bernicla nigricans*)

The number of brant nests was low with estimates 31% and 38% below short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also low with estimates 28% and 30% below short-term and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was good and clutch size (active eggs/active nest) moderate relative to the long-term means (Fig. 4). Rates of growth in nests indicate stable populations in the short-term and long-term (Fig. 4, Tables 2-3). Numbers of eggs were decreasing in the short-term and stable in the long-term (Fig. 4, Tables 2-3). Average hatch date for brant was 10 days earlier than the long-term mean (1982-2016; Table 4).

Tundra Swan (*Cygnus columbianus*)

The number of tundra swan nests was high with estimates 16% and 40% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also high with estimates 39% and 66% above short- and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was fair and clutch size (active eggs/active nest) high relative to the long-term mean (Fig. 4). Rates of growth in nest and egg numbers indicate increasing populations in the short- and long-term (Fig. 4, Tables 2-3). Average hatch date for tundra swans was 12 days earlier than the long-term mean (1982-2016; Table 4).

Sandhill Crane (*Grus canadensis*)

The number of sandhill crane nests was high with estimates 24% and 35% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also high with estimates 34% and 50% above short- and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was good and clutch size (active eggs/active nest) moderate relative to the long-term mean (Fig. 4). Rates of growth in nest and egg numbers indicate increasing populations in the short- and long-term (Fig. 4, Tables 2-3). Average hatch date for sandhill cranes was nine days earlier than the long-term mean (1982-2016; Table 4).

Spectacled Eider (*Somateria fischeri*)

The number of spectacled eider nests was high with estimates 45% and 82% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also high with estimates 4% below and 17% above short-term and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was poor and clutch size (active eggs/active nest) was very low relative to the long-term mean (Fig. 4). Rates of growth in nests numbers indicate increasing populations in the short-term and stable over the long-term (Fig. 4, Tables 2-3). Numbers of eggs were stable in the short- and long-term (Fig. 4, Tables 2-3). Average hatch date for spectacled eiders was nine days earlier than the long-term mean (1982-2016; Table 4).

Common Eider (*Somateria mollissima*)

The number of common eider nests was high with estimates 30% and 106% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was also high with estimates 16% and 86% above short- and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was fair and clutch size (active eggs/active nest) very low relative to the long-term mean (Fig. 4). Rates of growth in nests and eggs indicate stable populations in the short-term and increasing populations in the long-term (Fig. 4, Tables 2-3). Average hatch date for common eiders was eight days earlier than the long-term mean (1982-2016; Table 4).

Gulls and Terns

Colonial nesting seabirds including glaucous gulls (*Larus hyperboreus*), Sabine's gulls (*Xema sabini*), mew gulls (*Larus canus*), and Arctic terns (*Sterna paradisaea*) are not monitored with precision by the nest plot survey. Nonetheless, the survey does provide an index of potential production and nest success for these species.

The number of glaucous gull nests was high with estimates 63% and 78% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The numbers of eggs was also high with estimates 68% and 98% above short- and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was excellent and clutch size (active eggs/active nest) moderate relative to the long-term mean (Fig. 4). Rates of growth in nests indicate stable populations in the short-term and long-term. Numbers of eggs were stable in the short-term and increasing in the long-term (Fig. 4, Tables 2-3). Average hatch date for glaucous gulls was 10 days earlier than the long-term mean (1982-2016; Table 4).

The number of mew gull nests was moderate with estimates 11% and 5% below short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was moderate with estimates 8% below and 1% above short-term and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was good and clutch size (active eggs/active nest) was moderate relative to the long-term mean (Fig. 4). Rates of growth in nests and eggs indicate stable populations in the short- and long-term (Fig. 4, Tables 2-3). Average hatch date for mew gulls was nine days earlier than the long-term mean (1982-2016; Table 4).

The number of Sabine's gull nests was high with estimates 14% below and 46% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The numbers of eggs was moderate with estimates 34% below and 10% above short- and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was poor and clutch size (active eggs/active nest) was very low relative to the long-term mean (Fig. 4). Rates of growth in nests and eggs indicate stable populations in the short-term and increasing populations in the long-term (Fig. 4, Tables 2-3). Average hatch date for Sabine's gulls was six days earlier than the long-term mean (1982-2016; Table 4).

The number of Arctic terns nests was high with estimates 21% and 66% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The numbers of eggs was also high with estimates 19% and 54% above short-term and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was good and clutch size (active eggs/active nest) was very low relative to the long-term mean (Fig. 4). Rates of growth in nests and eggs indicate the population is increasing in the short-term and long-term (Fig. 4, Tables 2-3). Average hatch date for arctic terns was seven days earlier than the long-term mean (1982-2016; Table 4).

Loons

The number of red-throated loon (*Gavia stellata*) nests was moderate with estimates 17% and 11% above short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The number of eggs was moderate with estimates 5% and 14% below short-term and long-term means, respectively (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was poor and clutch size (active eggs/active nest) very low relative to the long-term mean (Fig. 4). Number of nests and eggs is stable in the short-term and long-term (Fig. 4, Tables 2-3). Average hatch date for red-throated loons was nine days earlier than the long-term mean (1982-2016; Table 4).

The numbers of Pacific loon (*G. pacifica*) nests were very low with estimates 32% and 32% below short-term (2007-2016) and long-term (1985-2016) means, respectively (Fig. 4, Tables 2-3). The numbers of eggs was also very low with estimates 46% and 47% below short-term and long-term means (Fig. 4, Tables 2-3). Nest success (active nests/total nests) was poor and clutch size (active eggs/active nest) very low relative to the long-term mean (Fig. 4). Number of nests and eggs are declining over the short-term and stable in the long-term (Fig. 4, Tables 2-3). Average hatch date for Pacific loons was nine days earlier than the long-term mean (1982-2016; Table 4).

DISCUSSION

Overview of abundance, trends, and productivity

The nest plot survey was designed to provide annual abundance and trend estimates of nests and eggs, and to measure nest success and hatching dates for four focal species: cackling geese (*minima* subspecies), emperor geese, greater white-fronted geese, and spectacled eiders. Results for black brant, tundra swans, sandhill cranes, common eiders, gulls, terns, and loons, were also collected and reported.

In 2016, production of nests and eggs, rates of nest success, and estimates of clutch size varied widely among the four focal species. Cackling geese and greater white-fronted geese produced high numbers of nests and eggs but nest success was fair to poor and clutch sizes low to very low. Emperor geese produced low numbers of nests and eggs, had poor nest success and very low clutch sizes. In contrast, spectacled eiders had high numbers of overall nests and eggs but experienced poor nest success and very low clutch sizes.

Numbers of nests and eggs of three of the four focal species have increased significantly over the 32-year time span of this survey (1985-2016); the one exception being spectacled eiders whose growth rate is stable over this period. Given the relatively high numbers of spectacled eider nests estimated through the late 1980s followed by 11 years of relatively few nests, positive growth will be required in the years ahead before a long-term positive trend will be statistically significant. Spectacled eiders are continuing to increase in recent years as evidenced by a positive 10-year growth rate in numbers of nests. The 2016 estimate for spectacled eider nests was the second highest since 1985 and was higher than the short- and long-term means (Tables 2-3).

Status of Spectacled Eiders

Using criteria defined in the Spectacled Eider Recovery Plan (U.S. Fish and Wildlife Service 1996), the Yukon-Kuskokwim Delta spectacled eider population may be approaching one benchmark for consideration of delisting from threatened status. For delisting to occur, the species must first be evaluated relative to a five factor threat analysis as described in section 4(a)(1) of the Endangered Species Act. The next requirement for delisting is that each of three spectacled eider populations (Yukon-Kuskokwim Delta, North Slope Alaska, and Arctic Russia) must meet at least one of the following two benchmarks: 1) the population is increasing over the most recent 10-15 years as measured by a Bayesian analysis of trend specified in the Spectacled Eider Recovery Plan (U.S. Fish and Wildlife Service 1996), and the minimum (lower 95% confidence limit) estimated population size exceeds 6,000 breeding pairs (as measured in nests or pairs); **or** 2) the minimum estimated population size exceeds 10,000 breeding pairs for three or more years; **or** the minimum estimated population size exceeds 25,000 breeding pairs in any one survey.

The first criterion to satisfy population benchmark #1- a Bayesian trend analysis, will be completed by USGS in 2018. The second criterion of benchmark #1- the lower 95% confidence limit of the total number of nests, was surpassed in 2016. We estimated 9,464 nests and a lower 95% confidence limit of 6,880 nests. However, this estimate relies on unbiased estimates of aerial detection to derive an expanded nest estimate outside of the ground sampled area. Specifically, the estimate of numbers of nests outside of the ground sampled area is derived by the OUT:IN ratio of aerial observations (see methods) which assumes a linear relationship between aerial observations and nests throughout the entire coastal zone of the Yukon-Kuskokwim Delta. This assumption is being investigated by USGS-Alaska Science Center (Lewis and Schmutz, *in prep*.) by comparing estimates of nests and aerial observations among low, medium, and high density strata. The resulting analysis will provide density-specific aerial visibility correction factors (VCF) to account for incomplete detection of spectacled eiders by aerial survey crews. If the aerial detection rate is negatively related to density of birds, then the ratio of aerial observations outside of the ground sampled area to within the ground sampled area (OUT:IN ratio) will yield a lower nest expansion factor than what we reported here, resulting in a lower estimate of numbers of nests.

Unlike the nest plot survey, the aerial survey samples habitat throughout the entire coastal zone of the Yukon-Kuskokwim Delta; thus it could provide a less biased estimate of the total breeding population size in western Alaska if aerial detection is accounted for. Currently there is no reliable VCF to account for incomplete detection of aerially observed spectacled eiders, though a VCF estimate of 3.58 has been applied to some aerial data (Hodges et al. 1996) and was based on an estimate by Lensink (1968). However, in his report, Lensink referred to his VCF estimate of 3.58 in the following way, "*Present sampling levels…are not adequate to provide statistical reliability…for correction of aerial observations*". The analyses underway by Lewis and Schmutz described above will address this shortcoming.

Delisting of the spectacled eider from threatened status requires that all three populations (Yukon-Kuskokwim Delta, North Slope Alaska, and Arctic Russia) meet delisting criteria outlined above. Breeding and winter population surveys indicate that the Arctic Russia subpopulation is above the 25,000 breeding pair threshold even without accounting for incomplete detection (Hodges and Eldridge 2001). The North Slope (NS) Alaska spectacled eider subpopulation has remained stable since the initiation of breeding pair surveys in 1992 with no indication of significant positive or negative growth (Stehn et al. 2013, H. Wilson, USFWS, unpubl. data). Further, the lower 95% confidence limit of the unadjusted aerial breeding pair index has never exceeded 4,000 indicated pairs. To account for incomplete aerial detection for the North Slope population, analyses are underway using front-seat, back-seat paired observations in a mark-recapture model (Wilson et al. *in prep*). When VCF estimates are completed, the status of the YKD and NS populations will be evaluated relative to recovery criteria by the Alabama Cooperative Fish and Wildlife Research Unit using the Bayesian analysis detailed in the Recovery Plan.

Predation

Mammalian and avian predators are known to destroy nests on the YKD during incubation (Anthony et al. 1991, Bowman and Stehn 2003). In prior studies, up to 61% brant nests were lost to fox predation in small YKD brant colonies (Raveling 1989). Data collected in our study provides an indirect measure of arctic fox (*Alopex lagopus*) presence on plots. Presence of recent fox activity is indicated by fur, scat, tracks, active dens or direct observations, and was noted in 48% of sampled plots in 2016 (Table 5), essentially the same as the long-term mean of 47% (1988-2016). Over the long-term, fox abundance (as measured by the proportion of plots with recent fox activity) is correlated with nest failure of cacklers (1-nest success index; $F_{1,27} = 15.48$, $P = 0.001$; Figs. 5-6) and fox abundance explained 36% of the variation in nest failure in 1988-2016 ($R^2 = 0.36$). In 2016, the proportion of nests with at least one destroyed egg was not significantly higher in plots with recent fox activity (16% of nests with $\geq$1 egg destroyed) than in plots without recent fox activity (12% of nests with $\geq$1 egg destroyed; $F_{1,64} = 2.17$; P = 0.145). While fox contributed to some nest failure in 2016, avian predators likely contributed to egg loss as well. An analysis of nest failure relative to the presence or absence of avian predators would increase understanding of the relative cost of avian and mammalian predation on waterfowl production.

The relationship between voles (*Microtus oeconomus*), foxes, and nesting success is unclear. High egg depredation from foxes in 2001 followed a year of unprecedented high numbers of voles (Table 5). One hypothesis for this relationship is that high vole populations in 2000 provided fall and winter food for foxes, thus increasing fox overwinter survival and resulting in high fox populations in 2001. With a reduced vole population in 2001, foxes may have turned to bird eggs as alternative prey resulting in low nest success that year. Given the high frequency of voles in 2009 and 2010, we expected that fox populations would increase in 2010 and/or 2011 with negative repercussions for avian nest success if vole populations declined. Vole populations did decline in 2011 and remained below average in 2012-2016 (Table 5), yet there was little evidence suggesting this change resulted in a higher than average nest failure due to fox predation. One interpretation is that vole populations may have declined in fall 2010 or winter 2010/2011 resulting in low fox survival, thereby reducing predation effects on birds in 2011 and 2012. Alternatively, voles may not play a predictable role in population dynamics of foxes.

Phenology and Climate Change

Timing of waterfowl nest initiation is correlated with timing of spring breakup (Raveling 1978, Dau and Mickelson 1979). The chronology of spring warming along the coast in 2016 was similar to 2014 and 2015, and was substantially earlier than recent decades. This resulted in the earliest nest initiation of cackling geese every measured by this survey. Nest initiation of geese, eiders and swans in 2016 was eight to twelve days earlier than long-term means (1982-2016, Table 4). The timing of nesting has advanced eight days during the last 35 years (Fig. 7). Since 1982, we estimate that average hatch for cackling geese, for which the most data are available, has occurred 0.235 days earlier each year on average (Fig. 7). The trend towards earlier nesting is significant at the alpha=0.05 level ($F_{1,33}$ = 8.240, P =0.007, R^2 = 0.200).

Long-term increases in spring temperatures and earlier occurrence of spring events, such as river breakup and snow melt are predicted in many climate change models (Root et. al. 2003, IPCC 2014). Such models predict with very high confidence that coastal habitats will experience submergence, flooding and erosion as a result of climate change (IPCC 2014). Current trends in waterfowl nests on the Yukon-Kuskokwim Delta do not indicate that habitat impacts have reduced population sizes. Standardized pond salinity monitoring since 2006, conducted in coordination with this survey, provides baseline and trend information that will be used assess changes to the waterfowl nesting habitats of the YKD over the long-term (H. Wilson, USFWS, unpubl. data) providing an additional tool to measure impacts of a changing climate on waterfowl, should such changes occur.

Comparison With Other Survey Results

The spectacled eider nest success index (number of active nests divided by total nests times 100%, corrected for detection rate) has been variable among years. Plots are visited one time, so the nest success index overestimates actual nest success (number of nests that hatch at least one chick/total nests) because some nests undoubtedly fail prior to hatch. Nonetheless, the index is calculated consistently each year and provides an annual index measure of nest success. The spectacled eider nest success index generally matches apparent nest success (successful hatched nests/total nests) on Kigigak Island where nests were visited by Yukon Delta National Wildlife Refuge staff every seven days until hatch in 1992-2015 (Moore and Sowl 2017;

Fig. 8). The largest divergence between estimates from these two surveys was noted in 2001, 2003, 2013, and 2015. In all four cases, nest success was lower on Kigigak Island than on the core nesting area as a whole. These years also occurred when nest success was relatively poor, and the pronounced low estimates on Kigigak Island may have been due to the fact that monitoring continued through hatch allowing crews to detect nest failures late in incubation when the nest plot project was already completed. Despite periodic differences in nest success between the two studies, estimates of clutch size measured on the nest plot survey closely parallel those reported from Kigigak Island (Moore and Sowl 2017; Fig. 9). Apparent nest success and clutch size was not calculated on Kigigak Island in 2016.

In general, nest population trends were similar to those derived from aerial breeding pair surveys (Swaim et al. 2016, Swaim and Stehn *in prep.*). For example, estimates of cackling goose and greater white-fronted goose nests were at record lows in the mid-1980s prior to adoption of the Yukon-Kuskokwim Delta Goose Management Plan that provided protection for nesting and wintering populations of geese (Pamplin 1986). Results from the ground-based plot survey and an aerial breeding pair survey (Swaim et al. 2016) both show that by the late-1980s, the cackling goose population of nests and pairs increased rapidly, and peaked in the late-1990s. Since 1999, the trend for cackling Canada geese has been generally stable, though estimates from both surveys showed a temporary drop during the mid-2000s (this study, Swaim et al. 2016). The dramatic increase in population of greater white-fronted geese from the mid-1980s to present is documented by both aerial (growth rate 1.083, Swaim et al. 2016) and ground surveys (growth rate 1.086 this study). Unlike populations of the other goose species, emperor geese and black brant did not increase markedly after adoption of the Yukon Delta Goose Management Plan. While long-term trends indicate a slow annual increase for emperor geese in the aerial survey (growth rate 1.020, Swaim et al. 2016) and ground surveys (growth rate 1.011, this study), black brant growth rates do not indicate significant growth or decline as measured by aerial or ground surveys (growth rates 1.008 and 0.994, Swaim et al. 2016, and this study, respectively).

Similar to geese, spectacled eiders are also monitored by aerial survey crews (starting in 1988). The average long-term growth rates as measured by the aerial survey is 1.055 (1988-2016; Swaim and Stehn *in prep*.). The growth rate based on aerial survey data is higher than that derived from nest survey data during the same time period (1.022 [1988-2016]). The difference in estimated growth rates is likely due to low numbers of pairs detected by aerial crews in the late 1980s followed by continuous growth, whereas numbers of nests did not increase until the mid-1990s. The reasons for this could be related to age structure of the population or changes in habitat conditions during the early 1990s that influenced breeding propensity.

Standard aerial surveys and the current ground-sampling methods do not estimate the number of colony-nesting brant with precision. To address this, photographic methods were initiated in the 1990s to monitor nest populations in five major brant (Anthony et al. 1995, Wilson 2016). These surveys indicate a decline in brant nest populations since 1992 whereas nest numbers in the ground sampled area (this study) and the fall and winter counts of the entire Pacific population indicate relative stability (U.S. Fish and Wildlife Service 2016). There are three hypotheses that may contribute to this dichotomy. Stehn et al. (2011) explored the hypothesis that brant are nesting in increasing proportions at small dispersed colonies rather than the five large primary colonies on the YKD. They found that growth rates outside of the primary colonies are positive in some locations but are not sufficient to offset region-wide declines. A second hypothesis is that brant populations are increasing on the Arctic Coastal Plain of Alaska and in Arctic Canada, to some degree offsetting declines of the primary YKD brant colonies. There is some support for this explanation based on data from aerial surveys of the Alaskan Arctic that show brant have increased significantly since 1986 (Stehn et al. 2013; H. Wilson, USFWS, unpubl. data). A third hypothesis is that bias inherent in the fall and midwinter surveys mask actual trends in the Pacific black brant population. Alternative methods to track the Pacific brant population size, including mark-recapture methods and photographic population surveys are being considered as independent methods to assess population size.

<u>Range of Inference</u>

The core nesting area (716 km^2) is the only portion of the Yukon-Kuskokwim Delta coastal zone that is currently sampled for numbers of nests. Expansion of nest estimation beyond the sampled area is accomplished by multiplying the nest estimate within the core breeding area by the ratio of aerially indicated pairs outside the ground sampled area to inside the ground sampled area (OUT:IN ratio, Stehn et al. 1993). This approach relies on the assumption that the pair to nest ratio and aerial detection rate is constant throughout the entire coastal zone. Current analyses of detection rate (Lewis and Schmutz *in prep*.) will address these assumptions and the results may alter historical nest abundance estimates and future analyses techniques for calculating abundance of nests on the YKD.

The number of nests should not be interpreted as direct estimates of species population size. A year with poor nesting conditions may result in fewer nesting attempts, but does not represent a loss of adults from the population. This was particularly apparent in 2001 and 2003 when nesting failures resulted in relatively low estimates of spectacled eider nests and eggs, whereas aerial surveys documented numbers of pairs close to long-term means (Swaim and Stehn *in prep.*). These results suggest that pairs were present on the breeding grounds during those years but failed to initiate nesting. Similarly, relatively few spectacled eider nests were constructed in 2011 and 2013, but spectacled eiders were seen by ground crews on 81% and 83% of plots sampled during these years, respectively. We believe the relatively low nest estimates in 2011 and 2013 were the result of either reduced breeding effort or a substantial nesting failure during early incubation prior to the initiation of field work, both representing only a temporary setback in long-term population growth.

Inter-annual variation in nest population size, as described above, highlights the importance of annual and long-term data collection. Annual changes in nest population size are less informative than long-term trends because of sampling error, distribution of plots, and small sample size for less common species. Only multiple years of consistent declines or increases will indicate a true change in the number of nests and eggs produced on the Yukon-Kuskokwim coastal zone. A primary advantage of the random nest plot sampling procedure over intensive local studies is that it assures applicability of estimates for the entire core nesting area, not just the immediate areas around biological study camps. Moreover, the single brief visit to scattered plots ensures that the monitoring of populations occurs with minimum disturbance.

<u>Summary</u>

In 2016, the estimated number of spectacled eider nests (9,464) was the second highest in the history of the survey, second only to 1987 when 9,586 nests were estimated. While the 2016 nest estimate was well above short- and long-term averages, spectacled eider nest success was poor and clutch size very low. Cackling geese and greater white-fronted geese produced high numbers of nests and eggs but nest success was fair to poor and clutch sizes low to very low. Emperor geese produced low numbers of nests and eggs, had poor nest success and very low clutch sizes. Data from the focal species sampled in this ground-based survey suggest that numbers of nests on the Yukon-Kuskokwim Delta are stable or increasing in the short-term (2007-2016) and long-term (1985-2016). No significant declines in nest population size of any species reported herein are apparent over the long-term (1985-2016). A negative trend in numbers of Pacific loon nests is apparent over the short-term (2007-2016). It appears that timing of nesting waterfowl varies with onset of spring as witnessed by relatively early nest initiation corresponding to warm spring conditions. The trend of earlier nesting activity since 1982 suggests a response to advancing dates of spring thaw.

The growth of the Yukon-Kuskokwim Delta spectacled eider subpopulation is encouraging. Based on numbers of nests, the subpopulation may meet some of the criteria for delisting from Threatened status, but analysis of aerial detection rate and a trend analysis based on detection corrected aerial estimates are still pending. We recommend a complete analysis of abundance and trend data of all three subpopulations within the next few years to determine if the species meets criteria to be considered for delisting.

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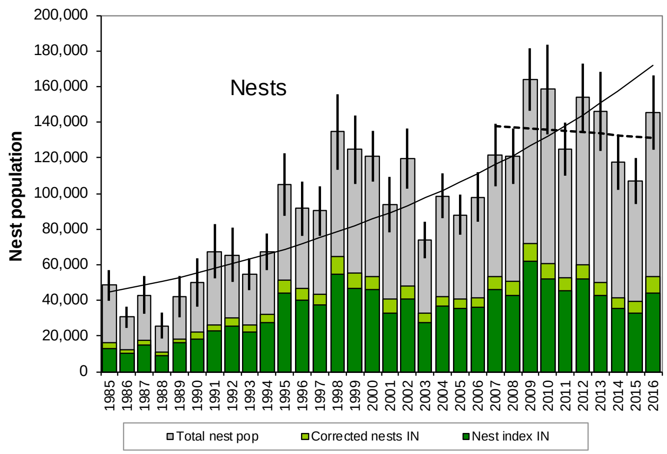
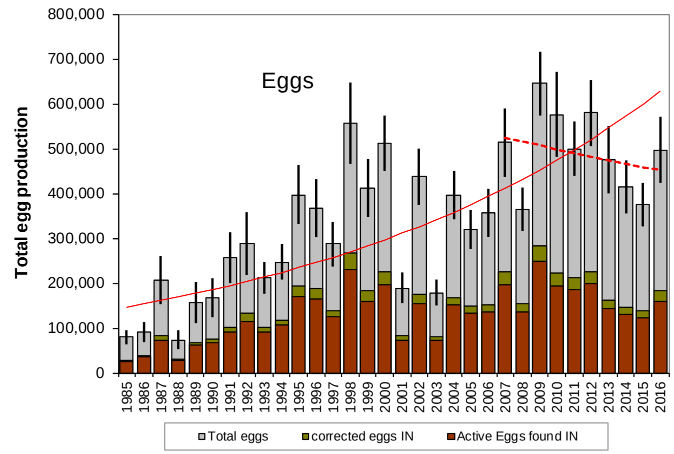
Figure 4 (Subsequent pages). Population size with ± 90% confidence intervals and trends of waterbird nests and egg production on the Yukon-Kuskokwim Delta Alaska, 1985-2016, with accompanying tabulated data. Column heading definitions follow:

Year = survey year;
N plots = number of ground sampled plots used in the analysis;
Sampled km^2 = total area searched (N plots*plot size);
Nest index IN = number of nests within the core 716 km^2 ground sampled area uncorrected for nest detection;
SE nest index IN= standard error for Nest index IN;
Avg nest detection rate = annual proportion of nests detected based on predictive model that includes the covariates of species, nest status, habitat, and observer experience;
Corrected nests IN = Nest index in ground sampled area corrected for nest detection;
Aerial OUT:IN ratio = Ratio of aerial population index estimate outside of the ground sampled area vs. within the ground sampled area
Corrected nests OUT = number of nests extrapolated beyond the ground sampled area based on the Aerial OUT:IN ratio, corrected for nest detection rate (Corrected nests IN * Aerial OUT:IN ratio);
Total nests IN+OUT = "Corrected nest IN" + "Corrected nests OUT"
SE total nests = standard error for total nest estimate;
Total eggs IN+OUT = total number of viable eggs at time of plot search in the YKD coastal zone, corrected for detection rate;
SE total eggs = standard error for total eggs IN+OUT estimate;
Total eggs/active nests = total viable eggs IN+OUT divided by the nests with eggs IN+OUT, corrected for detection rate;
Corrected % nest success index = number of active nests divided by total nests times 100%, corrected for detection rate

CCGO **Cackling Goose**



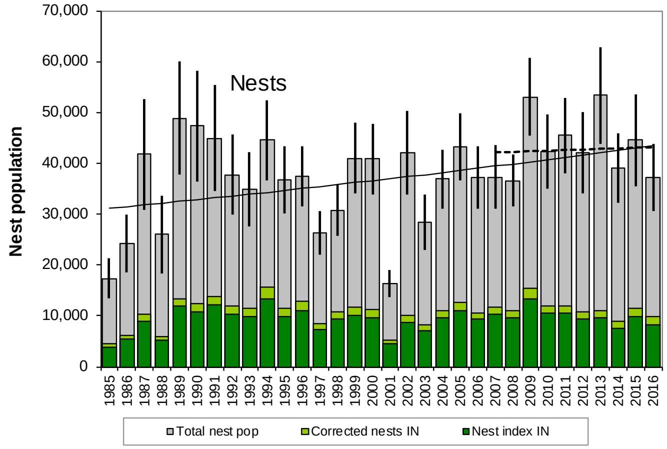
1985-2016 avg annual growth rate= 1.045 (90%c.i.= 1.036-1.054)
2007-2016 avg annual growth rate= 0.994 (90%c.i.= 0.967-1.023)

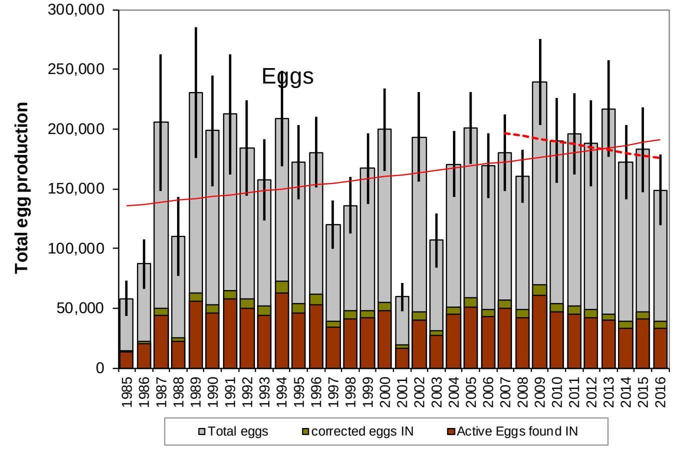


1985-2016 avg annual growth rate= 1.048 (90%c.i.= 1.035-1.061)
2007-2016 avg annual growth rate= 0.984 (90%c.i.= 0.950-1.018)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	12,788	812	79.2%	16,149	1.995	32,216	**48,365**	5,287	**79,771**	9,643	3.91	42%
1986	46	22.16	10,594	1,406	85.0%	12,467	1.444	18,002	**30,469**	3,818	**91,057**	13,116	4.89	61%
1987	37	12.67	14,909	2,693	86.1%	17,319	1.483	25,687	**43,007**	6,544	**206,640**	32,996	5.12	94%
1988	32	10.48	8,947	1,912	83.2%	10,749	1.397	15,021	**25,770**	4,315	**73,386**	12,590	4.52	63%
1989	23	7.45	16,053	3,536	87.3%	18,390	1.294	23,796	**42,185**	6,998	**156,666**	28,379	4.85	77%
1990	33	10.70	18,465	3,890	83.9%	21,997	1.264	27,815	**49,812**	8,200	**167,174**	26,847	4.55	74%
1991	36	11.66	22,840	3,763	86.5%	26,414	1.553	41,028	**67,442**	9,355	**256,599**	34,366	4.64	82%
1992	42	13.39	25,662	4,554	85.3%	30,098	1.173	35,304	**65,402**	9,342	**288,319**	42,749	4.82	91%
1993	47	15.23	22,469	2,877	85.4%	26,323	1.076	28,322	**54,646**	5,626	**211,650**	21,529	4.51	86%
1994	41	13.27	27,391	3,099	85.5%	32,051	1.090	34,928	**66,978**	6,242	**246,251**	24,019	4.58	80%
1995	50	22.56	43,839	5,413	85.9%	51,015	1.058	53,970	**104,985**	10,605	**396,791**	39,987	4.46	85%
1996	54	19.44	39,761	4,827	85.3%	46,617	0.964	44,916	**91,532**	9,373	**366,991**	39,062	4.49	89%
1997	72	23.31	37,516	4,527	86.1%	43,550	1.070	46,617	**90,167**	8,526	**287,214**	29,832	4.03	79%
1998	64	20.71	54,802	6,330	85.1%	64,403	1.088	70,076	**134,479**	12,779	**555,904**	54,837	4.47	92%
1999	53	16.97	46,698	5,561	84.1%	55,508	1.244	69,074	**124,582**	11,784	**411,500**	39,220	3.89	85%
2000	80	25.86	46,279	3,884	87.0%	53,165	1.270	67,541	**120,706**	8,677	**511,906**	37,225	4.50	94%
2001	81	26.23	32,937	3,999	80.7%	40,799	1.299	53,016	**93,815**	9,398	**188,511**	20,630	3.64	55%
2002	84	27.15	40,438	3,989	84.3%	47,948	1.492	71,518	**119,467**	10,248	**437,177**	37,942	4.42	83%
2003	83	26.87	27,323	2,905	82.6%	33,071	1.233	40,788	**73,859**	6,179	**177,886**	17,640	3.96	61%
2004	81	26.22	36,574	3,024	87.5%	41,818	1.356	56,697	**98,515**	7,627	**395,182**	32,856	4.72	85%
2005	83	26.87	35,666	3,192	87.2%	40,898	1.153	47,137	**88,035**	6,772	**319,740**	25,799	4.27	85%
2006	75	24.28	35,842	3,708	85.9%	41,706	1.348	56,209	**97,914**	8,389	**356,660**	32,362	4.43	82%
2007	79	25.58	46,112	4,684	86.2%	53,492	1.273	68,098	**121,590**	10,680	**513,382**	46,953	4.60	92%
2008	82	26.55	42,566	3,963	83.7%	50,846	1.375	69,899	**120,745**	9,473	**364,555**	30,167	4.06	74%
2009	81	26.24	62,090	4,476	86.5%	71,807	1.282	92,054	**163,860**	10,753	**644,838**	43,884	4.34	91%
2010	66	21.37	51,850	5,637	85.2%	60,861	1.602	97,493	**158,354**	15,223	**576,305**	57,226	4.21	86%
2011	82	26.55	45,690	3,602	86.5%	52,806	1.363	71,986	**124,791**	8,938	**499,323**	36,558	4.35	92%
2012	77	24.94	51,765	4,218	86.5%	59,828	1.570	93,924	**153,752**	11,650	**579,085**	44,267	4.08	92%
2013	59	19.12	42,490	3,986	84.7%	50,144	1.917	96,109	**146,253**	13,465	**474,041**	45,629	3.86	84%
2014	76	24.56	35,168	3,072	85.4%	41,174	1.854	76,340	**117,514**	9,541	**414,800**	35,980	4.25	83%
2015	71	22.95	32,967	2,671	83.4%	39,512	1.713	67,666	**107,178**	7,883	**375,440**	29,064	4.36	80%
2016	65	21.01	44,050	4,534	82.4%	53,463	1.719	91,909	**145,373**	12,733	**497,068**	45,324	4.20	81%

EMGO **Emperor Goose**



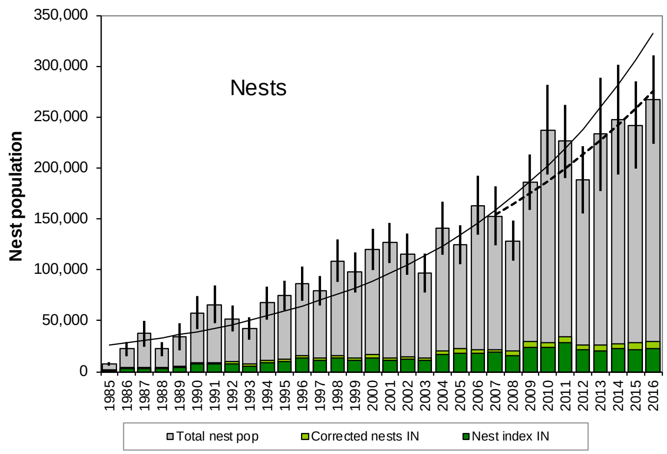


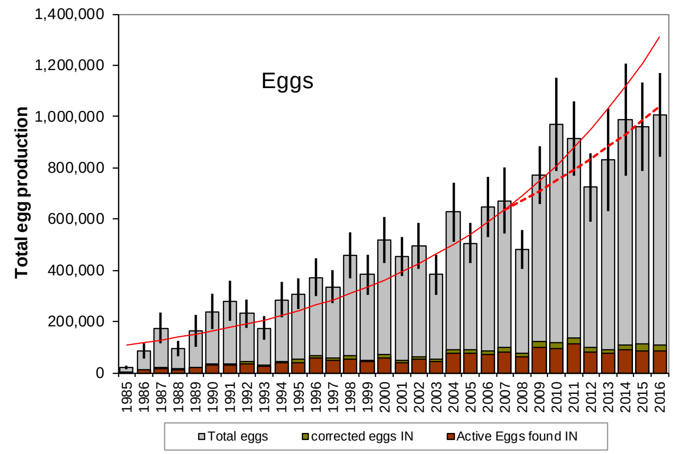
1985-2016 avg annual growth rate= 1.011 (90%c.i.= 1.002-1.019)
2007-2016 avg annual growth rate= 1.003 (90%c.i.= 0.976-1.030)

1985-2016 avg annual growth rate= 1.011 (90%c.i.= 1.000-1.022)
2007-2016 avg annual growth rate= 0.987 (90%c.i.= 0.963-1.013)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	3,816	343	86.5%	4,411	2.936	12,950	**17,361**	2,359	**58,000**	8,895	5.67	59%
1986	46	22.16	5,426	620	89.0%	6,096	2.974	18,129	**24,225**	3,387	**87,140**	12,622	4.93	73%
1987	37	12.67	8,979	1,477	87.9%	10,218	3.084	31,513	**41,731**	6,635	**205,416**	34,793	5.12	96%
1988	32	10.48	5,259	981	88.5%	5,942	3.373	20,045	**25,988**	4,650	**110,072**	20,064	4.70	90%
1989	23	7.45	11,824	1,769	88.9%	13,306	2.670	35,530	**48,836**	6,752	**230,286**	33,092	5.12	92%
1990	33	10.70	10,704	1,299	85.7%	12,490	2.789	34,836	**47,326**	6,618	**198,478**	28,050	4.91	85%
1991	36	11.66	12,157	1,812	88.4%	13,758	2.264	31,142	**44,900**	6,315	**212,362**	30,669	4.89	97%
1992	42	13.39	10,265	1,372	86.2%	11,906	2.173	25,868	**37,774**	4,743	**184,421**	24,253	5.07	96%
1993	47	15.23	9,777	1,116	84.5%	11,571	2.019	23,357	**34,928**	4,436	**157,136**	20,569	4.78	94%
1994	41	13.27	13,372	1,647	85.9%	15,561	1.865	29,020	**44,581**	4,794	**208,610**	24,345	4.99	94%
1995	50	22.56	9,738	1,127	85.5%	11,389	2.223	25,316	**36,706**	4,052	**172,136**	18,985	4.86	96%
1996	54	19.44	11,008	1,105	85.6%	12,866	1.915	24,636	**37,502**	3,571	**180,571**	18,272	5.14	94%
1997	72	23.31	7,368	736	87.1%	8,461	2.119	17,926	**26,387**	2,613	**120,153**	12,271	4.78	95%
1998	64	20.71	9,295	964	86.7%	10,719	1.874	20,086	**30,806**	3,089	**136,130**	14,211	4.64	95%
1999	53	16.97	10,166	875	86.2%	11,794	2.478	29,221	**41,015**	4,243	**166,974**	17,931	4.44	92%
2000	80	25.86	9,715	929	86.9%	11,185	2.653	29,672	**40,856**	4,200	**199,499**	20,830	4.98	98%
2001	81	26.23	4,503	478	86.4%	5,209	2.148	11,188	**16,398**	1,608	**59,479**	7,073	4.81	75%
2002	84	27.15	8,699	942	85.8%	10,142	3.145	31,898	**42,040**	4,994	**193,287**	22,998	4.98	92%
2003	83	26.87	7,057	768	84.9%	8,311	2.424	20,149	**28,461**	3,295	**106,667**	13,876	4.79	78%
2004	81	26.22	9,690	909	87.7%	11,051	2.336	25,813	**36,865**	3,521	**170,706**	16,709	4.88	95%
2005	83	26.87	10,948	812	87.0%	12,588	2.439	30,697	**43,285**	3,994	**200,858**	18,428	4.97	93%
2006	75	24.28	9,373	957	88.0%	10,648	2.500	26,624	**37,272**	3,716	**169,471**	16,445	4.78	95%
2007	79	25.58	10,241	976	87.6%	11,688	2.190	25,601	**37,288**	3,814	**179,736**	19,443	4.98	97%
2008	82	26.55	9,570	782	86.2%	11,103	2.293	25,457	**36,561**	3,092	**160,421**	13,264	4.81	91%
2009	81	26.24	13,340	1,137	86.8%	15,369	2.453	37,704	**53,073**	4,661	**239,437**	22,032	4.71	96%
2010	66	21.37	10,517	1,118	88.6%	11,873	2.555	30,340	**42,213**	4,427	**190,299**	21,493	4.62	98%
2011	82	26.55	10,459	994	87.6%	11,945	2.811	33,576	**45,521**	4,506	**195,615**	20,670	4.41	97%
2012	77	24.94	9,412	831	86.7%	10,851	2.869	31,131	**41,981**	4,859	**187,921**	21,966	4.59	98%
2013	59	19.12	9,659	828	87.9%	10,993	3.855	42,376	**53,369**	5,749	**217,082**	24,411	4.27	95%
2014	76	24.56	7,576	613	85.8%	8,832	3.419	30,199	**39,030**	4,188	**172,363**	19,039	4.71	94%
2015	71	22.95	9,918	1,249	86.0%	11,530	2.861	32,994	**44,524**	5,545	**182,909**	21,522	4.60	89%
2016	65	21.01	8,176	921	84.0%	9,737	2.822	27,475	**37,212**	4,028	**148,602**	17,993	4.60	87%

WFGO **White-fronted Goose**



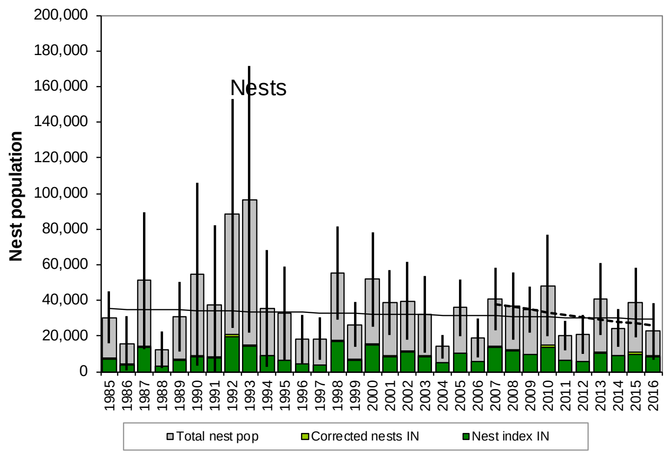


1985-2016 avg annual growth rate= 1.086 (90%c.i.= 1.075-1.097)
2007-2016 avg annual growth rate= 1.067 (90%c.i.= 1.040-1.094)

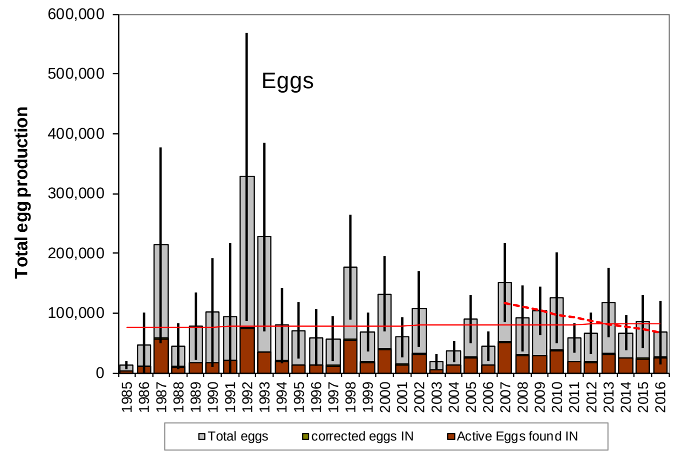
1985-2016 avg annual growth rate= 1.084 (90%c.i.= 1.070-1.097)
2007-2016 avg annual growth rate= 1.056 (90%c.i.= 1.024-1.090)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	1,078	128	81.0%	1,331	4.522	6,019	**7,350**	1,270	**21,715**	4,047	4.20	70%
1986	46	22.16	2,907	463	83.2%	3,493	5.376	18,778	**22,270**	4,424	**86,685**	18,096	4.37	89%
1987	37	12.67	3,275	629	81.4%	4,026	8.226	33,116	**37,141**	7,964	**174,833**	36,910	4.90	96%
1988	32	10.48	2,937	576	83.7%	3,509	5.282	18,533	**22,043**	4,336	**94,499**	18,749	4.40	98%
1989	23	7.45	4,037	1,004	84.9%	4,753	6.208	29,507	**34,260**	8,285	**162,572**	37,428	5.01	95%
1990	33	10.70	7,025	1,108	81.0%	8,674	5.679	49,263	**57,938**	10,084	**239,146**	42,114	4.45	93%
1991	36	11.66	7,184	1,009	86.1%	8,345	6.865	57,291	**65,636**	11,235	**280,870**	47,911	4.53	94%
1992	42	13.39	8,019	1,001	82.6%	9,710	4.362	42,355	**52,065**	7,609	**230,387**	34,443	4.52	98%
1993	47	15.23	5,641	853	80.4%	7,015	4.997	35,050	**42,064**	6,757	**174,546**	27,384	4.27	97%
1994	41	13.27	8,789	1,097	81.3%	10,813	5.228	56,528	**67,341**	9,708	**284,768**	41,410	4.34	97%
1995	50	22.56	9,992	1,093	81.0%	12,340	5.074	62,613	**74,953**	8,961	**308,174**	37,373	4.26	97%
1996	54	19.44	12,849	1,303	82.6%	15,558	4.534	70,547	**86,105**	10,025	**372,290**	43,969	4.49	96%
1997	72	23.31	11,298	1,145	81.7%	13,823	4.772	65,961	**79,783**	8,786	**335,254**	38,736	4.28	98%
1998	64	20.71	12,785	1,320	81.7%	15,657	5.956	93,249	**108,906**	12,884	**459,372**	55,005	4.33	97%
1999	53	16.97	10,588	1,157	82.4%	12,853	6.597	84,788	**97,641**	12,114	**382,657**	47,809	4.17	94%
2000	80	25.86	13,646	1,258	82.9%	16,461	6.285	103,457	**119,918**	12,431	**518,199**	55,012	4.45	97%
2001	81	26.23	11,407	935	82.8%	13,775	8.172	112,578	**126,353**	12,226	**453,365**	47,101	3.86	93%
2002	84	27.15	11,994	1,001	81.6%	14,694	6.825	100,280	**114,974**	12,303	**493,098**	54,715	4.39	98%
2003	83	26.87	11,265	1,151	81.8%	13,773	5.992	82,532	**96,305**	11,588	**384,189**	47,536	4.25	94%
2004	81	26.22	17,059	1,465	82.7%	20,638	5.840	120,536	**141,174**	15,943	**626,956**	70,447	4.59	97%
2005	83	26.87	18,432	1,472	82.2%	22,421	4.571	102,491	**124,912**	11,767	**505,765**	48,443	4.24	96%
2006	75	24.28	17,685	1,571	82.1%	21,537	6.585	141,827	**163,363**	17,922	**647,317**	71,213	4.15	96%
2007	79	25.58	18,579	1,518	84.4%	22,017	5.940	130,768	**152,785**	17,532	**671,280**	77,831	4.47	98%
2008	82	26.55	16,175	1,124	80.8%	20,010	5.415	108,360	**128,370**	11,902	**480,801**	45,934	4.05	92%
2009	81	26.24	24,252	1,481	82.7%	29,327	5.351	156,944	**186,271**	16,514	**770,036**	69,065	4.30	96%
2010	66	21.37	23,614	1,738	83.2%	28,397	7.366	209,164	**237,561**	26,608	**969,369**	109,908	4.19	97%
2011	82	26.55	28,169	1,575	83.5%	33,736	5.707	192,520	**226,256**	21,664	**913,009**	88,336	4.10	98%
2012	77	24.94	21,005	1,794	82.3%	25,518	6.371	162,584	**188,102**	20,284	**723,455**	80,323	3.99	96%
2013	59	19.12	20,665	2,137	80.6%	25,637	8.091	207,438	**233,074**	33,771	**830,928**	121,066	3.76	95%
2014	76	24.56	22,290	1,552	80.8%	27,573	7.964	219,602	**247,175**	32,670	**988,509**	132,076	4.21	95%
2015	71	22.95	21,801	1,493	77.3%	28,205	7.579	213,770	**241,975**	26,004	**960,246**	103,997	4.16	95%
2016	65	21.01	22,383	1,820	77.1%	29,048	8.213	238,580	**267,629**	26,414	**1,005,755**	99,816	4.01	94%

BLBR **Black Brant**



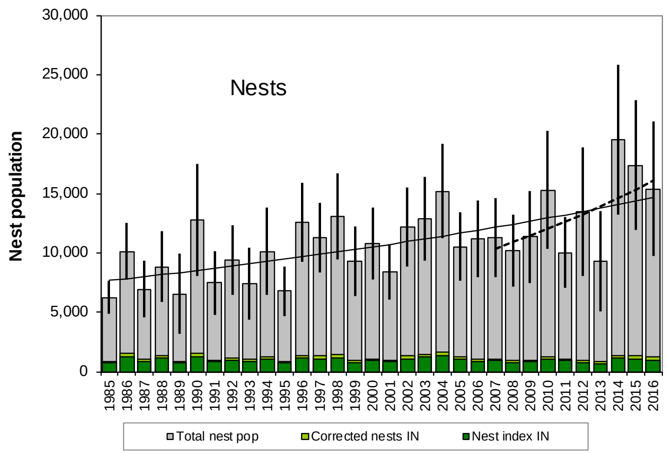
1985-2016 avg annual growth rate= 0.994 (90%c.i.= 0.979-1.010)
2007-2016 avg annual growth rate= 0.958 (90%c.i.= 0.905-1.014)

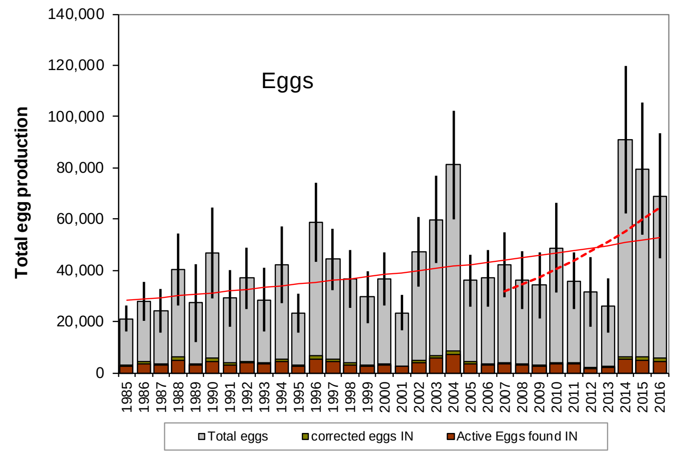


1985-2016 avg annual growth rate= 1.002 (90%c.i.= 0.981-1.024)
2007-2016 avg annual growth rate= 0.941 (90%c.i.= 0.895-0.990)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	7,107	1,285	92.6%	7,675	2.959	22,710	**30,385**	8,767	**12,698**	3,991	3.09	14%
1986	46	22.16	3,844	2,304	95.7%	4,017	2.900	11,652	**15,669**	9,276	**46,086**	33,315	3.99	74%
1987	37	12.67	13,497	6,158	95.6%	14,117	2.614	36,895	**51,012**	23,528	**213,772**	99,671	4.26	98%
1988	32	10.48	2,732	1,554	95.9%	2,848	3.363	9,577	**12,425**	6,190	**44,237**	23,815	3.98	89%
1989	23	7.45	6,537	2,701	94.8%	6,893	3.436	23,685	**30,578**	11,862	**78,403**	34,288	3.49	73%
1990	33	10.70	8,563	4,710	94.7%	9,047	5.056	45,745	**54,792**	31,279	**100,888**	55,075	3.15	58%
1991	36	11.66	7,859	6,513	94.3%	8,335	3.476	28,972	**37,306**	27,386	**94,736**	73,994	3.66	69%
1992	42	13.39	19,835	9,859	95.6%	20,742	3.278	67,992	**88,734**	38,936	**327,700**	146,550	3.87	95%
1993	47	15.23	14,196	6,832	95.7%	14,838	5.515	81,829	**96,668**	45,531	**227,141**	95,855	3.23	73%
1994	41	13.27	8,681	5,693	96.0%	9,047	2.920	26,414	**35,461**	19,750	**79,508**	38,549	2.42	93%
1995	50	22.56	6,186	3,119	96.5%	6,410	4.139	26,528	**32,937**	15,875	**70,389**	28,704	2.98	72%
1996	54	19.44	4,050	2,022	95.6%	4,235	3.293	13,947	**18,182**	8,144	**58,919**	28,632	3.75	87%
1997	72	23.31	3,807	1,423	96.7%	3,938	3.690	14,532	**18,470**	7,182	**57,157**	23,004	3.32	93%
1998	64	20.71	16,862	5,452	95.3%	17,702	2.120	37,523	**55,226**	16,033	**175,831**	53,390	3.67	87%
1999	53	16.97	6,581	2,064	94.1%	6,991	2.776	19,405	**26,396**	7,560	**67,315**	19,900	3.16	81%
2000	80	25.86	15,140	5,069	96.6%	15,679	2.299	36,044	**51,723**	16,134	**131,782**	38,190	2.87	89%
2001	81	26.23	8,487	2,391	92.7%	9,156	3.241	29,677	**38,833**	11,191	**59,386**	20,271	2.95	52%
2002	84	27.15	11,177	4,344	94.8%	11,792	2.344	27,640	**39,431**	13,296	**107,264**	38,318	3.12	87%
2003	83	26.87	8,229	4,048	94.1%	8,741	2.680	23,422	**32,163**	13,153	**18,787**	7,291	1.25	47%
2004	81	26.22	4,968	1,710	95.7%	5,192	1.695	8,801	**13,993**	4,111	**35,552**	11,191	3.28	77%
2005	83	26.87	10,015	2,732	96.4%	10,385	2.444	25,380	**35,765**	9,795	**89,973**	24,835	3.02	83%
2006	75	24.28	5,541	1,993	95.4%	5,810	2.231	12,963	**18,773**	6,580	**44,475**	15,437	3.44	69%
2007	79	25.58	13,711	4,083	96.5%	14,214	1.853	26,344	**40,557**	10,680	**150,990**	40,220	3.94	95%
2008	82	26.55	11,619	4,337	95.5%	12,169	2.028	24,674	**36,843**	11,336	**91,232**	33,649	3.20	77%
2009	81	26.24	9,384	2,276	96.1%	9,769	2.543	24,843	**34,612**	7,932	**103,587**	24,886	3.56	84%
2010	66	21.37	13,833	5,850	94.6%	14,618	2.299	33,602	**48,219**	17,433	**125,336**	46,374	3.29	79%
2011	82	26.55	6,038	1,550	95.7%	6,307	2.156	13,598	**19,906**	5,022	**58,412**	14,608	3.72	79%
2012	77	24.94	5,395	1,693	96.6%	5,583	2.727	15,223	**20,806**	6,553	**66,704**	20,880	3.66	88%
2013	59	19.12	10,445	2,799	95.6%	10,923	2.724	29,755	**40,678**	12,220	**117,793**	35,461	3.53	82%
2014	76	24.56	8,770	2,102	95.7%	9,163	1.656	15,169	**24,332**	6,425	**66,912**	18,333	3.44	80%
2015	71	22.95	9,918	3,306	92.1%	10,768	2.591	27,902	**38,670**	11,743	**85,383**	26,873	3.36	66%
2016	65	21.01	8,108	4,442	93.6%	8,660	1.619	14,017	**22,677**	9,650	**67,443**	32,504	3.51	85%

TUSW Tundra Swan



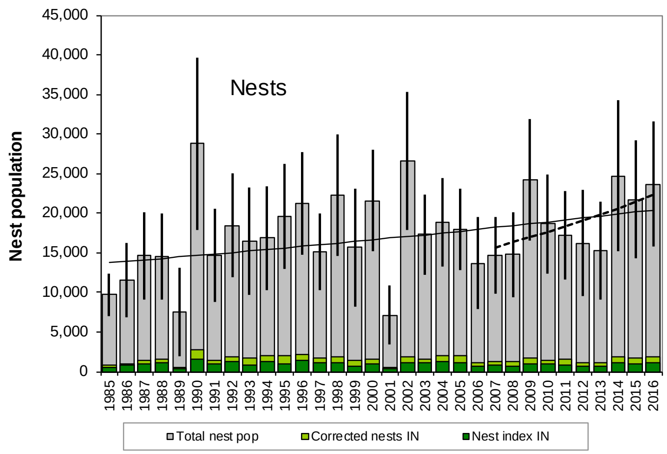


1985-2016 avg annual growth rate= 1.021 (90%c.i.= 1.014-1.028)
2007-2016 avg annual growth rate= 1.050 (90%c.i.= 1.009-1.093)

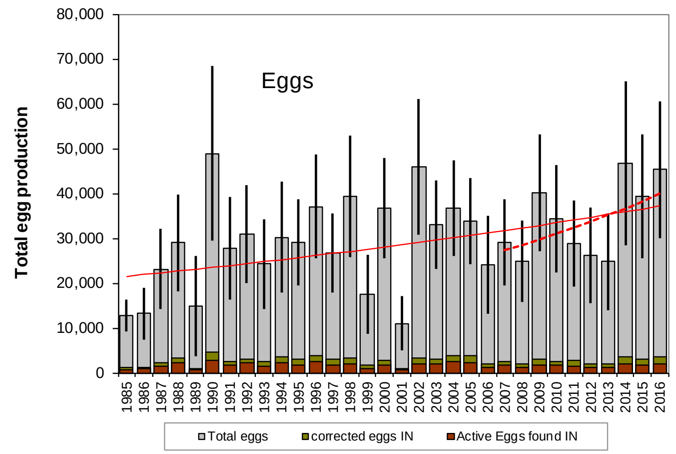
1985-2016 avg annual growth rate= 1.020 (90%c.i.= 1.010-1.031)
2007-2016 avg annual growth rate= 1.081 (90%c.i.= 1.011-1.157)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	699	60	81.0%	863	6.234	5,378	**6,240**	837	**21,172**	2,977	3.93	86%
1986	46	22.16	1,227	166	80.4%	1,527	5.632	8,600	**10,126**	1,438	**27,865**	4,616	3.21	86%
1987	37	12.67	847	189	82.5%	1,027	5.753	5,909	**6,936**	1,454	**24,255**	5,115	3.50	100%
1988	32	10.48	1,093	237	78.7%	1,388	5.347	7,419	**8,807**	1,817	**40,224**	8,528	4.57	100%
1989	23	7.45	769	263	88.5%	869	6.533	5,679	**6,549**	2,058	**27,205**	9,158	4.15	100%
1990	33	10.70	1,204	288	76.3%	1,579	7.070	11,165	**12,744**	2,862	**46,708**	10,807	3.92	93%
1991	36	11.66	798	178	81.8%	976	6.664	6,505	**7,482**	1,638	**29,087**	6,766	4.25	92%
1992	42	13.39	962	174	83.5%	1,152	7.137	8,224	**9,376**	1,793	**37,039**	7,262	3.95	100%
1993	47	15.23	846	226	79.6%	1,063	5.947	6,319	**7,381**	1,827	**28,480**	7,483	4.07	95%
1994	41	13.27	1,024	231	82.8%	1,237	7.178	8,878	**10,115**	2,220	**42,121**	9,092	4.16	100%
1995	50	22.56	730	135	82.1%	889	6.609	5,874	**6,763**	1,260	**23,291**	4,539	3.79	91%
1996	54	19.44	1,141	177	82.2%	1,389	8.039	11,162	**12,550**	2,035	**58,878**	9,337	4.89	96%
1997	72	23.31	1,074	155	81.0%	1,326	7.491	9,932	**11,258**	1,774	**44,295**	7,222	4.20	94%
1998	64	20.71	1,140	182	81.7%	1,396	8.371	11,688	**13,084**	2,214	**36,552**	6,880	3.10	90%
1999	53	16.97	759	145	82.2%	924	9.041	8,353	**9,276**	1,769	**29,530**	6,259	3.63	88%
2000	80	25.86	913	153	84.2%	1,085	8.938	9,696	**10,781**	1,835	**36,438**	6,329	3.62	93%
2001	81	26.23	819	134	83.1%	986	7.536	7,427	**8,413**	1,435	**23,360**	4,155	3.38	82%
2002	84	27.15	1,054	166	80.9%	1,303	8.330	10,857	**12,160**	2,009	**47,119**	8,296	4.35	89%
2003	83	26.87	1,198	187	82.7%	1,449	7.876	11,408	**12,857**	2,158	**59,861**	10,226	4.79	97%
2004	81	26.22	1,337	189	83.2%	1,608	8.427	13,549	**15,157**	2,416	**81,222**	12,844	5.48	98%
2005	83	26.87	1,039	150	82.5%	1,259	7.345	9,247	**10,506**	1,745	**35,978**	6,102	3.63	94%
2006	75	24.28	884	143	83.3%	1,062	9.546	10,136	**11,198**	1,973	**36,857**	6,680	3.54	93%
2007	79	25.58	895	154	83.6%	1,071	9.526	10,205	**11,276**	2,017	**42,169**	7,792	3.87	97%
2008	82	26.55	782	127	83.3%	939	9.844	9,242	**10,180**	1,818	**36,128**	6,962	3.85	92%
2009	81	26.24	818	155	84.3%	971	10.668	10,360	**11,331**	2,338	**34,102**	7,910	3.40	88%
2010	66	21.37	1,038	201	83.5%	1,244	11.293	14,046	**15,290**	3,021	**48,800**	10,717	3.87	83%
2011	82	26.55	917	159	84.4%	1,086	8.231	8,939	**10,026**	1,816	**35,867**	6,822	3.81	94%
2012	77	24.94	717	158	77.6%	924	13.553	12,522	**13,446**	3,288	**31,543**	8,302	3.05	77%
2013	59	19.12	636	140	73.3%	868	9.703	8,421	**9,289**	2,554	**26,159**	6,412	3.59	78%
2014	76	24.56	1,107	180	83.2%	1,331	13.667	18,186	**19,516**	3,862	**91,068**	17,446	5.01	93%
2015	71	22.95	1,092	190	78.9%	1,384	11.558	15,995	**17,378**	3,326	**79,635**	15,677	4.58	100%
2016	65	21.01	954	172	77.0%	1,238	11.423	14,146	**15,385**	3,421	**68,891**	14,831	4.81	93%

SACR Sandhill Crane



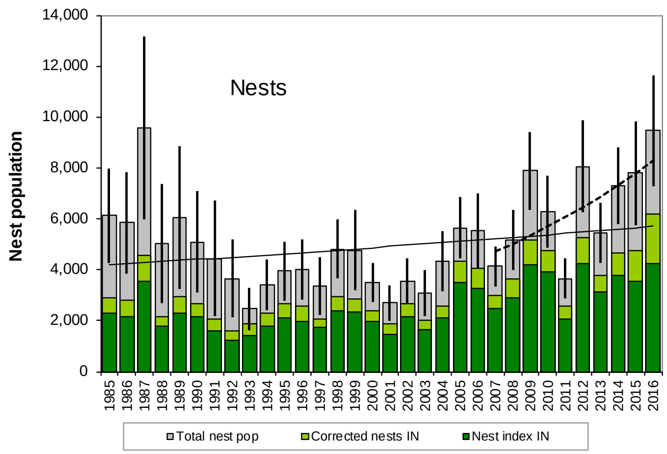
1985-2016 avg annual growth rate= 1.013 (90%c.i.= 1.003-1.023)
2007-2016 avg annual growth rate= 1.040 (90%c.i.= 1.005-1.076)



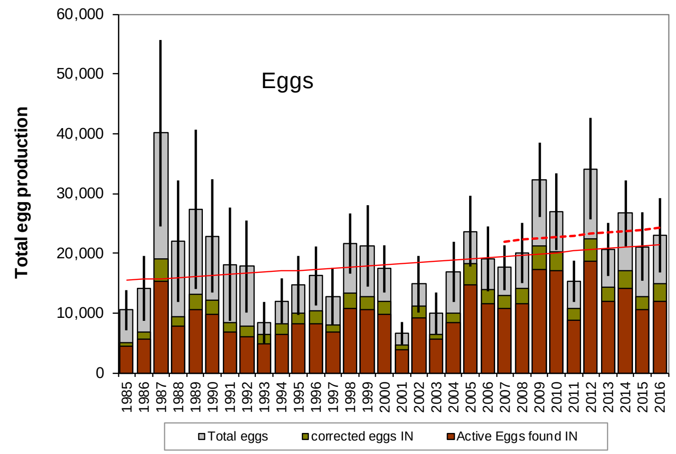
1985-2016 avg annual growth rate= 1.018 (90%c.i.= 1.007-1.029)
2007-2016 avg annual growth rate= 1.043 (90%c.i.= 1.002-1.086)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	553	72	63.3%	875	10.097	8,833	**9,708**	1,640	**12,726**	2,178	1.63	80%
1986	46	22.16	775	188	74.5%	1,040	10.097	10,503	**11,543**	2,864	**13,277**	3,526	1.48	78%
1987	37	12.67	904	192	62.8%	1,439	9.155	13,172	**14,610**	3,368	**23,060**	5,430	1.58	100%
1988	32	10.48	1,093	220	67.2%	1,627	7.901	12,855	**14,482**	3,296	**28,965**	6,592	2.14	94%
1989	23	7.45	385	178	73.2%	526	13.234	6,955	**7,481**	3,391	**14,962**	6,781	2.00	100%
1990	33	10.70	1,606	305	59.5%	2,696	9.673	26,080	**28,777**	6,605	**48,875**	11,873	1.79	95%
1991	36	11.66	982	222	72.8%	1,350	9.846	13,295	**14,645**	3,579	**27,740**	7,024	1.89	100%
1992	42	13.39	1,283	267	68.2%	1,881	8.818	16,587	**18,468**	3,984	**30,904**	6,654	1.75	96%
1993	47	15.23	893	227	51.8%	1,723	8.569	14,766	**16,489**	4,137	**24,218**	6,012	1.67	88%
1994	41	13.27	1,240	254	62.0%	2,001	7.422	14,854	**16,855**	3,986	**30,240**	7,508	1.79	100%
1995	50	22.56	983	154	49.1%	2,003	8.768	17,560	**19,562**	4,055	**28,993**	5,850	1.92	77%
1996	54	19.44	1,362	213	62.2%	2,191	8.705	19,074	**21,265**	3,947	**37,096**	7,028	1.88	93%
1997	72	23.31	1,044	187	59.8%	1,746	7.671	13,394	**15,140**	2,923	**26,731**	5,403	1.77	100%
1998	64	20.71	1,071	175	58.2%	1,839	11.096	20,407	**22,246**	4,676	**39,392**	8,214	1.77	100%
1999	53	16.97	633	162	44.7%	1,416	10.069	14,256	**15,672**	4,503	**17,485**	5,420	1.69	66%
2000	80	25.86	969	139	62.0%	1,563	12.791	19,991	**21,554**	3,898	**36,639**	6,767	1.84	92%
2001	81	26.23	355	111	65.4%	542	12.172	6,599	**7,141**	2,235	**10,937**	3,674	1.70	90%
2002	84	27.15	1,054	149	54.6%	1,933	12.754	24,648	**26,581**	5,324	**45,911**	9,164	2.00	86%
2003	83	26.87	1,092	155	67.9%	1,608	9.759	15,690	**17,298**	3,084	**33,073**	6,033	1.96	97%
2004	81	26.22	1,256	161	62.7%	2,003	8.416	16,856	**18,859**	3,377	**36,623**	6,491	1.94	100%
2005	83	26.87	1,145	164	58.4%	1,962	8.123	15,940	**17,902**	3,115	**33,814**	5,849	1.89	100%
2006	75	24.28	648	141	61.6%	1,052	12.023	12,646	**13,697**	3,523	**24,119**	6,604	1.76	100%
2007	79	25.58	811	147	66.8%	1,215	11.117	13,510	**14,725**	2,938	**28,983**	5,826	1.97	100%
2008	82	26.55	728	136	60.7%	1,199	11.303	13,554	**14,753**	3,260	**24,879**	5,539	1.76	96%
2009	81	26.24	1,009	143	57.0%	1,771	12.639	22,378	**24,149**	4,671	**40,043**	7,940	1.85	89%
2010	66	21.37	971	157	68.3%	1,423	12.104	17,223	**18,646**	3,822	**34,327**	7,217	1.93	95%
2011	82	26.55	890	145	55.3%	1,609	9.660	15,540	**17,149**	3,401	**28,724**	5,832	1.80	93%
2012	77	24.94	660	127	56.9%	1,159	13.009	15,080	**16,239**	4,035	**26,171**	6,438	1.88	86%
2013	59	19.12	711	144	59.7%	1,192	11.762	14,016	**15,207**	3,764	**24,807**	6,583	1.74	94%
2014	76	24.56	1,078	155	57.1%	1,889	12.081	22,823	**24,712**	5,792	**46,671**	11,145	2.00	94%
2015	71	22.95	967	168	55.7%	1,737	11.493	19,967	**21,705**	4,543	**39,324**	8,363	1.81	100%
2016	65	21.01	1,056	173	57.9%	1,825	11.977	21,859	**23,684**	4,761	**45,294**	9,339	1.91	100%

SPEI Spectacled Eider



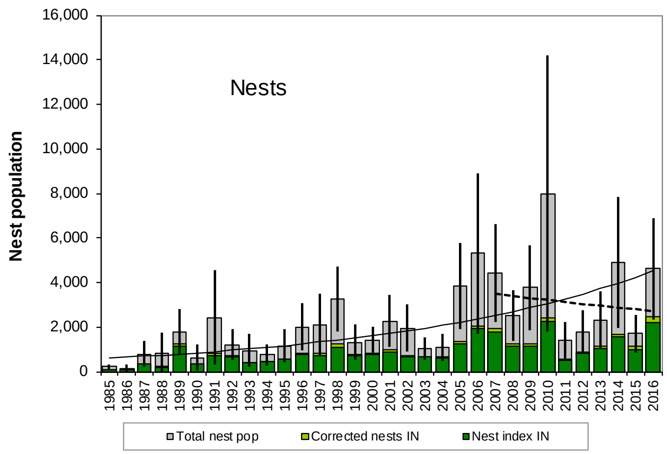
1985-2016 avg annual growth rate= 1.010 (90%c.i.= 0.999-1.021)
2007-2016 avg annual growth rate= 1.064 (90%c.i.= 1.015-1.116)



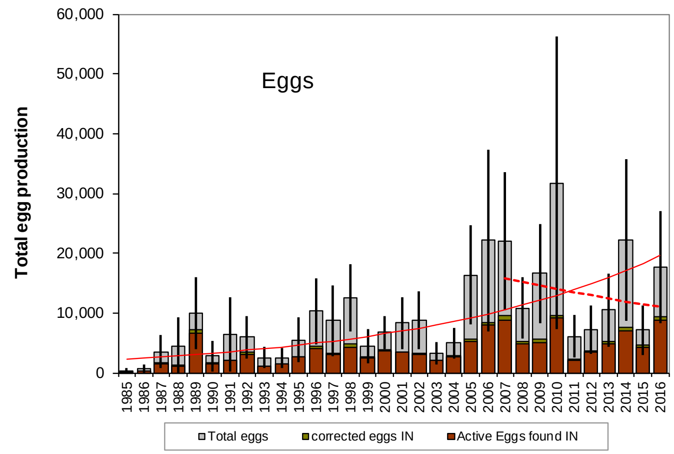
1985-2016 avg annual growth rate= 1.011 (90%c.i.= 0.998-1.023)
2007-2016 avg annual growth rate= 1.011 (90%c.i.= 0.963-1.061)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	2,272	245	77.8%	2,919	1.099	3,207	**6,126**	1,128	**10,482**	2,029	3.84	45%
1986	46	22.16	2,164	366	77.7%	2,786	1.099	3,060	**5,846**	1,212	**14,146**	3,291	4.40	55%
1987	37	12.67	3,558	758	77.9%	4,568	1.099	5,018	**9,586**	2,182	**40,082**	9,499	5.06	83%
1988	32	10.48	1,776	484	82.0%	2,166	1.325	2,871	**5,037**	1,417	**22,026**	6,159	4.81	91%
1989	23	7.45	2,307	751	78.8%	2,927	1.074	3,144	**6,071**	1,704	**27,380**	8,124	4.99	90%
1990	33	10.70	2,141	552	79.6%	2,689	0.896	2,410	**5,098**	1,201	**22,863**	5,756	5.03	89%
1991	36	11.66	1,596	491	76.9%	2,075	1.141	2,368	**4,443**	1,381	**18,150**	5,803	5.27	77%
1992	42	13.39	1,230	308	77.5%	1,587	1.307	2,075	**3,662**	932	**17,820**	4,681	5.43	90%
1993	47	15.23	1,410	348	75.3%	1,874	0.317	593	**2,467**	510	**8,430**	2,070	4.27	80%
1994	41	13.27	1,779	344	77.4%	2,300	0.483	1,110	**3,410**	598	**12,017**	2,246	4.65	76%
1995	50	22.56	2,094	417	78.0%	2,684	0.468	1,257	**3,941**	714	**14,667**	2,991	4.88	76%
1996	54	19.44	1,988	377	77.3%	2,573	0.563	1,447	**4,020**	711	**16,213**	3,013	5.06	80%
1997	72	23.31	1,719	404	82.7%	2,079	0.612	1,273	**3,353**	692	**12,791**	2,895	4.38	87%
1998	64	20.71	2,384	374	80.6%	2,956	0.629	1,858	**4,815**	699	**21,548**	3,053	4.87	92%
1999	53	16.97	2,320	532	81.0%	2,864	0.665	1,905	**4,769**	951	**21,306**	4,144	4.96	90%
2000	80	25.86	1,965	295	82.0%	2,398	0.465	1,114	**3,512**	469	**17,382**	2,407	5.34	93%
2001	81	26.23	1,474	275	78.7%	1,873	0.440	824	**2,698**	425	**6,609**	1,134	4.18	59%
2002	84	27.15	2,135	407	80.1%	2,664	0.326	868	**3,532**	547	**14,872**	2,883	5.26	80%
2003	83	26.87	1,651	350	82.7%	1,998	0.540	1,079	**3,077**	543	**9,956**	2,082	4.41	73%
2004	81	26.22	2,102	387	81.1%	2,590	0.679	1,758	**4,349**	723	**16,796**	3,051	4.97	78%
2005	83	26.87	3,489	538	80.3%	4,346	0.301	1,308	**5,654**	743	**23,682**	3,584	4.69	89%
2006	75	24.28	3,272	641	80.6%	4,061	0.366	1,485	**5,545**	889	**19,059**	3,252	4.50	76%
2007	79	25.58	2,490	340	82.7%	3,013	0.373	1,124	**4,136**	485	**17,640**	2,275	5.06	84%
2008	82	26.55	2,911	482	79.5%	3,662	0.412	1,509	**5,170**	715	**20,017**	3,089	5.04	77%
2009	81	26.24	4,201	576	81.2%	5,176	0.523	2,707	**7,883**	928	**32,227**	3,752	4.50	91%
2010	66	21.37	3,919	646	82.8%	4,735	0.327	1,547	**6,282**	863	**26,946**	3,883	4.98	86%
2011	82	26.55	2,076	329	81.0%	2,562	0.427	1,094	**3,655**	486	**15,376**	2,102	4.77	88%
2012	77	24.94	4,247	757	80.5%	5,278	0.527	2,783	**8,062**	1,110	**34,111**	5,174	4.98	85%
2013	59	19.12	3,107	489	82.3%	3,775	0.440	1,660	**5,435**	713	**20,598**	2,741	4.91	77%
2014	76	24.56	3,788	553	81.4%	4,655	0.571	2,657	**7,312**	915	**26,729**	3,358	4.46	82%
2015	71	22.95	3,524	545	74.4%	4,740	0.644	3,052	**7,792**	1,236	**21,066**	3,455	4.32	63%
2016	65	21.01	4,258	754	68.9%	6,179	0.532	3,286	**9,464**	1,318	**22,927**	3,763	4.38	55%

COEI Common Eider



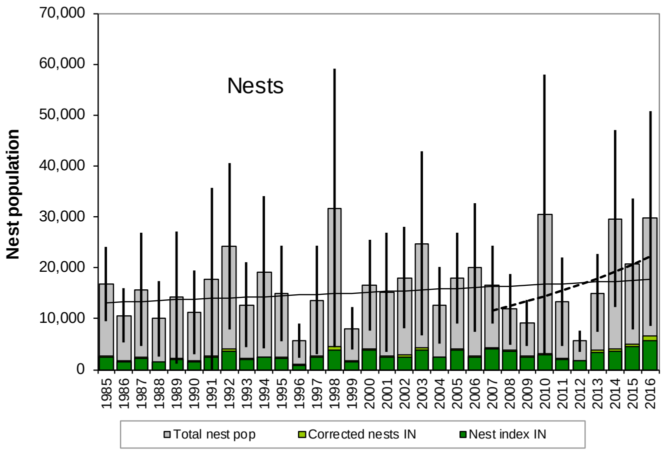
1985-2016 avg annual growth rate= 1.067 (90%c.i.= 1.046-1.088)
2007-2016 avg annual growth rate= 0.973 (90%c.i.= 0.875-1.083)

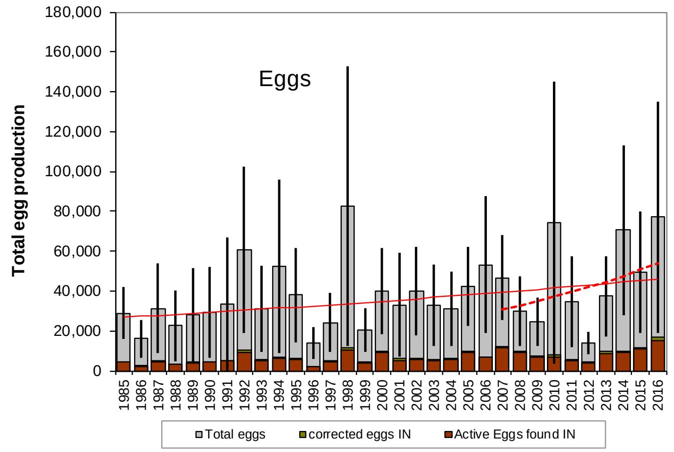


1985-2016 avg annual growth rate= 1.071 (90%c.i.= 1.048-1.096)
2007-2016 avg annual growth rate= 0.961 (90%c.i.= 0.864-1.068)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	87	24	90.2%	97	1.187	115	**212**	75	**390**	184	6.00	31%
1986	46	22.16	65	45	94.2%	69	1.187	81	**150**	91	**678**	413	4.52	100%
1987	37	12.67	339	152	94.7%	358	1.187	425	**782**	349	**3,501**	1,657	5.41	83%
1988	32	10.48	205	150	86.3%	237	2.442	580	**817**	576	**4,373**	3,033	5.35	100%
1989	23	7.45	1,154	456	91.9%	1,256	0.402	504	**1,760**	622	**10,001**	3,631	5.68	100%
1990	33	10.70	335	216	91.2%	367	0.717	263	**630**	348	**2,838**	1,566	4.50	100%
1991	36	11.66	737	381	90.6%	814	1.989	1,618	**2,432**	1,288	**6,415**	3,768	4.76	55%
1992	42	13.39	642	254	91.9%	698	0.742	518	**1,217**	416	**5,959**	2,157	5.38	91%
1993	47	15.23	376	203	89.5%	420	1.258	529	**949**	448	**2,526**	1,086	4.43	60%
1994	41	13.27	431	205	92.7%	465	0.635	296	**761**	291	**2,453**	988	3.73	86%
1995	50	22.56	539	247	95.1%	567	1.047	594	**1,161**	449	**5,508**	2,287	5.08	93%
1996	54	19.44	773	271	91.4%	846	1.375	1,164	**2,010**	656	**10,354**	3,360	5.44	95%
1997	72	23.31	737	285	92.1%	800	1.641	1,312	**2,112**	842	**8,719**	3,574	4.53	91%
1998	64	20.71	1,106	299	87.7%	1,261	1.590	2,005	**3,266**	887	**12,506**	3,405	5.01	76%
1999	53	16.97	717	296	91.7%	782	0.690	539	**1,321**	481	**4,432**	1,723	4.47	75%
2000	80	25.86	775	212	92.6%	837	0.705	590	**1,427**	368	**6,712**	1,715	4.90	96%
2001	81	26.23	900	292	93.6%	962	1.352	1,300	**2,262**	704	**8,317**	2,627	4.10	90%
2002	84	27.15	685	191	92.6%	740	1.625	1,203	**1,943**	640	**8,800**	2,957	4.72	96%
2003	83	26.87	639	225	92.9%	688	0.512	352	**1,040**	307	**3,256**	1,141	4.28	73%
2004	81	26.22	600	212	94.3%	637	0.699	445	**1,082**	359	**4,940**	1,602	4.80	95%
2005	83	26.87	1,225	298	92.4%	1,325	1.893	2,509	**3,835**	1,177	**16,331**	5,050	4.93	86%
2006	75	24.28	1,916	751	94.4%	2,030	1.610	3,268	**5,298**	2,182	**22,107**	9,269	4.81	87%
2007	79	25.58	1,763	540	90.5%	1,948	1.281	2,496	**4,444**	1,338	**22,016**	7,018	5.22	95%
2008	82	26.55	1,132	329	91.9%	1,232	1.032	1,271	**2,504**	693	**10,787**	3,135	4.82	89%
2009	81	26.24	1,146	295	90.5%	1,266	1.979	2,506	**3,772**	1,162	**16,601**	5,040	4.91	90%
2010	66	21.37	2,278	976	93.8%	2,428	2.290	5,560	**7,988**	3,767	**31,729**	14,878	4.86	82%
2011	82	26.55	485	146	90.5%	536	1.640	880	**1,416**	499	**6,087**	2,183	4.89	88%
2012	77	24.94	832	316	92.6%	898	0.990	889	**1,788**	586	**7,213**	2,406	4.59	88%
2013	59	19.12	1,048	409	90.4%	1,159	1.002	1,162	**2,321**	777	**10,468**	3,723	4.90	92%
2014	76	24.56	1,544	395	91.2%	1,693	1.894	3,207	**4,900**	1,785	**22,164**	8,244	4.82	94%
2015	71	22.95	998	385	88.9%	1,123	0.521	585	**1,708**	516	**7,127**	2,526	4.95	84%
2016	65	21.01	2,214	779	89.6%	2,473	0.868	2,147	**4,620**	1,384	**17,639**	5,718	4.48	85%

GLGU Glaucous Gull



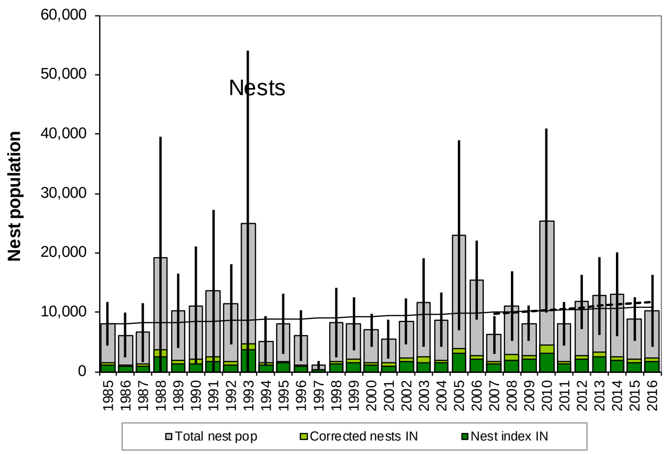


1985-2016 avg annual growth rate= 1.010 (90%c.i.= 0.996-1.023)
2007-2016 avg annual growth rate= 1.076 (90%c.i.= 0.975-1.187)

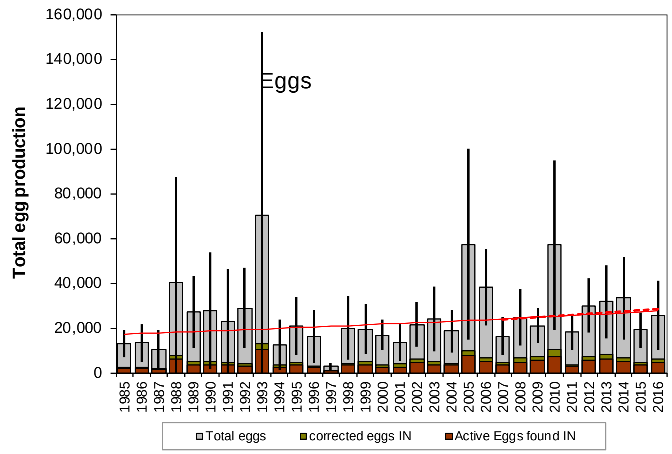
1985-2016 avg annual growth rate= 1.018 (90%c.i.= 1.004-1.032)
2007-2016 avg annual growth rate= 1.065 (90%c.i.= 0.965-1.174)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	2,330	244	88.8%	2,625	5.408	14,197	**16,822**	4,411	**28,993**	7,804	2.08	83%
1986	46	22.16	1,486	316	89.3%	1,663	5.408	8,997	**10,660**	3,283	**16,144**	5,774	2.15	70%
1987	37	12.67	2,089	766	85.0%	2,457	5.408	13,289	**15,746**	6,755	**31,296**	13,700	2.15	93%
1988	32	10.48	1,434	622	92.2%	1,556	5.408	8,415	**9,971**	4,561	**22,589**	10,721	2.53	89%
1989	23	7.45	2,019	1,106	91.4%	2,208	5.408	11,940	**14,148**	7,901	**27,994**	14,398	2.27	87%
1990	33	10.70	1,606	689	91.3%	1,758	5.408	9,508	**11,266**	5,052	**29,326**	13,789	2.91	90%
1991	36	11.66	2,395	1,501	86.9%	2,754	5.408	14,896	**17,650**	10,926	**33,630**	20,311	2.99	64%
1992	42	13.39	3,582	1,211	88.9%	4,027	4.992	20,105	**24,132**	9,930	**60,560**	25,328	2.71	92%
1993	47	15.23	2,021	703	90.7%	2,228	4.695	10,462	**12,690**	5,100	**31,152**	13,025	2.53	97%
1994	41	13.27	2,319	1,103	91.6%	2,532	6.538	16,555	**19,087**	9,102	**52,398**	26,289	2.83	97%
1995	50	22.56	2,252	643	92.8%	2,428	5.154	12,512	**14,940**	5,674	**38,178**	14,398	2.56	100%
1996	54	19.44	884	241	94.0%	940	4.965	4,666	**5,606**	2,022	**13,971**	4,984	2.49	100%
1997	72	23.31	2,548	1,188	93.8%	2,716	4.023	10,924	**13,640**	6,527	**24,126**	8,958	1.79	99%
1998	64	20.71	3,939	1,749	87.6%	4,495	6.063	27,252	**31,747**	16,589	**82,465**	42,716	2.67	97%
1999	53	16.97	1,603	387	88.9%	1,804	3.487	6,290	**8,094**	2,583	**20,577**	6,657	2.72	94%
2000	80	25.86	3,709	974	91.5%	4,054	3.064	12,422	**16,475**	5,432	**40,042**	13,272	2.50	97%
2001	81	26.23	2,347	955	86.3%	2,718	4.557	12,386	**15,104**	7,117	**33,055**	15,954	2.36	93%
2002	84	27.15	2,531	580	86.7%	2,917	5.189	15,138	**18,056**	6,026	**39,955**	13,472	2.59	85%
2003	83	26.87	3,835	1,748	88.4%	4,338	4.709	20,427	**24,765**	11,030	**32,803**	12,305	1.64	81%
2004	81	26.22	2,320	717	91.5%	2,534	3.980	10,088	**12,622**	4,542	**30,963**	11,312	2.49	99%
2005	83	26.87	3,782	1,049	92.6%	4,084	3.406	13,911	**17,995**	5,397	**42,366**	12,042	2.41	98%
2006	75	24.28	2,446	742	94.1%	2,600	6.715	17,458	**20,058**	7,619	**53,238**	20,945	2.69	99%
2007	79	25.58	4,057	1,101	93.0%	4,360	2.823	12,311	**16,671**	4,610	**46,762**	13,125	2.83	99%
2008	82	26.55	3,558	1,156	91.2%	3,901	2.032	7,926	**11,828**	4,222	**29,782**	10,688	2.67	94%
2009	81	26.24	2,537	688	92.8%	2,735	2.353	6,436	**9,171**	2,754	**24,621**	7,295	2.72	99%
2010	66	21.37	2,847	1,429	88.8%	3,206	8.478	27,180	**30,386**	16,706	**74,570**	42,993	2.54	96%
2011	82	26.55	1,887	621	89.8%	2,102	5.321	11,186	**13,288**	5,280	**34,363**	13,855	2.63	98%
2012	77	24.94	1,636	293	92.5%	1,769	2.165	3,830	**5,598**	1,312	**13,965**	3,369	2.60	96%
2013	59	19.12	3,444	960	89.5%	3,847	2.913	11,207	**15,054**	4,677	**37,445**	12,326	2.58	96%
2014	76	24.56	3,700	800	90.6%	4,086	6.259	25,573	**29,659**	10,577	**70,701**	25,899	2.54	94%
2015	71	22.95	4,522	1,629	91.1%	4,964	3.186	15,817	**20,781**	7,789	**49,457**	18,469	2.46	97%
2016	65	21.01	5,723	2,412	87.1%	6,572	3.521	23,140	**29,712**	12,820	**77,036**	35,295	2.63	99%

MEGU **Mew Gull**



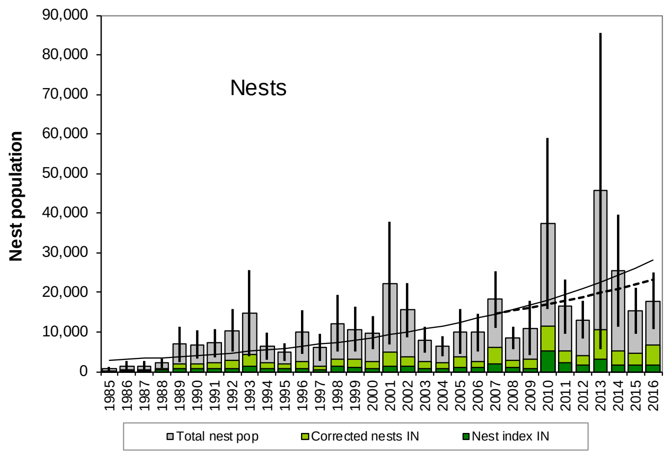
1985-2016 avg annual growth rate= 1.010 (90%c.i.= 0.992-1.028)
2007-2016 avg annual growth rate= 1.022 (90%c.i.= 0.951-1.099)

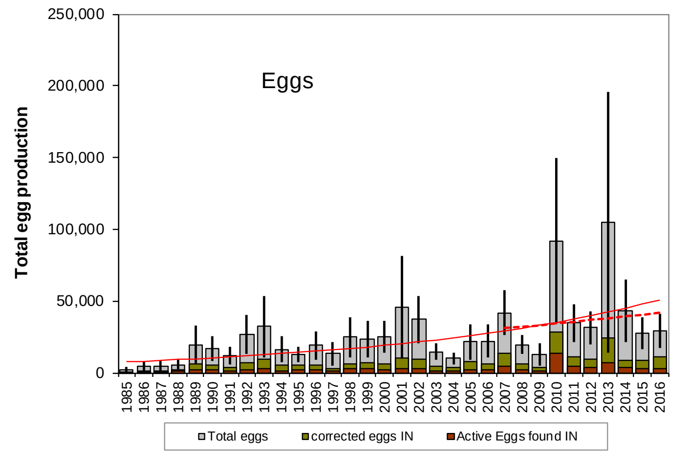


1985-2016 avg annual growth rate= 1.015 (90%c.i.= 0.997-1.034)
2007-2016 avg annual growth rate= 1.020 (90%c.i.= 0.951-1.094)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	1,107	135	72.6%	1,525	4.299	6,555	**8,079**	2,202	**12,993**	3,690	1.95	82%
1986	46	22.16	937	286	80.9%	1,157	4.299	4,976	**6,133**	2,276	**13,291**	5,055	2.29	95%
1987	37	12.67	847	385	67.8%	1,249	4.299	5,369	**6,618**	3,031	**10,333**	5,372	1.56	100%
1988	32	10.48	2,390	1,793	65.9%	3,629	4.299	15,602	**19,231**	12,317	**40,152**	28,602	2.47	85%
1989	23	7.45	1,346	385	69.7%	1,930	4.299	8,295	**10,225**	3,838	**26,980**	9,820	2.64	100%
1990	33	10.70	1,338	814	63.9%	2,095	4.299	9,005	**11,099**	6,037	**27,630**	15,873	2.68	93%
1991	36	11.66	1,719	1,037	67.1%	2,562	4.299	11,016	**13,579**	8,262	**23,002**	14,150	2.37	72%
1992	42	13.39	1,176	323	72.9%	1,612	6.025	9,715	**11,327**	4,148	**28,795**	10,818	2.69	95%
1993	47	15.23	3,667	2,931	78.7%	4,661	4.358	20,309	**24,970**	17,627	**70,045**	49,845	2.81	100%
1994	41	13.27	1,024	547	70.7%	1,450	2.515	3,645	**5,094**	2,544	**12,435**	6,848	2.65	92%
1995	50	22.56	1,396	403	81.2%	1,719	3.655	6,285	**8,004**	3,048	**20,713**	7,927	2.59	100%
1996	54	19.44	847	241	78.2%	1,083	4.599	4,983	**6,066**	2,622	**16,007**	7,121	2.64	100%
1997	72	23.31	276	85	85.6%	323	2.416	780	**1,103**	387	**2,707**	974	2.45	100%
1998	64	20.71	1,348	446	80.0%	1,685	3.892	6,558	**8,244**	3,577	**20,000**	8,690	2.43	100%
1999	53	16.97	1,476	399	70.7%	2,089	2.877	6,011	**8,101**	2,724	**19,413**	6,720	2.48	97%
2000	80	25.86	1,024	189	72.4%	1,414	3.967	5,610	**7,024**	1,673	**16,840**	4,169	2.59	93%
2001	81	26.23	982	300	61.8%	1,588	2.428	3,857	**5,446**	1,973	**13,252**	4,905	2.43	100%
2002	84	27.15	1,687	378	73.2%	2,305	2.645	6,098	**8,403**	2,351	**21,531**	6,017	2.68	96%
2003	83	26.87	1,465	387	57.8%	2,535	3.612	9,159	**11,694**	4,516	**23,961**	8,933	2.58	79%
2004	81	26.22	1,419	326	73.4%	1,934	3.498	6,765	**8,699**	2,780	**18,505**	5,697	2.45	87%
2005	83	26.87	3,090	1,366	81.0%	3,813	5.035	19,202	**23,015**	9,725	**57,251**	25,942	2.49	100%
2006	75	24.28	2,004	507	76.4%	2,623	4.884	12,813	**15,437**	4,030	**38,157**	10,306	2.47	100%
2007	79	25.58	1,287	252	75.5%	1,705	2.614	4,458	**6,163**	1,941	**16,237**	5,134	2.63	100%
2008	82	26.55	1,968	520	68.7%	2,866	2.854	8,178	**11,043**	3,529	**24,629**	7,698	2.49	90%
2009	81	26.24	2,128	370	77.2%	2,755	1.948	5,368	**8,124**	1,796	**21,039**	4,680	2.65	98%
2010	66	21.37	3,015	960	67.1%	4,489	4.657	20,908	**25,397**	9,451	**56,889**	23,053	2.56	87%
2011	82	26.55	1,240	261	77.2%	1,605	3.977	6,385	**7,990**	2,241	**17,918**	4,866	2.33	96%
2012	77	24.94	2,152	423	78.6%	2,737	3.297	9,024	**11,761**	2,782	**29,946**	7,270	2.55	100%
2013	59	19.12	2,508	706	77.1%	3,253	2.917	9,491	**12,744**	3,983	**31,724**	9,936	2.49	100%
2014	76	24.56	1,952	576	76.5%	2,552	4.083	10,419	**12,971**	4,300	**33,186**	11,181	2.62	98%
2015	71	22.95	1,528	271	73.6%	2,078	3.256	6,765	**8,843**	2,221	**18,987**	4,869	2.22	97%
2016	65	21.01	1,737	463	73.3%	2,370	3.305	7,832	**10,202**	3,685	**25,502**	9,410	2.50	100%

SAGU Sabine's Gull



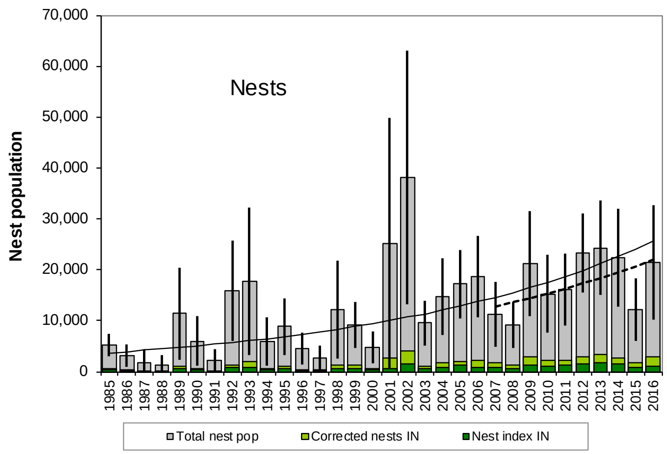


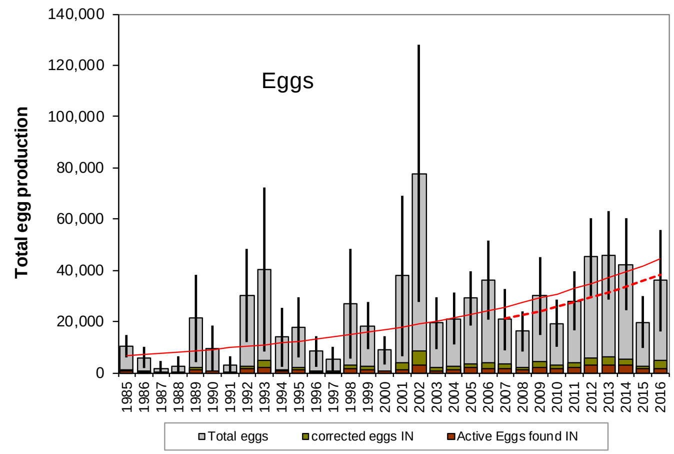
1985-2016 avg annual growth rate= 1.077 (90%c.i.= 1.057-1.097)
2007-2016 avg annual growth rate= 1.052 (90%c.i.= 0.956-1.158)

1985-2016 avg annual growth rate= 1.063 (90%c.i.= 1.043-1.084)
2007-2016 avg annual growth rate= 1.034 (90%c.i.= 0.916-1.167)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	65	39	31.5%	205	2.351	482	**687**	379	**2,061**	1,137	3.00	100%
1986	46	22.16	129	78	31.5%	410	2.351	964	**1,374**	758	**4,122**	2,273	3.00	100%
1987	37	12.67	113	76	25.9%	436	2.351	1,025	**1,461**	804	**4,381**	2,412	3.00	100%
1988	32	10.48	341	142	54.3%	628	2.351	1,478	**2,106**	783	**5,733**	2,099	2.72	100%
1989	23	7.45	673	291	32.8%	2,053	2.351	4,828	**6,882**	2,690	**19,714**	8,004	2.86	100%
1990	33	10.70	669	223	33.3%	2,007	2.351	4,719	**6,726**	2,184	**16,588**	5,237	2.47	100%
1991	36	11.66	675	192	31.6%	2,134	2.351	5,019	**7,153**	2,132	**11,908**	3,762	1.66	100%
1992	42	13.39	802	291	28.3%	2,833	2.680	7,592	**10,425**	3,343	**26,736**	8,469	2.56	100%
1993	47	15.23	1,410	724	33.4%	4,225	2.482	10,487	**14,712**	6,556	**32,109**	13,088	2.41	91%
1994	41	13.27	647	220	29.7%	2,179	1.892	4,123	**6,302**	2,069	**16,207**	5,561	2.57	100%
1995	50	22.56	698	185	34.5%	2,024	1.486	3,009	**5,033**	1,341	**12,772**	3,378	2.54	100%
1996	54	19.44	736	216	28.4%	2,591	2.834	7,344	**9,935**	3,293	**18,924**	5,912	2.42	79%
1997	72	23.31	460	136	38.5%	1,196	4.048	4,843	**6,039**	2,115	**13,196**	4,969	2.18	100%
1998	64	20.71	1,486	720	49.1%	3,026	3.018	9,132	**12,159**	4,307	**25,018**	8,463	2.06	100%
1999	53	16.97	1,181	560	37.9%	3,113	2.421	7,536	**10,648**	3,477	**23,394**	7,727	2.20	100%
2000	80	25.86	775	182	32.2%	2,408	3.074	7,402	**9,810**	2,588	**25,109**	6,950	2.56	100%
2001	81	26.23	1,201	423	24.4%	4,915	3.544	17,420	**22,335**	9,401	**45,608**	21,888	2.30	89%
2002	84	27.15	1,239	404	32.8%	3,774	3.120	11,776	**15,549**	4,215	**37,289**	10,066	2.40	100%
2003	83	26.87	692	186	26.1%	2,656	1.979	5,257	**7,913**	2,001	**14,667**	3,489	2.18	85%
2004	81	26.22	600	148	27.3%	2,199	1.897	4,172	**6,371**	1,566	**9,889**	2,508	1.99	78%
2005	83	26.87	1,145	256	32.0%	3,579	1.824	6,529	**10,108**	3,420	**21,495**	7,494	2.13	100%
2006	75	24.28	1,061	372	40.6%	2,616	2.766	7,236	**9,853**	2,907	**22,111**	6,918	2.24	100%
2007	79	25.58	1,819	398	30.4%	5,992	2.041	12,230	**18,222**	4,323	**41,809**	9,622	2.29	100%
2008	82	26.55	944	151	33.5%	2,819	2.046	5,768	**8,588**	1,720	**19,461**	3,969	2.27	100%
2009	81	26.24	764	187	24.4%	3,130	2.497	7,817	**10,947**	4,155	**12,882**	4,760	1.76	67%
2010	66	21.37	5,326	3,366	46.2%	11,524	2.256	25,999	**37,523**	13,128	**92,069**	35,001	2.56	96%
2011	82	26.55	2,156	830	42.4%	5,091	2.220	11,305	**16,397**	4,101	**34,847**	7,951	2.22	96%
2012	77	24.94	1,550	383	37.9%	4,085	2.185	8,925	**13,010**	2,915	**31,380**	7,074	2.41	100%
2013	59	19.12	3,182	1,392	29.8%	10,681	3.275	34,980	**45,661**	24,298	**104,995**	55,168	2.34	98%
2014	76	24.56	1,777	528	34.1%	5,213	3.890	20,278	**25,491**	8,546	**43,227**	13,395	1.99	85%
2015	71	22.95	1,591	345	33.9%	4,690	2.255	10,577	**15,267**	3,559	**27,656**	6,811	1.87	97%
2016	65	21.01	1,635	371	24.8%	6,605	1.706	11,266	**17,871**	4,400	**29,021**	7,241	1.92	85%

ARTE Arctic Tern



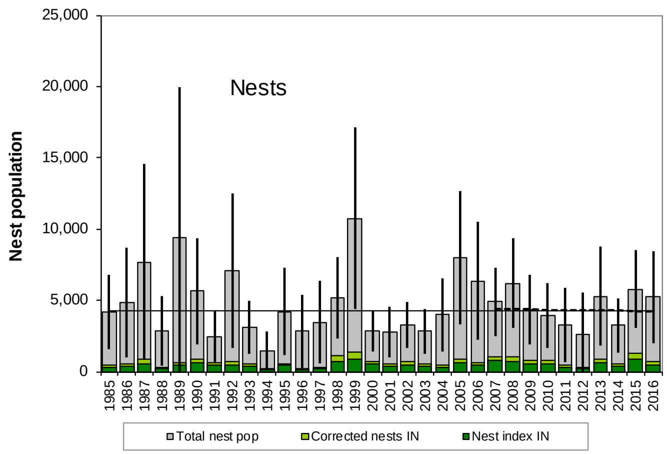


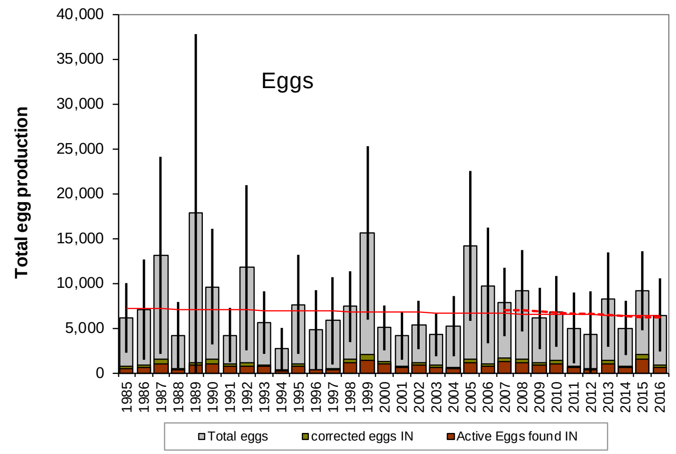
1985-2016 avg annual growth rate= 1.064 (90%c.i.= 1.043-1.086)
2007-2016 avg annual growth rate= 1.061 (90%c.i.= 1.003-1.123)

1985-2016 avg annual growth rate= 1.063 (90%c.i.= 1.039-1.086)
2007-2016 avg annual growth rate= 1.069 (90%c.i.= 1.003-1.139)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	291	55	60.3%	483	9.814	4,737	**5,220**	1,310	**10,440**	2,723	2.00	100%
1986	46	22.16	194	77	66.6%	291	9.814	2,857	**3,149**	1,287	**5,879**	2,587	1.87	100%
1987	37	12.67	113	112	70.1%	161	9.814	1,580	**1,741**	1,637	**1,741**	1,637	1.00	100%
1988	32	10.48	68	68	57.9%	118	9.814	1,157	**1,275**	1,199	**2,550**	2,398	2.00	100%
1989	23	7.45	577	284	54.7%	1,054	9.814	10,340	**11,394**	5,541	**21,228**	10,394	1.86	100%
1990	33	10.70	335	168	60.3%	554	9.814	5,440	**5,995**	3,006	**9,591**	5,318	1.60	100%
1991	36	11.66	123	85	63.3%	194	9.814	1,904	**2,098**	1,401	**3,094**	2,147	1.48	100%
1992	42	13.39	748	235	61.1%	1,225	11.886	14,557	**15,782**	5,991	**30,033**	11,084	1.90	100%
1993	47	15.23	893	482	43.2%	2,066	7.567	15,630	**17,696**	8,817	**40,266**	19,339	2.28	100%
1994	41	13.27	323	163	59.5%	544	9.990	5,430	**5,973**	2,895	**13,911**	7,065	2.33	100%
1995	50	22.56	539	165	56.1%	961	8.226	7,902	**8,862**	3,402	**17,724**	7,011	2.00	100%
1996	54	19.44	221	85	52.5%	421	9.757	4,103	**4,524**	1,903	**8,392**	3,628	1.86	100%
1997	72	23.31	154	78	64.6%	238	10.407	2,472	**2,710**	1,497	**5,419**	2,994	2.00	100%
1998	64	20.71	691	193	51.3%	1,348	8.013	10,798	**12,146**	5,816	**26,828**	12,973	2.21	100%
1999	53	16.97	591	170	49.6%	1,190	6.756	8,039	**9,229**	2,768	**18,358**	5,543	1.99	100%
2000	80	25.86	277	90	58.6%	473	9.253	4,372	**4,844**	1,902	**8,825**	3,450	1.82	100%
2001	81	26.23	682	269	26.0%	2,623	8.605	22,568	**25,190**	14,950	**37,812**	19,126	1.92	78%
2002	84	27.15	1,529	434	37.4%	4,091	8.330	34,080	**38,172**	15,117	**77,797**	30,528	2.04	100%
2003	83	26.87	506	136	49.2%	1,028	8.306	8,537	**9,565**	2,678	**19,442**	6,215	2.03	100%
2004	81	26.22	737	137	41.2%	1,789	7.183	12,851	**14,640**	4,595	**21,152**	6,135	1.77	82%
2005	83	26.87	1,199	258	60.4%	1,985	7.655	15,197	**17,182**	4,061	**29,096**	6,463	1.69	100%
2006	75	24.28	884	175	42.4%	2,087	7.935	16,558	**18,645**	4,903	**35,987**	9,352	1.93	100%
2007	79	25.58	923	169	51.1%	1,806	5.231	9,446	**11,252**	3,821	**20,788**	7,218	1.85	100%
2008	82	26.55	647	170	53.4%	1,213	6.572	7,970	**9,182**	2,696	**16,288**	4,743	1.77	100%
2009	81	26.24	1,309	463	44.3%	2,956	6.166	18,228	**21,184**	6,284	**30,114**	9,260	1.75	81%
2010	66	21.37	971	216	42.1%	2,305	5.595	12,894	**15,198**	4,657	**19,298**	5,595	1.74	73%
2011	82	26.55	1,213	244	55.2%	2,199	6.305	13,865	**16,064**	4,278	**27,997**	6,936	1.84	95%
2012	77	24.94	1,607	243	55.4%	2,900	7.016	20,344	**23,244**	4,692	**45,182**	9,286	1.94	100%
2013	59	19.12	1,685	435	51.7%	3,257	6.464	21,055	**24,313**	5,616	**45,723**	10,458	1.88	100%
2014	76	24.56	1,486	372	54.6%	2,721	7.215	19,635	**22,357**	5,808	**42,333**	10,985	1.98	96%
2015	71	22.95	873	198	52.7%	1,658	6.324	10,483	**12,141**	3,753	**19,701**	6,200	1.62	100%
2016	65	21.01	1,090	244	38.2%	2,854	6.508	18,572	**21,426**	6,841	**35,991**	12,006	1.68	100%

RTLO Red-throated Loon



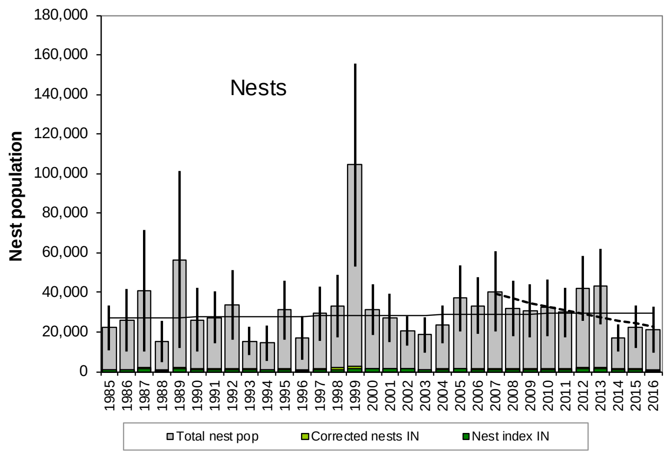


1985-2016 avg annual growth rate= 1.000 (90%c.i.= 0.986-1.014)
2007-2016 avg annual growth rate= 0.996 (90%c.i.= 0.942-1.052)

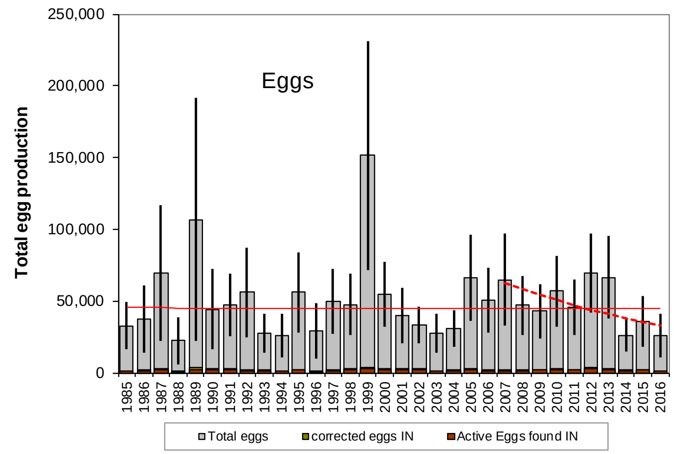
1985-2016 avg annual growth rate= 0.996 (90%c.i.= 0.982-1.010)
2007-2016 avg annual growth rate= 0.985 (90%c.i.= 0.936-1.037)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	323	57	68.7%	469	7.839	3,679	**4,149**	1,589	**6,162**	2,357	1.64	90%
1986	46	22.16	409	144	74.4%	549	7.839	4,305	**4,855**	2,344	**6,984**	3,397	1.64	88%
1987	37	12.67	554	216	63.9%	867	7.839	6,799	**7,667**	4,181	**13,063**	6,694	1.95	88%
1988	32	10.48	238	96	73.5%	324	7.839	2,536	**2,859**	1,473	**4,180**	2,244	1.66	88%
1989	23	7.45	426	241	72.9%	584	15.093	8,820	**9,405**	6,408	**17,773**	12,133	1.89	100%
1990	33	10.70	588	195	66.6%	883	5.391	4,762	**5,645**	2,251	**9,586**	3,896	1.82	93%
1991	36	11.66	433	170	71.9%	603	3.033	1,828	**2,431**	1,093	**4,199**	1,860	1.86	93%
1992	42	13.39	453	178	66.8%	678	9.441	6,403	**7,081**	3,288	**11,717**	5,604	1.86	89%
1993	47	15.23	365	126	71.8%	508	5.125	2,602	**3,110**	1,151	**5,545**	2,120	1.92	93%
1994	41	13.27	129	69	77.2%	168	7.764	1,302	**1,469**	814	**2,640**	1,422	1.80	100%
1995	50	22.56	420	139	73.0%	575	6.324	3,638	**4,213**	1,846	**7,609**	3,365	1.81	100%
1996	54	19.44	164	76	71.6%	229	11.351	2,596	**2,825**	1,551	**4,817**	2,701	1.71	100%
1997	72	23.31	192	86	63.7%	301	10.455	3,145	**3,446**	1,759	**5,812**	2,937	1.91	88%
1998	64	20.71	677	197	61.5%	1,100	3.724	4,097	**5,198**	1,742	**7,412**	2,403	1.87	76%
1999	53	16.97	845	277	61.8%	1,367	6.863	9,380	**10,746**	3,885	**15,568**	5,881	1.81	80%
2000	80	25.86	514	146	71.2%	722	2.961	2,138	**2,860**	861	**5,021**	1,506	1.89	93%
2001	81	26.23	361	116	68.4%	528	4.271	2,253	**2,781**	1,061	**4,147**	1,619	1.62	92%
2002	84	27.15	487	123	71.7%	680	3.834	2,607	**3,286**	991	**5,324**	1,638	1.72	94%
2003	83	26.87	367	113	66.4%	553	4.103	2,268	**2,821**	950	**4,224**	1,440	1.73	86%
2004	81	26.22	283	97	64.9%	436	8.129	3,548	**3,985**	1,547	**5,234**	2,046	1.72	76%
2005	83	26.87	623	191	74.8%	833	8.571	7,136	**7,969**	2,852	**14,141**	5,112	1.81	98%
2006	75	24.28	462	141	72.0%	642	8.925	5,727	**6,369**	2,515	**9,726**	3,897	1.72	89%
2007	79	25.58	752	193	73.4%	1,023	3.776	3,864	**4,888**	1,453	**7,857**	2,317	1.74	92%
2008	82	26.55	712	191	69.2%	1,029	5.020	5,163	**6,192**	1,904	**9,179**	2,774	1.64	91%
2009	81	26.24	517	166	66.3%	780	4.579	3,570	**4,350**	1,480	**6,078**	2,075	1.73	81%
2010	66	21.37	551	177	72.3%	762	4.121	3,141	**3,903**	1,386	**6,835**	2,425	1.85	95%
2011	82	26.55	323	125	69.0%	468	5.957	2,788	**3,256**	1,578	**4,980**	2,417	1.84	83%
2012	77	24.94	205	121	69.9%	294	7.793	2,288	**2,581**	1,779	**4,266**	2,950	1.83	90%
2013	59	19.12	589	180	66.8%	881	5.012	4,416	**5,298**	2,093	**8,193**	3,215	1.75	88%
2014	76	24.56	349	106	70.1%	498	5.527	2,750	**3,247**	1,155	**4,968**	1,825	1.80	85%
2015	71	22.95	883	223	70.2%	1,258	3.580	4,506	**5,764**	1,657	**9,108**	2,689	1.73	91%
2016	65	21.01	430	137	59.2%	726	6.186	4,490	**5,215**	1,966	**6,443**	2,487	1.70	73%

PALO Pacific Loon



1985-2016 avg annual growth rate= 1.003 (90%c.i.= 0.990-1.016)
2007-2016 avg annual growth rate= 0.942 (90%c.i.= 0.897-0.988)



1985-2016 avg annual growth rate= 1.000 (90%c.i.= 0.986-1.013)
2007-2016 avg annual growth rate= 0.932 (90%c.i.= 0.881-0.985)

Year	N plots	Sampled km^2	Nest index IN	SE nest index IN	Avg nest detection rate	Corrected nests IN	Aerial OUT:IN ratio	Corrected nests OUT	**Total nests IN+OUT**	SE total nests	**Total eggs IN+OUT**	SE total eggs	Total eggs / active nests	Corrected % nest success index
1985	49	24.57	697	86	68.7%	1,014	20.833	21,123	**22,137**	6,797	**32,881**	10,074	1.64	90%
1986	46	22.16	883	217	74.4%	1,186	20.833	24,718	**25,905**	9,710	**37,270**	14,138	1.64	88%
1987	37	12.67	1,197	354	63.9%	1,874	20.833	39,036	**40,910**	18,565	**69,706**	28,780	1.95	88%
1988	32	10.48	514	159	73.5%	699	20.833	14,560	**15,258**	6,355	**22,306**	9,889	1.66	88%
1989	23	7.45	1,304	429	72.9%	1,789	30.597	54,751	**56,540**	27,164	**106,852**	51,508	1.89	100%
1990	33	10.70	1,018	292	66.6%	1,528	16.045	24,523	**26,051**	9,775	**44,238**	17,019	1.82	93%
1991	36	11.66	1,163	289	71.9%	1,617	15.857	25,647	**27,265**	7,959	**47,093**	13,179	1.86	93%
1992	42	13.39	937	261	66.8%	1,402	23.174	32,482	**33,884**	10,725	**56,069**	18,846	1.86	89%
1993	47	15.23	905	246	71.8%	1,260	11.160	14,064	**15,324**	4,406	**27,320**	8,317	1.92	93%
1994	41	13.27	679	252	77.2%	880	15.429	13,579	**14,459**	5,415	**25,978**	9,162	1.80	100%
1995	50	22.56	976	205	73.0%	1,337	22.194	29,676	**31,013**	9,184	**56,014**	16,933	1.81	100%
1996	54	19.44	462	153	71.6%	645	25.534	16,468	**17,113**	6,633	**29,179**	11,761	1.71	100%
1997	72	23.31	821	190	63.7%	1,289	21.841	28,152	**29,441**	8,331	**49,654**	13,622	1.91	88%
1998	64	20.71	1,154	252	61.5%	1,876	16.753	31,437	**33,313**	9,614	**47,505**	12,937	1.87	76%
1999	53	16.97	1,517	353	61.8%	2,454	41.593	102,080	**104,534**	31,184	**151,443**	48,535	1.81	80%
2000	80	25.86	1,202	219	71.2%	1,687	17.469	29,479	**31,167**	7,820	**54,720**	13,631	1.89	93%
2001	81	26.23	1,194	249	68.4%	1,745	14.381	25,096	**26,842**	7,424	**40,032**	11,609	1.62	92%
2002	84	27.15	1,226	201	71.7%	1,711	11.046	18,905	**20,617**	4,641	**33,398**	7,836	1.72	94%
2003	83	26.87	698	171	66.4%	1,052	16.595	17,465	**18,517**	5,473	**27,727**	8,351	1.73	86%
2004	81	26.22	836	157	64.9%	1,287	17.427	22,428	**23,715**	5,773	**31,149**	7,721	1.72	76%
2005	83	26.87	1,322	269	74.8%	1,767	20.019	35,375	**37,142**	10,095	**65,908**	18,233	1.81	98%
2006	75	24.28	894	199	72.0%	1,241	25.778	31,991	**33,232**	8,692	**50,749**	13,723	1.72	89%
2007	79	25.58	927	211	73.4%	1,263	30.971	39,102	**40,365**	12,303	**64,884**	19,580	1.74	92%
2008	82	26.55	1,040	230	69.2%	1,503	20.081	30,191	**31,694**	8,567	**46,987**	12,365	1.64	91%
2009	81	26.24	1,147	233	66.3%	1,730	16.730	28,944	**30,674**	8,231	**42,866**	11,576	1.73	81%
2010	66	21.37	1,190	263	72.3%	1,646	18.691	30,758	**32,404**	8,655	**56,752**	15,117	1.85	95%
2011	82	26.55	1,106	215	69.0%	1,602	17.702	28,356	**29,958**	7,642	**45,820**	11,747	1.84	83%
2012	77	24.94	1,660	264	69.9%	2,376	16.712	39,716	**42,092**	9,961	**69,559**	16,792	1.83	90%
2013	59	19.12	1,246	263	66.8%	1,865	22.053	41,137	**43,002**	11,537	**66,505**	17,547	1.75	88%
2014	76	24.56	933	181	70.1%	1,331	11.804	15,713	**17,044**	4,263	**26,077**	6,980	1.80	85%
2015	71	22.95	1,051	241	70.2%	1,497	14.121	21,146	**22,643**	6,643	**35,780**	10,849	1.73	91%
2016	65	21.01	558	154	59.2%	942	21.464	20,223	**21,165**	7,228	**26,147**	9,224	1.70	73%

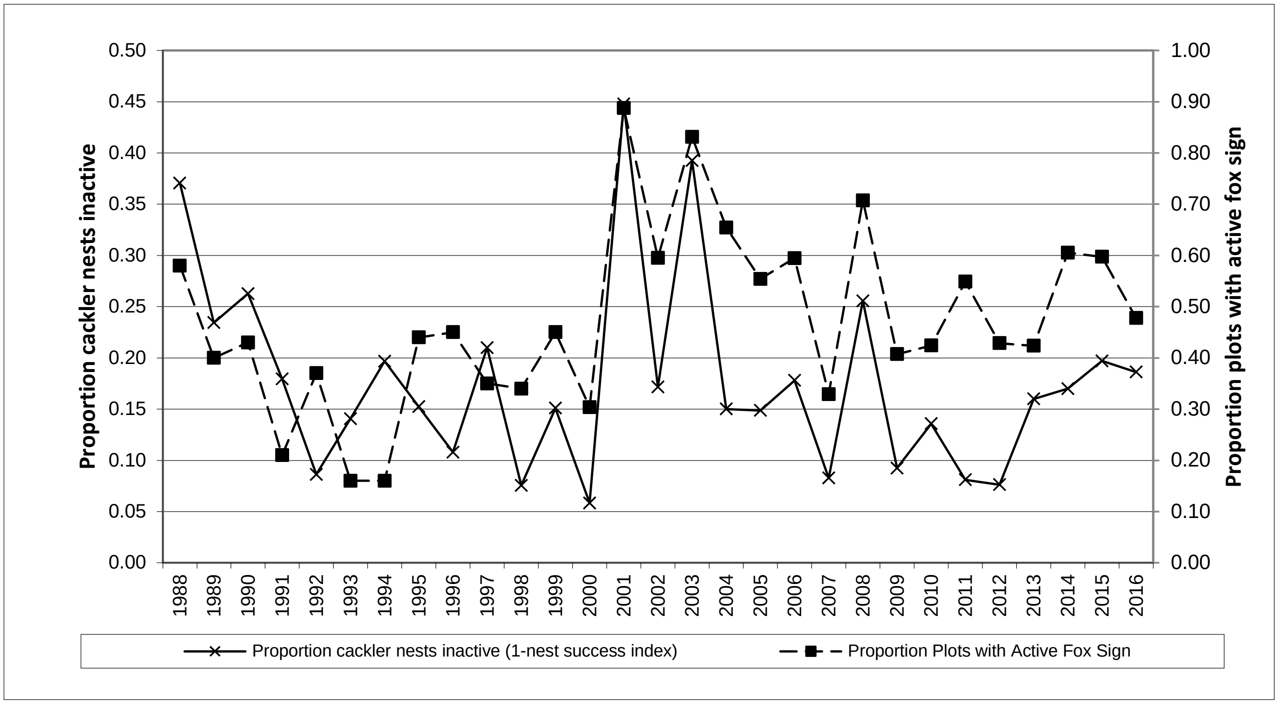


Figure 5. Trends in presence of fox (proportion of plots with observed fox, scat, fur, tracks, and/or active dens) and inactive (failed) cackling Canada goose nests (1-nest success index), 1988-2016.

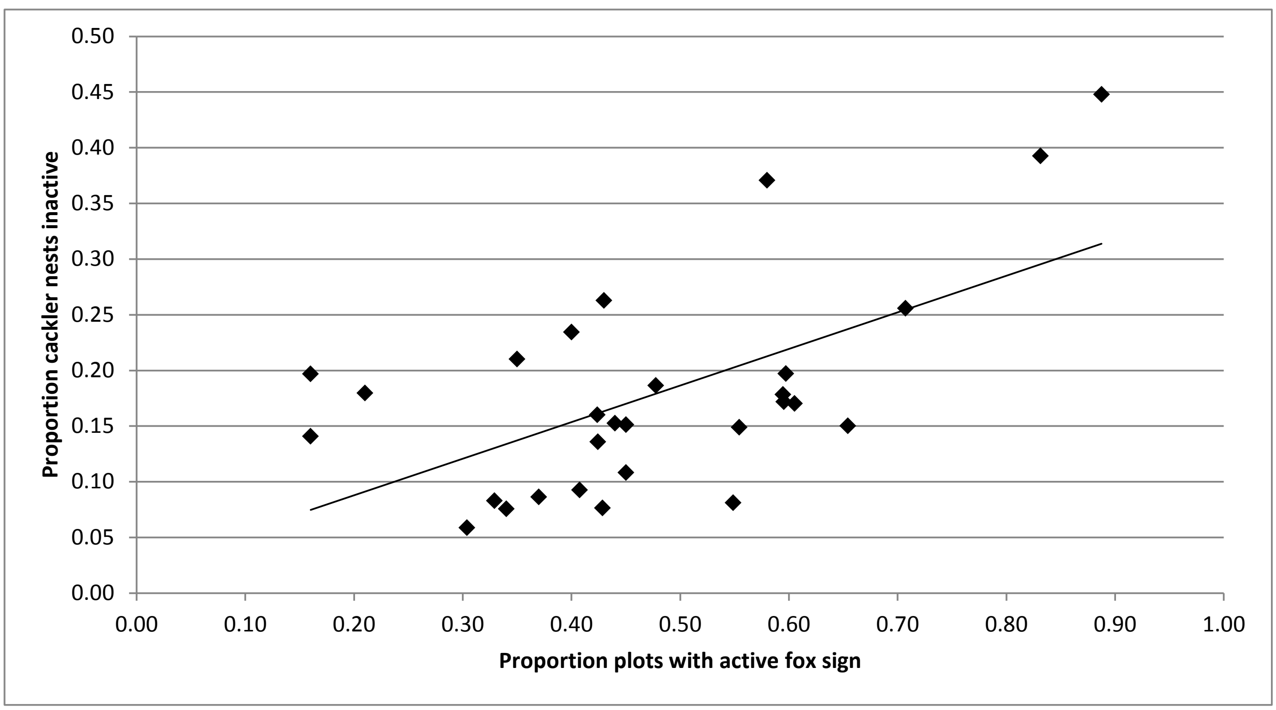


Figure 6. Relationship between presence of fox (proportion of plots with observed fox, scat, fur, tracks, and/or active dens) and inactive (failed) cackling Canada goose nests (1-nest success index), 1988-2016. Presence of fox explained 36% of the variation in nest failure. $F_{1,27} = 15.482$, $P = 0.001$, $R^2 = 0.364$.

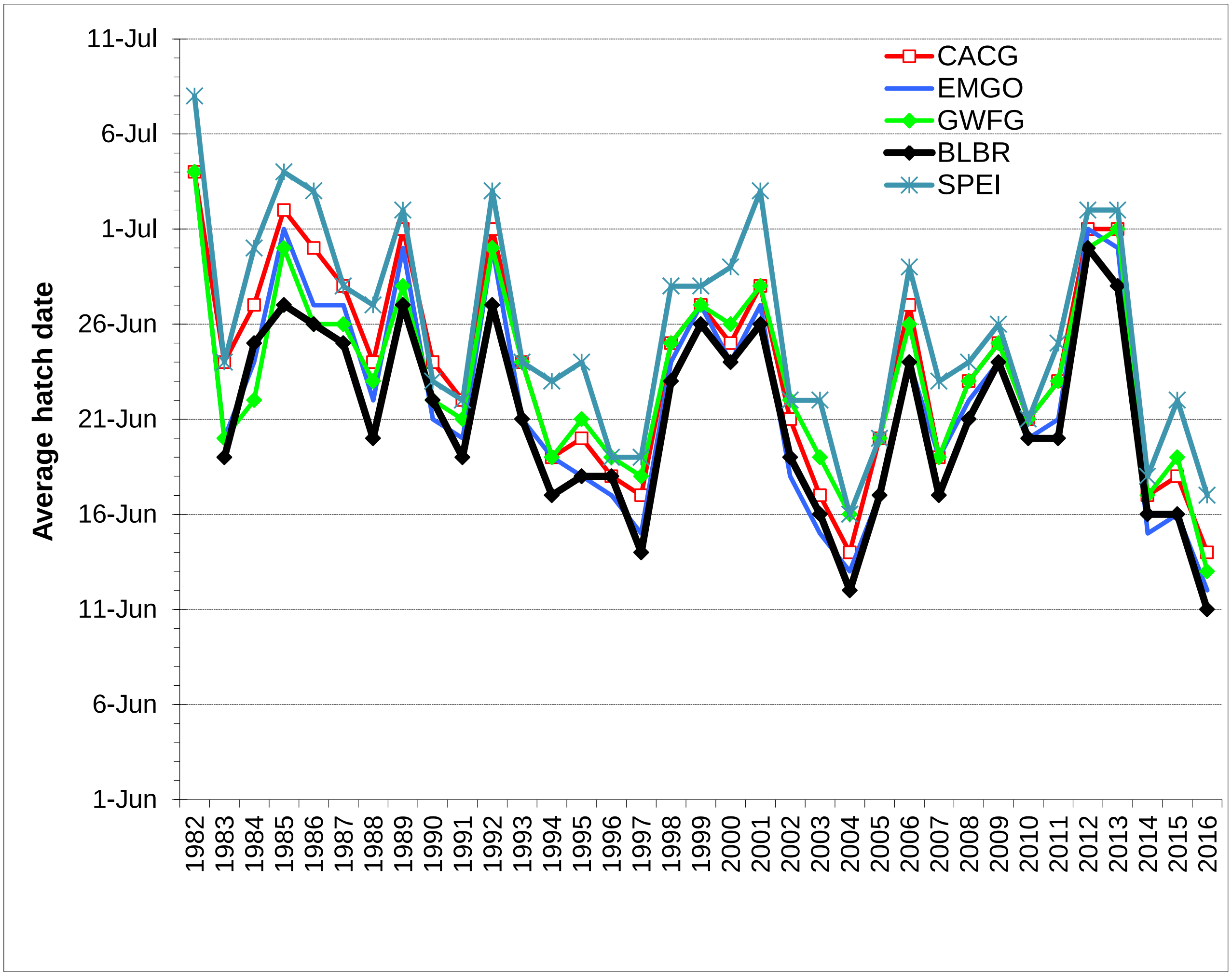


Figure 7. Average hatch dates of cackling geese (CACG) emperor geese (EMGO), greater white-fronted geese (GWFG), black brant (BLBR), and spectacled eiders (SPEI), 1982-2016. Linear regression of year on cackling goose hatch date indicates an average advance of 0.235 days per year since 1982 ($F_{1,33}$ = 8.240, P =0.007, R^2 = 0.200).

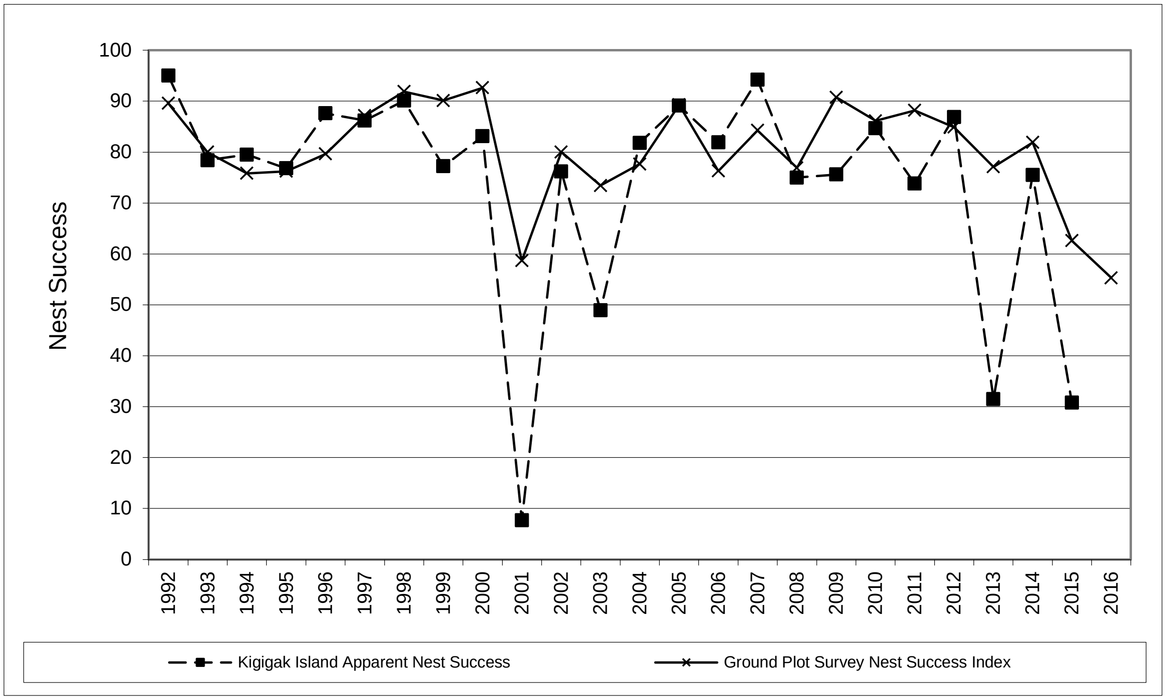


Figure 8. Comparison of spectacled eider apparent nest success measures at Kigigak Island (successful hatched nests/total nests; Moore and Sowl 2017) and the Yukon-Kuskokwim Delta nest plot survey (active nests at time of search/total active nests, corrected for nest detection rate), 1992-2016. Data from Kigigak Island unavailable after 2015.

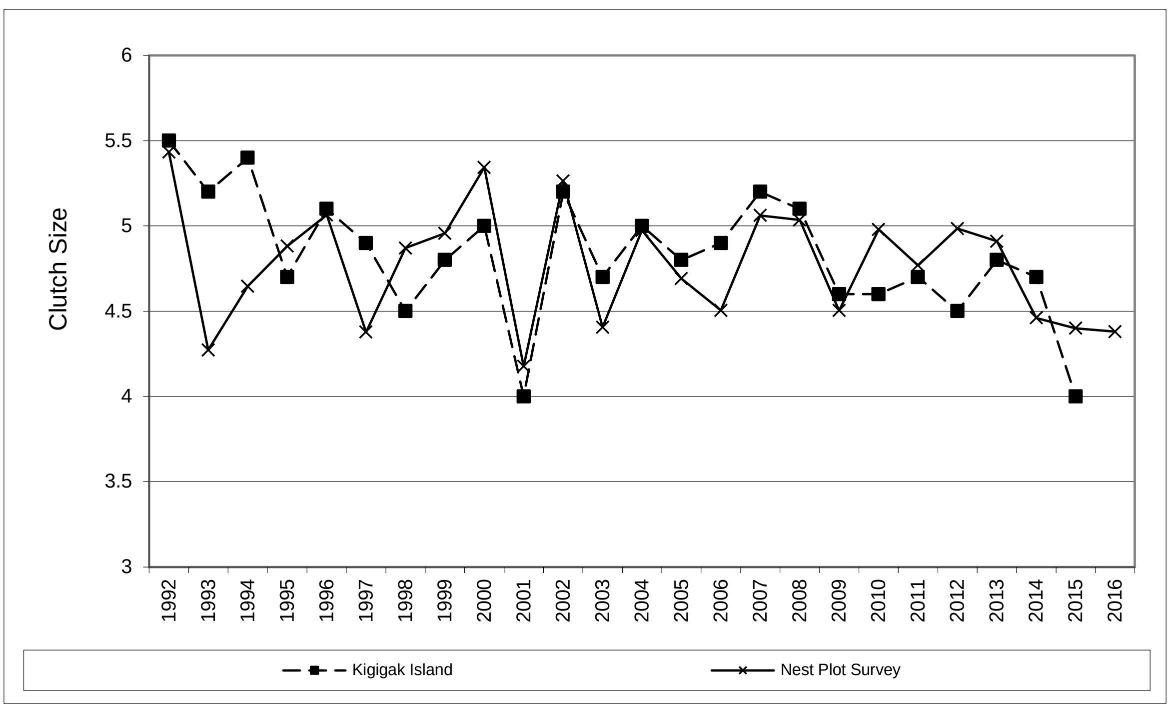


Figure 9. Comparison of spectacled eider clutch size on Kigigak Island (Moore and Sowl 2017) and the Yukon-Kuskokwim Delta nest plot survey 1992-2016. Data from Kigigak Island unavailable after 2015.

Table 1. Estimates used to calculate nest initiation and hatch dates: average incubation duration, laying rate (Afton and Paulus 1992, Alisauskas and Ankney 1992), and age of eggs in days per incubation stage category. See methods section for details on nest initiation and hatch date calculation procedures.

			Incubation Stage								
Species	average incubation (days)	eggs laid/day	1	2	3	4	5	6	7	8	9
Cackling Goose	25	0.77	**2**	**5**	**8**	**10**	**13**	**15**	**18**	**22**	**24**
Emperor Goose	24	0.77	1.9	4.8	7.7	9.6	12.5	14.4	17.3	21.1	23.0
White-fronted Goose	25	0.77	2.0	5.0	8.0	10.0	13.0	15.0	18.0	22.0	24.0
Black Brant	23	0.80	1.8	4.6	7.4	9.2	12.0	13.8	16.6	20.2	22.1
Tundra Swan	31	0.50	2.5	6.2	9.9	12.4	16.1	18.6	22.3	27.3	29.8
Sandhill Crane	30	0.50	2.4	6.0	9.6	12.0	15.6	18.0	21.6	26.4	28.8
Spectacled Eider	24	0.75	1.9	4.8	7.7	9.6	12.5	14.4	17.3	21.1	23.0
Common Eider	25	0.75	2.0	5.0	8.0	10.0	13.0	15.0	18.0	22.0	24.0
Loon (Pacific, red-throated)	27	0.50	2.2	5.4	8.6	10.8	14.0	16.2	19.4	23.8	25.9
Glaucous Gull	23	0.75	1.8	4.6	7.4	9.2	12.0	13.8	16.6	20.2	22.1
Mew Gull	23	0.75	1.8	4.6	7.4	9.2	12.0	13.8	16.6	20.2	22.1
Sabine's Gull	23	0.75	1.8	4.6	7.4	9.2	12.0	13.8	16.6	20.2	22.1
Arctic Tern	23	0.75	1.8	4.6	7.4	9.2	12.0	13.8	16.6	20.2	22.1
Long-tailed Duck	25	0.67	2.0	5.0	8.0	10.0	13.0	15.0	18.0	22.0	24.0
Dabbling Duck	23	1.00	1.8	4.6	7.4	9.2	12.0	13.8	16.6	20.2	22.1
Small Shorebirds	21	0.75	1.7	4.2	6.7	8.4	10.9	12.6	15.1	18.5	20.2

Table 2. Estimated 10-year average (2007-2016) population sizes and growth rates (90% CI) of nests and eggs on the YKD coastal zone (12,832 km^2). Nest and egg estimates are corrected for average nest detection rate. Growth rates significantly different from zero are indicated by bold italics font.

Species	Mean Nest Population	Nest Population Growth Rate (90% CI)	Mean Egg Population	Egg Population Growth Rate (90% CI)
Cackling Goose	135,941	0.994 (0.967-1.023)	493,884	0.984 (0.950-1.019)
Emperor Goose	43,077	1.003 (0.976-1.030)	187,438	0.988 (0.963-1.013)
White-fronted Goose	210,920	***1.066 (1.040-1.090)***	831,339	***1.056 (1.024-1.090)***
Black Brant	32,730	0.958 (0.905-1.014)	93,379	***0.941 (0.895-0.990)***
Tundra Swan	13,312	***1.050 (1.009-1.093)***	49,436	***1.081 (1.011-1.157)***
Sandhill Crane	19,097	***1.040 (1.005-1.076)***	33,922	***1.043 (1.002-1.086)***
Spectacled Eider	6,519	***1.064 (1.015-1.116)***	23,764	1.011 (0.963-1.061)
Common Eider	3,546	0.973 (0.875-1.083)	15,183	0.961 (0.864-1.068)
Glaucous Gull	18,215	1.076 (0.975-1.187)	45,870	1.065 (0.965-1.174)
Mew Gull	11,524	1.022 (0.951-1.099)	27,606	1.020 (0.951-1.094)
Sabine's Gull	20,898	1.052 (0.956-1.158)	43,735	1.034 (0.916-1.167)
Arctic Tern	17,636	***1.061 (1.003-1.123)***	30,342	***1.069 (1.003-1.139)***
Red-throated Loon	4,469	0.996 (0.942-1.052)	6,791	0.985 (0.936-1.037)
Pacific Loon	31,104	***0.942 (0.897-0.988)***	48,138	***0.932 (0.881-0.985)***

Table 3. Estimated 32-year average (1985-2016) population sizes and growth rates (90% CI) of nests and eggs on the YKD coastal zone (12,832 km^2). Nest and egg estimates are corrected for average nest detection rate. Growth rates significantly different from zero are indicated by bold italics font.

Species	Mean Nest Population	Nest Population Growth Rate (90% CI)	Mean Egg Population	Egg Population Growth Rate (90% CI)
Cackling Goose	96,611	***1.045 (1.036-1.054)***	347,557	***1.048 (1.035-1.061)***
Emperor Goose	38,000	***1.011 (1.002-1.019)***	168,820	***1.011 (1.000-1.022)***
White-fronted Goose	120,368	***1.086 (1.075-1.097)***	485,939	***1.084 (1.070-1.097)***
Black Brant	36,320	0.994 (0.979-1.010)	96,118	1.002 (0.981-1.024)
Tundra Swan	11,027	***1.021 (1.014-1.028)***	41,622	***1.020 (1.010-1.031)***
Sandhill Crane	17,529	***1.013 (1.003-1.023)***	30,156	***1.018 (1.007-1.029)***
Spectacled Eider	5,194	1.010 (0.999-1.021)	19,560	1.011 (0.998-1.023)
Common Eider	2,248	***1.067 (1.046-1.088)***	9,467	***1.071 (1.048-1.096)***
Glaucous Gull	16,670	1.010 (0.996-1.023)	38,891	***1.018 (1.004-1.032)***
Mew Gull	10,713	1.010 (0.992-1.028)	25,314	1.015 (0.997-1.034)
Sabine's Gull	12,267	***1.077 (1.057-1.097)***	26,449	***1.063 (1.043-1.084)***
Arctic Tern	12,887	***1.064 (1.043-1.086)***	23,406	***1.063 (1.039-1.086)***
Red-throated Loon	4,683	1.000 (0.986-1.014)	7,462	0.996 (0.982-1.010)
Pacific Loon	31,107	1.003 (0.990-1.016)	49,643	1.000 (0.986-1.013)

Table 4. Estimated nest initiation and hatch date based on egg float angles (1982-2016). Means calculated using nest as sample unit. Years with fewer than 3 nests per species excluded. 90% confidence interval of 1982-2016 mean is based on standard deviation of annual point estimates.

Cackling Goose

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	5-Jun	9.3	4-Jul	6.8	170
1983	25-May	9.5	24-Jun	8.2	428
1984	29-May	9.4	27-Jun	8.5	328
1985	4-Jun	8.0	2-Jul	6.3	278
1986	31-May	8.1	30-Jun	6.3	347
1987	30-May	8.0	28-Jun	6.3	209
1988	26-May	10.7	24-Jun	9.0	88
1989	1-Jun	8.1	1-Jul	6.5	55
1990	25-May	7.8	24-Jun	6.9	195
1991	24-May	7.7	22-Jun	6.5	356
1992	1-Jun	7.1	1-Jul	6.0	397
1993	26-May	7.1	24-Jun	6.0	358
1994	21-May	7.8	19-Jun	6.5	409
1995	22-May	7.0	20-Jun	6.2	725
1996	20-May	7.7	18-Jun	6.7	755
1997	19-May	7.3	17-Jun	6.7	812
1998	27-May	6.1	25-Jun	5.2	889
1999	29-May	7.3	27-Jun	6.4	772
2000	27-May	6.8	25-Jun	6.0	1014
2001	31-May	6.3	28-Jun	5.8	522
2002	22-May	6.4	21-Jun	5.3	930
2003	19-May	9.1	17-Jun	7.9	562
2004	16-May	7.9	14-Jun	7.1	964
2005	22-May	8.4	20-Jun	7.4	957
2006	29-May	6.4	27-Jun	5.3	845
2007	21-May	7.1	19-Jun	6.2	1027
2008	25-May	6.1	23-Jun	5.2	906
2009	27-May	6.4	25-Jun	5.6	1374
2010	23-May	6.5	21-Jun	5.7	773
2011	25-May	6.7	23-Jun	5.8	902
2012	2-Jun	6.3	1-Jul	5.6	519
2013	2-Jun	5.2	1-Jul	4.4	683
2014	18-May	8.6	17-Jun	7.7	764
2015	20-May	7.1	18-Jun	6.0	752
2016	16-May	8.7	14-Jun	7.9	733
Mean	26-May	1.5	24-Jun	1.5	

Emperor Goose

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	5-Jun	8.2	4-Jul	6.4	71
1983	22-May	9.3	20-Jun	7.7	177
1984	26-May	10.3	24-Jun	8.2	161
1985	2-Jun	7.6	1-Jul	5.7	107
1986	29-May	7.4	27-Jun	5.6	197
1987	30-May	7.3	27-Jun	5.5	142
1988	24-May	8.9	22-Jun	6.8	102
1989	1-Jun	8.1	30-Jun	6.0	63
1990	23-May	8.6	21-Jun	6.5	100
1991	22-May	7.2	20-Jun	6.0	263
1992	1-Jun	6.5	30-Jun	5.0	184
1993	24-May	7.2	21-Jun	5.9	139
1994	21-May	7.4	19-Jun	5.8	192
1995	21-May	7.4	18-Jun	6.0	188
1996	19-May	6.3	17-Jun	5.1	185
1997	18-May	7.5	15-Jun	5.8	153
1998	27-May	6.5	24-Jun	5.2	215
1999	30-May	6.5	27-Jun	5.6	188
2000	26-May	7.2	24-Jun	5.9	280
2001	29-May	7.5	27-Jun	5.4	104
2002	20-May	6.6	18-Jun	5.3	249
2003	18-May	8.6	15-Jun	6.8	153
2004	15-May	7.7	13-Jun	6.2	253
2005	19-May	9.4	17-Jun	7.2	303
2006	27-May	6.3	24-Jun	5.0	253
2007	21-May	7.0	19-Jun	5.4	275
2008	24-May	6.9	22-Jun	5.2	240
2009	26-May	6.5	24-Jun	5.1	349
2010	23-May	6.4	20-Jun	5.2	189
2011	24-May	6.6	21-Jun	5.0	206
2012	2-Jun	6.5	1-Jul	5.2	119
2013	1-Jun	5.9	30-Jun	5.0	162
2014	16-May	9.2	15-Jun	7.2	161
2015	18-May	7.9	16-Jun	6.2	257
2016	13-May	10.4	12-Jun	8.3	140
Mean	24-May	1.6	22-Jun	1.6	

Table 4. Continued

White-fronted Geese

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	6-Jun	7.0	4-Jul	6.4	14
1983	22-May	7.5	20-Jun	7.1	172
1984	24-May	10.3	22-Jun	8.7	84
1985	31-May	6.6	30-Jun	4.7	42
1986	28-May	7.4	26-Jun	6.6	102
1987	28-May	6.5	26-Jun	5.2	61
1988	26-May	9.0	23-Jun	7.3	32
1989	30-May	8.1	28-Jun	6.2	21
1990	24-May	7.2	22-Jun	6.4	52
1991	23-May	7.9	21-Jun	6.7	138
1992	1-Jun	6.8	30-Jun	5.6	115
1993	26-May	6.3	24-Jun	5.7	84
1994	21-May	8.0	19-Jun	5.9	129
1995	23-May	8.0	21-Jun	6.8	178
1996	21-May	8.6	19-Jun	7.5	144
1997	20-May	8.0	18-Jun	6.6	184
1998	28-May	6.7	25-Jun	5.5	261
1999	30-May	7.6	27-Jun	6.7	208
2000	28-May	8.2	26-Jun	6.6	334
2001	31-May	6.9	28-Jun	5.8	311
2002	24-May	6.3	22-Jun	5.0	306
2003	21-May	8.7	19-Jun	7.4	272
2004	17-May	8.0	16-Jun	6.5	364
2005	23-May	8.0	20-Jun	6.9	438
2006	28-May	7.2	26-Jun	5.9	370
2007	21-May	7.6	19-Jun	6.2	446
2008	25-May	6.8	23-Jun	5.6	327
2009	27-May	6.7	25-Jun	5.6	477
2010	23-May	7.3	21-Jun	6.0	353
2011	25-May	7.3	23-Jun	5.8	549
2012	1-Jun	7.3	30-Jun	5.6	155
2013	2-Jun	6.1	1-Jul	5.2	257
2014	18-May	7.9	17-Jun	6.9	433
2015	20-May	6.9	19-Jun	5.7	480
2016	15-May	8.6	13-Jun	7.8	362
Mean	25-May	1.4	23-Jun	1.3	

Black Brant

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	--	0.0	--	0.0	1
1983	24-May	9.1	19-Jun	6.7	448
1984	30-May	7.4	25-Jun	6.6	440
1985	1-Jun	4.8	27-Jun	6.0	29
1986	30-May	5.6	26-Jun	4.7	131
1987	1-Jun	5.2	25-Jun	3.5	172
1988	25-May	9.0	20-Jun	7.2	51
1989	1-Jun	6.4	27-Jun	5.6	40
1990	25-May	5.8	22-Jun	6.2	130
1991	24-May	6.6	19-Jun	6.0	183
1992	1-Jun	6.5	27-Jun	5.9	152
1993	26-May	6.0	21-Jun	5.5	107
1994	22-May	6.8	17-Jun	5.9	93
1995	23-May	7.7	18-Jun	6.7	41
1996	23-May	6.4	18-Jun	4.9	44
1997	20-May	7.6	14-Jun	7.0	100
1998	28-May	6.5	23-Jun	5.5	260
1999	31-May	7.2	26-Jun	6.6	108
2000	29-May	6.3	24-Jun	5.7	216
2001	1-Jun	6.2	26-Jun	5.5	77
2002	24-May	7.5	19-Jun	6.6	163
2003	22-May	8.2	16-Jun	7.5	56
2004	18-May	8.5	12-Jun	7.9	101
2005	23-May	6.9	17-Jun	6.6	148
2006	29-May	6.5	24-Jun	5.7	123
2007	22-May	7.1	17-Jun	6.1	147
2008	27-May	5.9	21-Jun	5.3	103
2009	29-May	7.7	24-Jun	6.7	202
2010	25-May	7.9	20-Jun	7.0	134
2011	25-May	6.2	20-Jun	5.6	50
2012	3-Jun	5.7	30-Jun	5.3	37
2013	1-Jun	5.9	28-Jun	5.2	99
2014	21-May	8.3	16-Jun	7.7	110
2015	21-May	6.1	16-Jun	5.5	119
2016	16-May	7.0	11-Jun	6.9	75
Mean	26-May	1.3	21-Jun	1.3	

Table 4. Continued

Tundra Swan

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	2-Jun	10.1	5-Jul	9.6	11
1983	19-May	6.3	24-Jun	6.5	11
1984	23-May	10.2	26-Jun	9.7	9
1985	31-May	8.0	4-Jul	7.0	14
1986	25-May	8.7	28-Jun	8.6	24
1987	27-May	7.1	30-Jun	6.5	12
1988	23-May	11.9	26-Jun	10.6	5
1989	27-May	3.2	2-Jul	2.7	4
1990	22-May	4.1	24-Jun	3.6	4
1991	21-May	9.8	25-Jun	9.5	12
1992	29-May	9.0	1-Jul	8.8	9
1993	22-May	7.4	26-Jun	7.7	6
1994	18-May	8.7	22-Jun	7.5	9
1995	23-May	4.6	26-Jun	4.7	9
1996	17-May	8.4	20-Jun	9.3	9
1997	18-May	7.6	21-Jun	5.8	13
1998	28-May	8.4	1-Jul	7.7	20
1999	29-May	7.1	1-Jul	7.1	14
2000	24-May	8.4	27-Jun	7.6	22
2001	28-May	9.2	1-Jul	9.0	16
2002	22-May	5.2	26-Jun	4.9	10
2003	13-May	7.2	18-Jun	6.5	21
2004	14-May	8.1	20-Jun	7.7	16
2005	21-May	7.9	23-Jun	6.8	18
2006	29-May	6.0	1-Jul	6.9	14
2007	21-May	7.2	24-Jun	6.7	19
2008	26-May	6.2	29-Jun	5.3	19
2009	29-May	7.7	2-Jul	6.6	19
2010	23-May	8.3	27-Jun	8.5	14
2011	24-May	7.6	28-Jun	6.9	20
2012	3-Jun	5.3	7-Jul	4.9	6
2013	29-May	4.5	5-Jul	4.7	9
2014	12-May	9.6	21-Jun	7.0	20
2015	14-May	8.0	23-Jun	7.6	27
2016	6-May	6.2	15-Jun	6.8	20
Mean	23-May	1.7	27-Jun	1.4	

Sandhill Crane

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	24-May	2.0	24-Jun	2.0	4
1983	23-May	11.9	22-Jun	11.5	21
1984	19-May	4.5	20-Jun	8.5	9
1985	30-May	7.0	30-Jun	6.6	13
1986	27-May	8.8	26-Jun	9.3	26
1987	25-May	8.6	24-Jun	8.4	16
1988	20-May	4.4	20-Jun	4.4	6
1989	19-May	3.3	19-Jun	3.3	2
1990	19-May	4.4	18-Jun	4.5	9
1991	16-May	7.1	16-Jun	7.0	25
1992	30-May	5.2	30-Jun	5.2	11
1993	19-May	4.6	19-Jun	4.8	14
1994	14-May	2.1	14-Jun	2.6	5
1995	18-May	9.0	17-Jun	8.7	10
1996	15-May	5.9	15-Jun	5.8	14
1997	15-May	7.3	14-Jun	7.2	8
1998	21-May	4.5	20-Jun	4.5	19
1999	23-May	4.9	23-Jun	4.5	12
2000	20-May	7.1	20-Jun	7.0	22
2001	21-May	2.5	20-Jun	1.9	7
2002	19-May	10.5	19-Jun	10.5	12
2003	13-May	9.6	13-Jun	9.6	13
2004	16-May	6.8	16-Jun	6.5	10
2005	15-May	6.4	15-Jun	6.4	23
2006	23-May	8.9	23-Jun	8.5	19
2007	12-May	7.8	12-Jun	7.8	16
2008	21-May	4.3	21-Jun	4.2	12
2009	23-May	8.8	23-Jun	8.9	20
2010	18-May	5.3	18-Jun	5.5	17
2011	20-May	9.8	20-Jun	9.4	14
2012	26-May	10.7	27-Jun	10.3	7
2013	25-May	7.7	27-Jun	8.1	7
2014	16-May	10.6	18-Jun	10.5	14
2015	11-May	5.8	13-Jun	5.5	26
2016	10-May	8.4	11-Jun	8.3	21
Mean	20-May	1.4	20-Jun	1.3	

Table 4. Continued

Spectacled Eider

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	13-Jun	9.4	8-Jul	5.2	18
1983	28-May	12.3	24-Jun	11.6	35
1984	6-Jun	9.1	30-Jun	8.8	9
1985	7-Jun	9.0	4-Jul	7.6	20
1986	8-Jun	10.7	3-Jul	9.0	38
1987	31-May	8.2	28-Jun	7.4	28
1988	30-May	6.8	27-Jun	7.0	19
1989	4-Jun	10.6	2-Jul	9.0	5
1990	26-May	5.4	23-Jun	4.9	15
1991	24-May	10.1	22-Jun	9.3	25
1992	4-Jun	7.5	3-Jul	6.0	18
1993	28-May	7.1	24-Jun	7.3	18
1994	27-May	13.0	23-Jun	11.2	15
1995	26-May	8.0	24-Jun	7.3	44
1996	22-May	7.1	19-Jun	6.9	33
1997	23-May	8.1	19-Jun	7.2	39
1998	31-May	8.6	28-Jun	7.4	52
1999	31-May	10.3	28-Jun	9.7	51
2000	31-May	8.2	29-Jun	8.0	52
2001	6-Jun	8.8	3-Jul	6.7	32
2002	24-May	7.4	22-Jun	6.5	59
2003	26-May	11.0	22-Jun	10.1	36
2004	19-May	10.3	16-Jun	9.3	57
2005	24-May	9.2	20-Jun	8.7	101
2006	1-Jun	9.4	29-Jun	8.5	78
2007	26-May	8.8	23-Jun	8.0	68
2008	27-May	10.2	24-Jun	9.3	73
2009	30-May	9.2	26-Jun	8.3	124
2010	24-May	7.5	21-Jun	6.8	71
2011	28-May	10.1	25-Jun	9.0	50
2012	3-Jun	7.5	2-Jul	6.9	47
2013	3-Jun	8.1	2-Jul	6.5	42
2014	20-May	12.1	18-Jun	10.6	88
2015	24-May	11.5	22-Jun	9.7	73
2016	19-May	12.9	17-Jun	11.3	77
Mean	29-May	1.7	26-Jun	1.5	

Common Eider

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	11-Jun	3.0	9-Jul	1.4	4
1983	29-May	5.6	26-Jun	6.2	3
1984	--	--	--	--	0
1985	--	--	--	--	0
1986	--	--	--	--	0
1987	1-Jun	5.3	29-Jun	5.7	10
1988	--	--	--	--	1
1989	2-Jun	7.4	2-Jul	6.1	4
1990	23-May	3.3	22-Jun	2.1	3
1991	28-May	5.9	26-Jun	5.7	27
1992	4-Jun	6.2	3-Jul	5.3	12
1993	25-May	5.4	24-Jun	5.2	5
1994	26-May	10.1	24-Jun	9.2	9
1995	25-May	11.2	23-Jun	10.7	13
1996	22-May	11.1	20-Jun	10.5	14
1997	22-May	9.4	19-Jun	8.0	15
1998	30-May	6.8	28-Jun	6.2	18
1999	2-Jun	9.5	30-Jun	9.8	12
2000	1-Jun	5.8	30-Jun	4.9	23
2001	2-Jun	7.6	30-Jun	7.0	23
2002	25-May	7.7	24-Jun	6.8	17
2003	25-May	12.1	22-Jun	10.8	16
2004	21-May	9.5	18-Jun	8.7	18
2005	21-May	8.4	19-Jun	8.2	34
2006	2-Jun	7.7	1-Jul	6.8	52
2007	22-May	7.2	21-Jun	6.9	50
2008	27-May	7.4	25-Jun	6.8	34
2009	28-May	5.7	26-Jun	5.5	33
2010	26-May	5.7	24-Jun	5.4	41
2011	25-May	7.6	23-Jun	6.4	10
2012	2-Jun	4.1	2-Jul	4.0	7
2013	1-Jun	6.4	2-Jul	6.0	21
2014	18-May	13.9	18-Jun	12.4	37
2015	20-May	10.2	20-Jun	9.6	24
2016	18-May	14.6	17-Jun	12.1	51
Mean	27-May	1.7	25-Jun	1.6	

Table 4. Continued

Glaucous Gull

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	11-Jun	8.0	5-Jul	6.2	23
1983	28-May	10.4	21-Jun	9.9	19
1984	30-May	4.8	25-Jun	9.7	8
1985	8-Jun	6.1	3-Jul	6.3	23
1986	2-Jun	8.0	27-Jun	7.4	19
1987	3-Jun	8.4	28-Jun	8.1	19
1988	29-May	8.9	23-Jun	9.1	9
1989	28-May	0.0	22-Jun	0.0	3
1990	24-May	2.5	19-Jun	4.1	3
1991	24-May	7.2	18-Jun	7.3	26
1992	3-Jun	5.9	27-Jun	5.6	24
1993	26-May	9.9	20-Jun	9.4	11
1994	23-May	7.5	17-Jun	7.0	17
1995	24-May	4.2	17-Jun	4.4	17
1996	22-May	4.3	15-Jun	4.2	15
1997	23-May	8.8	17-Jun	8.2	19
1998	28-May	7.5	22-Jun	7.2	64
1999	2-Jun	9.5	26-Jun	9.1	25
2000	29-May	8.8	23-Jun	8.6	72
2001	31-May	7.9	24-Jun	7.9	50
2002	23-May	7.7	17-Jun	7.4	56
2003	20-May	7.8	13-Jun	7.4	58
2004	17-May	7.2	11-Jun	7.0	21
2005	20-May	8.0	14-Jun	7.7	69
2006	31-May	8.6	25-Jun	8.3	46
2007	22-May	7.2	15-Jun	7.1	76
2008	27-May	7.2	21-Jun	6.8	67
2009	29-May	7.7	23-Jun	7.6	59
2010	27-May	9.1	20-Jun	8.5	28
2011	27-May	9.1	21-Jun	8.5	23
2012	4-Jun	11.0	29-Jun	9.9	8
2013	4-Jun	8.2	29-Jun	7.3	37
2014	21-May	8.5	15-Jun	7.9	73
2015	22-May	8.6	17-Jun	8.2	78
2016	17-May	9.3	11-Jun	9.0	87
Mean	27-May	1.7	21-Jun	1.6	

Mew Gull

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	17-Jun	4.6	10-Jul	1.9	11
1983	30-May	11.3	23-Jun	11.0	9
1984	--	--	--	--	2
1985	11-Jun	7.2	4-Jul	6.4	8
1986	7-Jun	13.0	2-Jul	10.6	18
1987	2-Jun	8.5	26-Jun	7.4	8
1988	25-May	7.1	19-Jun	6.5	4
1989	--	--	--	--	1
1990	28-May	7.4	22-Jun	7.4	2
1991	26-May	7.6	20-Jun	8.1	8
1992	4-Jun	5.1	28-Jun	4.9	10
1993	31-May	9.3	24-Jun	8.9	7
1994	21-May	6.4	15-Jun	6.1	8
1995	24-May	3.3	18-Jun	3.5	16
1996	21-May	6.0	15-Jun	5.5	10
1997	25-May	5.7	19-Jun	5.7	8
1998	30-May	7.0	24-Jun	6.5	19
1999	1-Jun	9.1	25-Jun	8.8	25
2000	2-Jun	8.4	26-Jun	8.0	17
2001	2-Jun	8.7	27-Jun	8.2	18
2002	22-May	8.3	16-Jun	8.0	40
2003	23-May	8.3	17-Jun	8.1	20
2004	21-May	4.4	14-Jun	3.9	19
2005	26-May	8.9	19-Jun	8.5	32
2006	2-Jun	9.3	26-Jun	9.1	45
2007	24-May	8.3	18-Jun	7.8	32
2008	27-May	7.2	20-Jun	6.9	42
2009	30-May	7.4	24-Jun	7.2	54
2010	26-May	5.4	20-Jun	5.1	44
2011	30-May	7.9	23-Jun	8.1	18
2012	4-Jun	5.8	29-Jun	4.9	13
2013	2-Jun	6.0	28-Jun	5.8	24
2014	22-May	8.6	17-Jun	8.7	23
2015	23-May	7.9	17-Jun	7.4	39
2016	19-May	10.1	13-Jun	9.3	48
Mean	29-May	1.9	22-Jun	1.8	

Table 4. Continued

Sabine's Gull

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	--	--	--	--	1
1983	28-May	11.9	21-Jun	13.0	3
1984	--	--	--	--	0
1985	9-Jun	12.7	2-Jul	9.7	3
1986	31-May	11.2	24-Jun	10.1	7
1987	28-May	10.1	21-Jun	9.1	7
1988	1-Jun	9.6	25-Jun	9.1	8
1989	7-Jun	16.5	1-Jul	15.6	2
1990	--	--	--	--	0
1991	22-May	5.5	15-Jun	5.9	9
1992	--	--	--	--	0
1993	24-May	5.8	17-Jun	5.6	8
1994	18-May	6.6	11-Jun	5.4	6
1995	25-May	9.8	18-Jun	8.6	6
1996	18-May	5.4	12-Jun	4.7	3
1997	21-May	6.7	14-Jun	6.9	8
1998	28-May	10.1	21-Jun	9.4	11
1999	27-May	7.2	20-Jun	7.4	20
2000	30-May	9.8	23-Jun	9.8	7
2001	3-Jun	6.6	27-Jun	6.4	10
2002	21-May	8.4	14-Jun	8.2	28
2003	19-May	7.7	12-Jun	7.5	5
2004	17-May	13.2	10-Jun	12.0	3
2005	23-May	9.7	16-Jun	9.3	30
2006	28-May	3.9	22-Jun	3.7	23
2007	24-May	8.9	17-Jun	8.2	30
2008	25-May	7.0	18-Jun	6.7	17
2009	29-May	10.0	22-Jun	9.6	17
2010	22-May	3.0	15-Jun	2.6	20
2011	24-May	3.8	17-Jun	4.0	40
2012	1-Jun	5.2	26-Jun	4.8	14
2013	2-Jun	5.4	27-Jun	5.6	21
2014	20-May	12.6	14-Jun	11.7	33
2015	22-May	9.6	15-Jun	9.8	35
2016	19-May	12.2	13-Jun	11.8	17
Mean	26-May	1.8	19-Jun	1.7	

Arctic Tern

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	--	--	--	--	0
1983	--	--	--	--	0
1984	--	--	--	--	0
1985	6-Jun	6.1	29-Jun	5.7	8
1986	3-Jun	14.7	26-Jun	13.7	6
1987	1-Jun	4.7	24-Jun	4.7	3
1988	2-Jun	0.8	25-Jun	0.0	2
1989	--	--	--	--	1
1990	--	--	--	--	1
1991	24-May	4.8	17-Jun	4.8	4
1992	8-Jun	8.6	2-Jul	8.1	6
1993	23-May	2.8	17-Jun	3.9	3
1994	--	--	--	--	1
1995	23-May	4.7	16-Jun	5.1	3
1996	--	--	--	--	1
1997	--	--	--	--	0
1998	3-Jun	10.5	26-Jun	10.0	5
1999	2-Jun	5.2	26-Jun	5.1	8
2000	3-Jun	4.8	26-Jun	4.8	5
2001	29-May	7.7	22-Jun	8.2	5
2002	25-May	6.2	18-Jun	5.8	37
2003	21-May	7.8	13-Jun	7.2	5
2004	25-May	11.5	17-Jun	10.9	9
2005	28-May	8.1	21-Jun	7.7	15
2006	30-May	5.9	23-Jun	5.7	17
2007	23-May	7.5	16-Jun	7.3	18
2008	28-May	7.9	21-Jun	7.5	16
2009	2-Jun	7.5	26-Jun	7.4	30
2010	30-May	8.8	22-Jun	8.5	9
2011	31-May	9.6	24-Jun	9.4	19
2012	3-Jun	7.4	28-Jun	7.0	14
2013	31-May	8.7	24-Jun	7.9	20
2014	21-May	7.2	15-Jun	7.3	27
2015	25-May	8.6	18-Jun	8.3	24
2016	22-May	11.8	15-Jun	11.4	19
Mean	29-May	1.6	22-Jun	1.6	

Table 4. Continued

Pacific Loon, Red-throated Loon

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	13-Jun	7.7	8-Jul	3.7	25
1983	2-Jun	11.7	29-Jun	9.9	16
1984	5-Jun	6.3	3-Jul	6.3	5
1985	12-Jun	10.9	7-Jul	6.7	15
1986	8-Jun	9.3	5-Jul	6.2	38
1987	5-Jun	6.5	3-Jul	5.9	35
1988	31-May	11.2	28-Jun	11.7	5
1989	5-Jun	12.3	2-Jul	10.4	5
1990	3-Jun	6.8	1-Jul	6.6	11
1991	30-May	7.1	26-Jun	6.9	21
1992	9-Jun	7.0	6-Jul	4.8	15
1993	28-May	6.9	25-Jun	6.6	12
1994	27-May	6.0	24-Jun	5.7	6
1995	29-May	5.7	26-Jun	5.4	10
1996	27-May	7.2	23-Jun	7.3	9
1997	25-May	6.6	22-Jun	6.5	17
1998	3-Jun	8.5	30-Jun	8.0	37
1999	5-Jun	8.6	3-Jul	8.1	48
2000	3-Jun	7.8	1-Jul	7.7	40
2001	6-Jun	8.4	4-Jul	7.2	27
2002	29-May	6.2	26-Jun	5.9	42
2003	27-May	8.9	24-Jun	9.0	14
2004	27-May	9.7	24-Jun	9.4	10
2005	30-May	10.3	27-Jun	10.0	42
2006	5-Jun	4.1	2-Jul	4.0	22
2007	27-May	7.1	24-Jun	7.3	31
2008	1-Jun	8.5	29-Jun	8.1	46
2009	4-Jun	8.4	1-Jul	7.9	35
2010	31-May	6.4	28-Jun	6.2	28
2011	1-Jun	7.6	29-Jun	7.4	29
2012	5-Jun	9.7	4-Jul	9.1	7
2013	6-Jun	5.7	6-Jul	5.1	28
2014	22-May	9.5	20-Jun	9.0	25
2015	26-May	10.4	25-Jun	9.6	47
2016	22-May	11.4	20-Jun	10.7	22
Mean	1-Jun	1.5	29-Jun	1.4	

Long-tailed Duck

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	18-Jun	5.8	10-Jul	0.0	5
1983	--	--	--	--	1
1984	--	--	--	--	1
1985	--	--	--	--	1
1986	7-Jun	5.9	9-Jul	3.4	4
1987	6-Jun	6.7	7-Jul	5.4	4
1988	--	--	--	--	1
1989	--	--	--	--	1
1990	8-Jun	4.9	7-Jul	1.6	2
1991	26-May	6.6	28-Jun	7.4	2
1992	7-Jun	6.3	8-Jul	5.4	21
1993	2-Jun	5.7	2-Jul	3.3	18
1994	2-Jun	3.8	2-Jul	1.4	7
1995	3-Jun	7.9	3-Jul	8.7	14
1996	31-May	11.7	29-Jun	9.3	7
1997	27-May	10.4	27-Jun	10.0	10
1998	2-Jun	7.5	4-Jul	6.4	14
1999	8-Jun	8.0	8-Jul	3.9	10
2000	5-Jun	5.5	7-Jul	5.2	26
2001	11-Jun	8.1	7-Jul	4.0	6
2002	31-May	6.0	1-Jul	2.3	8
2003	30-May	3.6	30-Jun	1.3	3
2004	22-May	8.2	21-Jun	3.3	2
2005	1-Jun	9.4	1-Jul	7.1	9
2006	3-Jun	6.4	5-Jul	5.2	5
2007	2-Jun	5.0	2-Jul	2.5	5
2008	--	--	--	--	1
2009	3-Jun	9.5	3-Jul	8.1	7
2010	29-May	10.0	29-Jun	10.9	6
2011	29-May	5.8	1-Jul	5.3	4
2012	8-Jun	2.5	9-Jul	0.8	2
2013	1-Jun	8.8	6-Jul	7.4	6
2014	23-May	15.3	24-Jun	9.4	4
2015	--	--	--	--	1
2016	25-May	12.5	26-Jun	9.5	4
Mean	2-Jun	1.8	3-Jul	1.5	

Table 4. Continued

Pintail, Mallard, Shoveler, Teal, Greater Scaup

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	--	--	--	--	1
1983	--	--	--	--	1
1984	10-Jun	3.3	8-Jul	5.8	2
1985	13-Jun	6.6	8-Jul	3.3	2
1986	6-Jun	11.6	4-Jul	9.0	13
1987	6-Jun	13.2	3-Jul	10.5	12
1988	3-Jun	4.9	2-Jul	4.1	2
1989	9-Jun	6.4	6-Jul	4.3	4
1990	1-Jun	7.8	28-Jun	5.6	4
1991	27-May	11.1	24-Jun	10.7	13
1992	7-Jun	10.9	5-Jul	8.0	18
1993	1-Jun	6.1	28-Jun	2.7	16
1994	31-May	5.8	28-Jun	2.4	5
1995	1-Jun	14.9	27-Jun	11.5	11
1996	28-May	13.2	26-Jun	11.4	10
1997	20-May	7.6	17-Jun	4.7	4
1998	4-Jun	8.2	1-Jul	6.9	39
1999	3-Jun	10.2	2-Jul	8.2	17
2000	3-Jun	7.9	1-Jul	6.3	28
2001	5-Jun	4.2	2-Jul	3.7	13
2002	28-May	13.8	24-Jun	9.8	21
2003	22-May	10.0	20-Jun	10.0	8
2004	21-May	12.4	19-Jun	10.8	19
2005	27-May	12.3	23-Jun	10.3	24
2006	4-Jun	9.1	1-Jul	7.9	15
2007	25-May	8.7	22-Jun	7.0	17
2008	30-May	11.1	27-Jun	8.5	21
2009	31-May	8.5	28-Jun	6.9	16
2010	27-May	8.5	24-Jun	6.6	18
2011	28-May	7.4	26-Jun	4.9	6
2012	4-Jun	6.7	3-Jul	5.6	4
2013	7-Jun	9.5	5-Jul	7.2	16
2014	27-May	12.0	25-Jun	9.5	17
2015	29-May	10.8	26-Jun	9.1	12
2016	23-May	12.0	20-Jun	10.6	16
Mean	31-May	1.7	28-Jun	1.6	

Shorebirds

Year	Mean Initiation	90% CI (days)	Mean Hatch	90% CI (days)	n (nests)
1982	--	--	--	--	1
1983	--	--	--	--	0
1984	--	--	--	--	3
1985	13-Jun	12.9	3-Jul	11.6	4
1986	1-Jun	13.3	27-Jun	9.6	23
1987	28-May	5.9	21-Jun	4.7	7
1988	24-May	1.6	18-Jun	1.6	2
1989	1-Jun	12.8	24-Jun	11.7	3
1990	1-Jun	7.4	26-Jun	7.4	2
1991	28-May	12.2	22-Jun	11.9	21
1992	3-Jun	4.0	28-Jun	4.2	11
1993	27-May	7.1	21-Jun	6.9	15
1994	25-May	9.9	19-Jun	9.0	2
1995	26-May	7.6	19-Jun	7.6	6
1996	27-May	13.7	20-Jun	13.9	10
1997	19-May	3.6	12-Jun	3.4	3
1998	29-May	8.3	22-Jun	7.3	8
1999	31-May	7.0	25-Jun	6.9	17
2000	30-May	7.2	24-Jun	6.4	13
2001	2-Jun	8.3	27-Jun	8.1	22
2002	25-May	5.7	19-Jun	5.8	21
2003	21-May	2.8	15-Jun	2.8	3
2004	20-May	5.9	13-Jun	6.1	10
2005	26-May	7.3	20-Jun	6.7	30
2006	2-Jun	9.0	26-Jun	8.1	29
2007	24-May	7.5	18-Jun	7.2	33
2008	26-May	8.3	20-Jun	7.8	53
2009	1-Jun	8.2	26-Jun	8.0	23
2010	27-May	9.2	21-Jun	8.9	29
2011	25-May	5.9	19-Jun	5.8	26
2012	3-Jun	8.8	29-Jun	8.1	27
2013	1-Jun	4.5	26-Jun	5.0	13
2014	17-May	10.4	12-Jun	9.8	7
2015	22-May	5.7	17-Jun	5.5	9
2016	19-May	8.5	13-Jun	8.2	27
Mean	28-May	1.6	21-Jun	1.5	

Table 5. Numbers and proportions of plots with recent fox sign (observed fox, scat, fur, tracks, and/or active dens) and vole sign (observed voles, digging, runways), 1988-2016.

Year	Number Plots Sampled	Number Plots with Fox Sign	Number Plots with Vole Sign	Proportion of Plots with Fox Sign	Proportion of Plots with Recent Vole Sign
1988	26	15	10	0.58	0.38
1989	20	8	8	0.40	0.40
1990	30	13	16	0.43	0.53
1991	33	7	12	0.21	0.36
1992	41	15	9	0.37	0.22
1993	45	7	8	0.16	0.18
1994	38	6	4	0.16	0.11
1995	48	21	14	0.44	0.29
1996	44	20	15	0.45	0.34
1997	72	25	18	0.35	0.25
1998	62	21	21	0.34	0.34
1999	53	24	20	0.45	0.38
2000	79	24	62	0.30	0.78
2001	80	71	31	0.89	0.39
2002	84	50	19	0.60	0.23
2003	83	69	44	0.83	0.53
2004	81	53	16	0.65	0.20
2005	83	46	10	0.55	0.12
2006	74	44	11	0.59	0.15
2007	79	26	26	0.33	0.33
2008	82	58	33	0.71	0.40
2009	81	33	58	0.41	0.72
2010	66	28	38	0.42	0.58
2011	82	45	11	0.55	0.13
2012	77	33	10	0.43	0.13
2013	59	25	16	0.42	0.27
2014	76	46	20	0.61	0.26
2015	72	43	14	0.60	0.19
2016	67	32	18	0.48	0.27
Mean	63	31	20	0.47	0.33